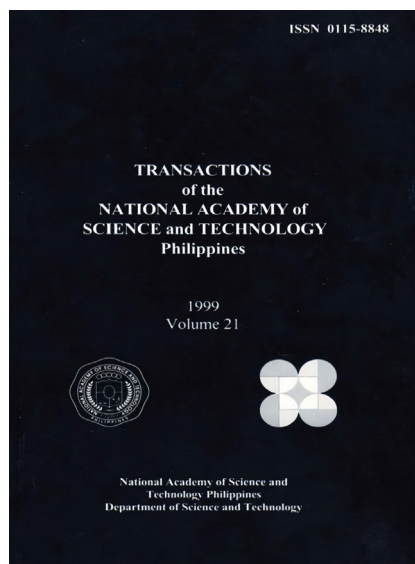


Transactions NAST PHL, is the official journal of the National Academy of Science and Technology Philippines. It has traditionally published papers presented during the Academy's Annual Scientific Meeting since 1979 to promote science-based policy discussions of and recommendations on timely and relevant national issues as part of its functions as a national science academy. Starting in 2021, this journal has been open to contributions from the global scientific community in all fields of science and technology.



Carrying Capacity: Food Production

Leonardo A. Gonzales

Founding President, SIKAP/STRIVE Foundation
Barangay Putho-Tuntungin, Los Baños, Laguna 4031

Citation

Gonzales LA. 1999. Carrying capacity: Food production. Transactions NAST PHL 21: 1-59. doi.org/10.57043/transnastphl.1999.5715

Copyright

© 1999 Gonzales LA

CARRYING CAPACITY: FOOD PRODUCTION

The Philippines and Selected Asian Countries

LEONARDO A. GONZALES

Founding President, SIKAP/STRIVE Foundation
Barangay Putho-Tuntungin, Los Baños, Laguna 4031
strive@lgn.csi.com.ph

ABSTRACT

This paper reviewed and analyzed the indicators of carrying capacity within the context of the globe, Asia and the Philippines. It also extended the application of the methodology on subsistence level carrying capacity in the rice and corn producing sectors of the Philippines.

Given the dynamic and complex and nature of the population-natural resource/environment-development interactions, the paper recommends six imperatives that can assist the Philippines and Asian countries in dealing with the carrying-capacity issue. These include among others:

1. Creation of a Futures Center to coordinate futures oriented studies
2. Emphasis on the role of technology in alleviating poverty;
3. Incorporation of the carrying-capacity methodologies into the main stream of development/planning, policy analysis and formulation;
4. Setting up congruent policies related to carrying-capacity and the economy;
5. Development of an integrative development framework that can link the complex and dynamic interactions of carrying-capacity factors with the other determinants of sustainable human and national development; and
6. Special role of political governance to provide the political will in efficiently implementing administrative and legislative reforms.

Keywords: carrying capacity, population, demographics, food production, rice, corn, Philippines

1. INTRODUCTION

One of the most pressing, if not the most important issue confronting us today is food security. In fact, Lester Brown of the Worldwatch Institute argued that food scarcity will be the defining issue of the coming new era.

As early as the 1970s, one big question raised in "Probing our Futures: The Philippines 2000 A.D." posed a challenge to many: "Since the food problem is already critical today, will the world's seven billion people in year 2000 be adequately fed?" The study went on further to answer YES, if two considerations are met – food production triples and resources are more equitably distributed.

To respond to the challenge of emerging food crisis, the United Nations World Food Council pledged in 1974 to: "Create a world without hunger, a world in which no child would go hungry, no family needs fear its next day's bread, and no human being's future would be stunted by malnutrition."

We have seen through the past years how modern agricultural technology has somehow multiplied food production and eased the burden of hunger. However, the last two decades also showed that there is a growing imbalance between food and people. Everyday, some 219,000 people are added to the world's population (WHO, 1998). More so, there are almost one billion people in the world who go to bed hungry, who simply lack the means to purchase enough food (UNDP, 1995). The World Health Report also cited that among these people, around 19,000 among them, mostly infants and children die daily because of hunger and malnutrition.

But feeding these hungry people and the rest of the world's population does not only involve producing food. Man's prodigious need for food contributed to deforestation, soil degradation and species loss. The recent study of the Worldwatch Institute, "Beyond Malthus: Sixteen Dimensions of the Population Problem," revealed that the unbridled population growth, combined with the rising individual consumption, is pushing our claims on the planet beyond its natural limits. After nearly four decades of unprecedented expansion in both land-based and oceanic food supplies, the world is experiencing a massive loss of momentum.

People require at least 2,200 calories a day for metabolism and basic activities. Apparently, to meet these requirements, more food must be produced to respond to the need of the rising population. To produce more food, more resources are required. The combined effects of intensification and extensification, as estimated by the World Resources Institute (WRI, 1993), are that agricultural activities have removed about 15 percent of organic carbon from the world's soil. Some 70,000 sq. km. of farmland are being abandoned each year because of soil exhaustion (Preston, 1995).

In facing the challenge of food scarcity, Lester Brown's *Tough Choices* (1996) argued that the world is faced with at least six new constraints:

- The backlog of unused agricultural technology is shrinking, leaving the more progressive farmers fewer agronomic options for expanding output.
- Growing human demands are pressing against the limits of fisheries and the crop sector to supply beef, mutton, and milk.
- Demands for water are pressing against the limits of the hydrological cycle to supply irrigation water in key food growing regions.
- In many countries, the use of additional fertilizer on currently available crop varieties has little or no effect on yields

- Countries are already densely populated when they begin to industrialize risk losing cropland at a rate that exceeds the rise of land productivity, initiating a long-term decline in food production
- Social disintegration, often fed by rapid population growth and environmental degradation, is undermining many national governments and their efforts to expand food production.

Cognizant of this global problem, the international community, has held at least four international summits (during the 90s) to tackle and draw out solutions to these emerging global concerns—particularly that of food-population-environment problems. These summits include: The Earth Summit of 1992 or the UN Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil; the International Conference on Population and Development (ICPD) in 1994 held in Cairo, Egypt; the World Summit for Social Development in 1995, in Copenhagen, Denmark; and the World Food Summit in 1996, held in Rome, Italy.

These past global summits all pointed out the urgent message for the need to reverse the negative current development trends in the world today, due to the interactions of population, environment, food (aqua-cultural) production and urbanization.

The world is indeed faced with a tough challenge of meeting the food requirements of the next generation without sacrificing mother earth. But we either **have to choose between the reproductive rights of the current generation and the survival rights of the next generation.**

This paper deals with the salient issues that await us all as we enter into the new millennium, particularly that of food-population-resources-environment problems. The objectives of this paper are:

1. To present the global development trends related to the environment, population, resources and food production;
2. To review the population/land carrying capacity methodology and compare selected carrying capacity indicators of the Philippines with other Asian countries; and
3. To recommend policy imperatives that can assist the Philippine and Asian countries in dealing with food carrying capacity.

2. CARRYING CAPACITY: THE BOTTOMLINE FOR POPULATION, RESOURCES, ENVIRONMENT AND DEVELOPMENT

Over the years, scientists have attempted several times to develop frameworks and models for examining the complex and dynamic relationship between population and the environment. The basic perspective probably was developed by Human Ecology through the works of Hawley (1950) and Duncan (1964). The basic assumption was that population constantly interacts with and adapt to their environments. This two-way adaptation is mediated by some form of organizations and technology. In

human ecology, this paradigm is known as population, organization, environment and technology or POET (Ness, 1994). However, despite the POET's paradigm, Ness further argued that there is no simple and direct relationship between population and environment. Identifiable forms of technology and social organizations mediate impact in both directions. It is only through this that either population or environment affect one another.

1.1 Defining Carrying Capacity

Biologists often apply the concept of "carrying capacity" to questions of population pressures on the environment. Carrying capacity is the largest number of any given species that a habitat can support indefinitely. When that maximum population level is surpassed, the resource base begins to decline—and sometime thereafter, so does the population (Postel, 1994).

An economist's perspective, Srinivasan (1988) viewed carrying capacity as the maximum population that can be sustained indefinitely in the future. But from the point of view of environmentalists Nebel and Wright (1998), the concept of carrying capacity refers to the number of a species that can be supported indefinitely without degrading the environment. They added that for human societies, it means the ability to meet food needs over the long term—that is, sustainably.

On the other hand, Brown (1994) cited that the earth's carrying capacity is shown by its capability to provide and sustain the basic needs of the present and future generation. He added that we are all depending on a finite environment where resources are easily depleted with an unabated use, hence the challenge lies on meeting present and future needs through sustainable resource utilization.

Biologist Garret Hardin, as cited by Nebel and Wright (1998), expressed that if ecology had a decalogue, the first commandment would be "Thou shall not transgress the carrying capacity."

2.3 Recent Developments and Models of Carrying Capacity*

2.3.1 Recent Developments

Modern thinking on the population-environment relationship reflects some continuity with Malthus' original formulation of population growth and environmental stress. A number of organizational, disciplinary, and methodological developments have both advanced and retarded systematic thinking about the population-environment relationship.

After the Second World War, the major issue that emerged was World Security. This was followed by massive physical reconstruction, which brought the creation of the International Bank for Reconstruction and Development (IBRD), popularly known as the World Bank; the Economic Commission for Europe (ECE) and the Economic Commission for Asia and the Far East (ECAFE).

*Condensed from Ness (1994).

By the 1960s, interest in development had increased considerably, partly legitimized by the agreement that security requires greater international cooperation. Thus, the United Nations Development Programme (UNDP), the Organization for Economic Cooperation and Development (OECD), and the U.S. Agency for International Development (USAID) were born. Later in 1965, when the population issue (family planning) started to emerge, the UN-ECAFE, now the Economic Commission for Asia and the Pacific (ESCAP), was created. This brought about large population programs mainly sponsored by the USAID.

As international population planning programs accelerated in the early 1970s, concerns for environmental degradation appeared in the horizon. This led to the creation of the United Nations Environment Program (UNEP) during the 1972 Stockholm Conference.

Thus, over the past four decades, both population and environment issues have come to occupy important and distinctive positions in the international and national arenas. Disciplinary development in both theory and methodology have paralleled organizational developments.

2.2.2 Theoretical and methodological developments

Demography has occupied the position of a special discipline for more than a century. In the West, it has developed principally within Sociology. During the 1960s, the developments of life tables and population theory which provided tools for population projections played an important role in linking population with other environmental issues. Improvements in observation and analysis technology in both coverage and accuracy have made demography a powerful analytical tool and had great impact on policy.

According to Ness, the theoretical methodological developments in environmental issues are much more difficult to document, primarily because the environment is so many things. It is located in a great variety of scientific disciplines, including agriculture, agronomy, atmospheric sciences, biology, forestry, geography, geology, limnology, meteorology, oceanography, physics, public health and zoology, plus all the social sciences. Each of these disciplines has developed its own specialized set of theories and methods. Each has also established a set of national and international organization that provide a political structure both binding the discipline together and cutting it off from others.

The observation from this near half-century of organizational, theoretical and methodological developments is twofolds. First, all of the individual disciplines have developed great powers of observation and analysis. Further, these analytical powers have often had substantial engineering potential, permitting us to intervene in human and natural processes with deliberate attempts to achieve highly specific goals. Sometimes, those goals have been laudable and sometimes the interrelations have been successful.

Second, however, the power of the disciplines has also made their practitioners unable, and often, unwilling, to attend to relevant developments in other disciplines.

Despite the deep divisions between population and environmental groups and disciplines, it is difficult to deny the relationship between population and environmental conditions in the real world. This empirical intrusion has led to some attempts to link the two in models and frameworks.

2.4 Carrying Capacity Models

There are at least six operational models that can illustrate the relationship between population and the environment. They are summarized below:

- A. Bongaarts 1992. The model estimates the relative impact of population growth, GDP/cap, energy intensity and carbon intensity on CO₂ emissions and global warming. Bongaarts considers the world as a whole, then groups countries according to those with more and less developed economies. For time horizons, Bongaarts looks into the future, from 1985 to 2100.
- B. Clark 1992. The Clark model also deals with the relative impact of population growth, GDP/capita, and energy intensity on CO₂ emissions. His analysis, however, examines the historical development in 12 countries over approximately the past 50 years.
- C. Harrizon 1992. It presents a series of two sector calculations, using Commoner's 1972 Approach. Like Clark, Harrizon examines the relative impact of population growth, consumption, and technology on recent changes in a series of environmental conditions.
- D. Meadows 1992. This is the updated WORLD3 model originally used in the 1972 Club of Rome's Limits to Growth study. It has five sectors, each with a number of indicators, dynamically related to each other with a range of positive and negative feedback loops. The study runs a number of extremely enlightening, different future scenarios.
- E. IIASA. (International Institute of Applied Systems Analysis) presents a multisectoral work suggesting how multi-indicator societal, ecological, and economic subsystems are tied together. From this complex framework, a model of population and environment dynamics was developed specifically for Mauritius.
- F. CIESIN. (Consortium for International Earth Science Information Network) is a multisectoral work for the human dimensions of global environmental change. It parallels the Brethernton "diagram" of atmospheric, oceanic, and terrestrial relations, which gave human activities the single small black box. The new CIESIN framework has been illustratively applied to sea level rise, human migration, and energy consumption.

The first five models are formal statements about population-environment relations, including data and calculations. The first three all attempt to estimate the relative impacts of population growth, technology, and consumption on one single environmental condition. These are all simple models in that they do not consider feedback process or linkages among the conditions that impact the environment. All

of these simple models reflect the basic human ecology proposition that some form of technology and organization mediate all population-environment relationships.

The fourth model is the more sophisticated, multisector dynamic model, WORLD3 used in the Limits to Growth study published in 1972. Meadows et al recently reexamined and slightly revised the model in a new edition. Beyond the Limits (1992).

The fifth is the IIISA model, being applied to Mauritius. This is the most developed of all the models and is probably the most appropriate for the more systematic empirical research on the problem.

The sixth and final model is a sophisticated multi-sector framework, from which we can work out options in specific sectors or arenas. In all of these multisectoral models, we can differentiate both population and environment by a number of characteristics. This will lead to much greater potential in tracing more complex connections.

2.5 Applications of Carrying Capacity (C-C) Models in the Philippines

During the past two decades, two C-C models were undertaken in the Philippines. One was national in scope and the other at a provincial level. The national C-C study was undertaken in 1978 under the "Population Resources Environment and the Philippine Futures (PREPF)", project, implemented jointly by the Development Academy of the Philippines (DAP), University of the Philippines School of Economics (UPSE), and the UP Population Institute (UPPI). The other Philippine C-C model was done in 1988 in the province of Palawan by the group of Dr. Candido Cabrido of the Population/Development Planning and Research Project of the National Economic Development Authority (NEDA). Salient points of these C-C models are discussed below.

2.5.1 Probing our futures: The Philippines 2000 A.D.

This study was perhaps the most pioneering C-C model of the Philippines in trying to project the World Situation and the Philippine Futures by the year 2000 using baseline data of 1975-1977, with the integrated components of population dimensions (fertility, mortality, spatial mobility, labor force and family formation); natural resources; education, nutrition and health; and income distribution. PREPF was a forward looking research that tried to identify not only historical trends and their implications for the future but also a feasible set of alternatives, preferred futures for the next Filipino generation, constrained only by the bias that scenarios of the future should be definite improvements over those of the present.

The major lessons learned from PREPF project was not the absolute accuracy of the projections made but rather the collective research efforts and the independent approach in delving into an exercise of projecting the futures under a Martial Law Regime. It was very "politically constraining" then to undergo into research activities

that might offend the regime. However, the research team of PREPF was able to forge a workable dialogue with the policy-makers at that time.

The recommendations of the PREPF study which are summarized below are still relevant to date.

A. *A Futures Research Center*

PREPF recommends setting up a national office to coordinate futures-oriented studies at the national level. The suggestion must also be broached to other ASEAN governments to consider setting up a similar center for futures-oriented studies at the regional level.

B. *Politics*

B.1 PREPF, in anticipation of the nation-state remaining as the viable international political unit till the year 2000, recommends the development of strong, viable nation-states through programs for political integration, social cohesion, and national development.

B.2 PREPF also anticipates increasing regional cooperation till the year 2000 and thus recommends increasing regional integration among nations.

B.3 Spell out policy packages based on empirical knowledge and the socio-political system.

C. *Population*

Population regulation policies should go hand in hand with a restructuring of the national society towards improving the whole society's quality of life.

D. *Human Resources Development*

D.1 Further studies on the objectives and context of our educational efforts, the efficient curricula, delivery systems, and the democratization of access to education.

D.2 The components of the education supplied should be closely matched to what are demanded. The work of the NMYC-Industrial Board (now TESDA Board) which links vocational training outside the school system to industry should be encouraged and expanded.

D.3 The self-employment assistance program for marginal workers, such as out-of-school youth, should be strengthened.

D.4 Equitable distribution for the opportunities of college education allowing the elite to produce a leadership whose values are consistent with those of society.

D.5 Categories of education (other than the conventional degrees in specific fields) should be demand driven.

E. Energy

E.1 In line with the national policy of self-reliance, policies on energy should be calculated to lessen the dependence on imported fossil fuel by accelerating the development of alternative energy resources (e.g., geothermal, solar, wind, nuclear, etc.) and encouraging the present national thrust towards oil exploration and development.

E.2 An important mechanism which can be used to moderate demand is the price system. Existing policies on price and tax schemes for petroleum products, other energy inputs, and energy-using equipment should be reviewed.

E.3 The growth of the private transport industry, the biggest energy-using sector, should be tempered to support the pollution control policies of the government. The mass transit system, being still the best alternative available to the car-riding public, should be seriously considered.

E.4 The proposal to build additional nuclear power plants to meet part of future power requirements should be re-evaluated in light of the large outlay of money that will be incurred and the dangers involved. Proper harnessing of the country's hydro resources will suffice to meet future power requirements.

F. Trade

F.1 Eliminate or reduce tariff and non-tariff barriers to products from less developed countries.

F.2 Diversify and expand sources of imports and markets for exports. Further develop tourism.

F.3 Encourage the export of labor until such time as the Philippine economy can absorb the labor supply.

F.4 Enhance the spatial mobility of the population, both within the country and abroad.

F.5 More research is needed on what would be a favorable commodity structure for the national economy.

G. Food

G.1 Greater efforts should be made towards the equitable distribution of food resources on both the national and international levels.

G.2 Philippine self-sufficiency in food should be achieved and maintained.

G.3 Health and nutrition programs should stress not only access to food but, more importantly, the mental development of young people.

H. Forestry

H.1 Priority should be given the reforestation of regions which are most deficient in forest cover and where serious water supply problems are occurring or are expected in the near future.

H.2 Multiple-use forest management should be pursued.

I. Fisheries

I.1 Technology diffusion (transfer) in fisheries should be carefully assessed and improved so that fishermen/fish farmers can avail of technological know-how to increase their production. Research on fishing gear technology and fishing boat construction should be pursued.

I.2 A Study of the microeconomics of important fishing gears and their relation to fishery resources in the country's different regions would be most useful.

I.3 One way to improve production is to encourage fishermen to undergo training in proper vessel and gear operation and fish catch handling and preservation. Fishermen's training centers should be put up in strategic regions of the country.

I.4 Extension service for and training of fishermen will have to be planned and implemented to help small-scale fishermen develop skills appropriate for the type of fishery obtaining in their own villages. Fishermen's associations and cooperatives can also help fishermen process and market their catches, and secure bank credit and government subsidy. If fishermen are properly organized, they can undertake fishing ventures on a commercial scale.

2.5.2 The Palawan C-C Model*

The Palawan C-C Model was a research activity under the Population/Development Planning and Research Project (PDPRP) funded by the UNFPA. The major objective of the project was to integrate population with development planning. Under the PDPRP, three methods were developed to assess the population-carrying capacity of Palawan. These were: real demand, effective demand and income subsistence need (Cabrido, 1988).

Cabrido (1988) outlined four general procedures in assessing these three methods. These are:

- a) *Classification of the ecosystems into major and subtypes on vegetation cover slope and dominant land use.* Ecosystems in the study were broadly classified into terrestrial and aquatic. Terrestrial ecosystems were then categorized into agroecosystem, forest ecosystem and urban ecosystem, while aquatic ecosystems were broken down into marine and freshwater categories. All areas considered too steep (30% slope) and marginal lands for crop cultivation were delineated for forestry. Future growth and expansion of urban areas were projected based on present trends and

* Two publications were reviewed for the Palawan C-C Model. These were: Candido Cabrido, Jr. 1988. *Methods for determining the Population-Supporting Capacity of Ecosystems: Palawan Province* NEDA, Manila; Candido Cabrido, Jr. 1994. *Integration of Population Dimension in the Environment and Natural Resources Management Sector: Planning Framework, Tools, Techniques and Illustration Cases.* NEDA, Manila. Needless to say, the discussions on this section were basically taken from these two research reports.

delineated as built-up areas. After deducting forest and urban areas, the remaining areas were assessed according to their land suitability.

- b) *Assessment of the extent, suitability, yield and production of the various ecosystems.* The assessment focused on the lowland agroecosystem, both irrigated and rainfed, and the upland agroecosystem. Areas with slopes of 9% and 30% and elevation of more than 100 meters were considered as uplands. Two crops were studied: rice and corn. Potential grazing lands were likewise considered in the study. For the aquatic ecosystem, the fisheries production of marine, river and lake ecosystems was determined.
- c) *Estimation of the potential net sustainable production of tile agroecosystems under different levels of inputs.* Sustainable production is considered in this study as the production level which will not harm the inherent productivity of the ecosystem (i.e., the rate of resource exploitation is equal to the rate of resource regeneration or renewal either through natural or artificial means). Net sustainable production was calculated by deducting from the sustainable production the amount of losses and wastage brought about by ecological stresses such as drought, flooding, typhoons, pests and diseases, water pollution and sedimentation, and other related factors. Likewise, losses caused by harvesting and post harvesting activities were accounted for.
- d) *Calculation of the human population-carrying capacity of the potential net sustainable production.* Human population-carrying capacity of food was estimated under three separate considerations: real demand, effective demand and subsistence level. As a principle, food production should meet the standards of all three indices. Real demand is the minimum nutritional food requirements of the population whether they can buy it or not. Effective demand is the market demand for a particular type of food. Subsistence level is the level just above the poverty line (or poverty threshold level)—when family income is just adequate to meet its basic needs.

Human population-carrying capacity in terms of real demand was calculated by deriving the calorie and protein values of the total output of food products, and dividing this with the calorie and protein requirements of the population.

Human population-carrying capacity in terms of effective demand was computed by determining the actual per capita consumption (in kilogram per unit time) of a particular food product, and using this figure to divide the total volume (i.e., net sustainable production) of the particular food product.

Human population-carrying capacity in terms of subsistence level was estimated by dividing the net income obtained from the sustainable production by the family's consumption cost, plus an allowance of 10-15

percent for savings. A positive ratio of one indicates that subsistence level is met. The subsistence level is established by using the poverty threshold level.

After assessing the income population-carrying capacity, the optimum population size, optimum population density and optimum farm size were determined. On the other hand, the results of the food population-carrying capacity determination provided the optimum crops (i.e., high energy crops) that are most ideal to grow in an area.

Some of the empirical findings of the Cabrido study include an estimation of the net sustainable production of lowland agroecosystems (Table 2.1) of Palawan; The sustainable population size and density and sustainable farm size for the different agroecosystems (Table 2.2); Existing and population ceilings of the different agroecosystems (Table 2.3) and Population-supporting capacity of the agroecosystems in terms of real and effective demand (Table 2.4)

The calculations were also made for the rangeland and aquatic ecosystems. From this comprehensive study, Cabrido concluded the following:

- a) Real demand and income population-supporting capacity are useful in monitoring agroeconomic and agroecological conditions, since they provide reliable indicators of the population of a certain area.
- b) When the income supporting capacity is met while real demand lags behind this could mean any or several of the following: low production of food crops, high consumption (population growth rate exceeds population growth), high government subsidy, and/or shift from food to cash/commercial crops. In this regard, there is a need to examine the existing policies/laws on food production, zoning and agricultural land use conversion.
- c) Population-carrying capacity depends on the level of technology and management of inputs.
- d) The results of the study indicate that the retention limit imposed by the Comprehensive Agrarian Reform Program (CARP) may create social inequities in some areas.
- e) The income-population-carrying capacity of the lake and river ecosystems of Palawan is inadequate to sustain its present populations.
- f) Overall, the aquatic ecosystem of Palawan has vast potential for supporting its projected population.
- g) The accuracy of the results of the income population carrying capacity assessment depends greatly on the accuracy of farm budget data.
- h) Palawan's uplanders could not be able to subsist if they were to depend mainly on their principal crops (rice and corn) in view of the low yield.
- i) The study has shown that the methods developed could be put into practical use by the agroecological, land use and environmental planners for provincial, regional, national-level planning.

Table 2.1 Net Sustainable Production of Lowland and Upland Agroecosystems of Palawan Province

Agroecosystem	Dominant land use	Suitable area(ha)	Yield (t/ha)	No. of croppings per year	Total net sustainable prod.(tons)+
Lowland		136,459			
Irrigated	Rice	36,000	5.25*	2.0	378,000
			2.5**	2.0	180,000
Rainfed	Rice	100,459	5.25*	1.0	527,409
			1.6**	1.0	160,734
Irrigated	Corn	36,000	5.0t	2.0	360,000
			2.0*	2.0	144,000
Rainfed	Corn	100,459	5.0*	1.0	502,295
			1.5**	1.0	150,688
Upland		322,052			
	Rice	322,052	3.5*	1.0	1,127,182
			0.8**	1.0	257,641
	Corn	322,052	3.5*	1.0	1,127,182
			1.0**	1.0	322,052

* Potential or attainable yield

** Existing yield level

+ Total net sustainable production was estimated on the basis of sustainable yield and number of sustainable croppings per year. sustainable yield and cropping intensity were calculated taking into account fallow period requirements and losses due to ecological constraints such as moisture and temperature stress, pests and diseases, and soil erosion.

Source: Cabrido, 1988

- j) After further refinement and computerization of the income-population carrying capacity method, it is recommended that its application be expanded to cover other major crops such as sugar cane, coconut, cassava, sweet potato, vegetables and others.

2.5.3 Extending C-C methodology: The role of technology

The methodology developed by Cabrido was extended to estimate the human population-capacity in terms of subsistence level for rice and corn nationwide. The data used in the estimation came from the 1998-1999 Farming Systems Surveys of SIKAP-STRIVE Foundation.

The respondents in these surveys were classified into different levels of technology using per hectare yield as indicators: low technology means yields of less than 3 mt/ha; medium technology, from greater than 3 m.t./ha to less than 5 m.t./ha; and high technology, yields with 5.0 mt/ha and above.

Table 2.2 Sustainable Population Size and Density and Sustainable Farm Size for the Different Agroecosystems of Palawan Province: Critical and Optimum Levels

Agroecosystem	Net income (Pl/ha/yr)	Sustainable population (no. of families)				Sustainable farm size (ha/family)	
		SIZE		DENSITY		C/MNS	OS
		C/MS	OS	C/MS	OS		
Lowland							
Irrigated rice	18854 *	21895	16421	0.6	0.45	1.64	2.87
	3344 **	3883	2912	0.1	0.08	9.27	16.2
Rainfed rice	9704 *	31450	23587	0.31	0.23	319	5.58
	(558) **	op	op	op	op	op	op
Irrigated corn	18236 *	21177	15882	0.58	0.44	1.69	2.95
	2636 **	3061	2295	0.08	0.06	11.7	20.6
Rainfed corn	9118 *	29548	22161	0.29	0.22	3.39	5.93
	17 **	58	43	0.0006	0.0004	1732	3031
	2499 ***	8101	6075	0.08	0.06	1.2	21
Upland							
Rice	6370 *	66176	49632	0.20	0.15	4.86	8.5
	(1244) **	op	op	op	op	op	op
Corn	6600 *	68565	51423	0.21	0.16	4.69	8.2
	100 **	1038	778	0.0032	0.0024	310	542

* Based on potential or attainable yield

** Based on existing yield level

*** Based on existing yield and low cost of production/investment

op overpopulated, an indication of the nonprofitability of culti-vating a given crop under a particular farming system

C/MS critical or maximum size

C/MNS critical or minimum size

OS optimum size

Source: Cabrido, 1988

The farm budgets were also generated by technology and net farm incomes by technology, were calculated using the standard cost and returns methodology. Average landholdings and cropping intensity were also based on the surveys while the subsistence level expenditures (Poverty threshold) by region came from the National Economic Development Authority.

Extending the formula of Cabrido (1988), the index of C-C at subsistence level for a crop was estimated as:

$$C-C = \frac{NFI_{it} \times L \times CI}{1.15 \times SE}$$

Table 2.3 Existing and Ceiling Population Levels of the Different Agroecosystems of Palawan Province

Agroecosystem	Present population		Ceiling population (no. of persons)	Optimum pop. size (no. of persons)
	(no. of families)	(no. of persons)		
Lowland				
Irrigated rice	6,700	40,200	131,370	98,527
Rainfed rice	24,100	144,600	188,700	141,525
Irrigated corn	6,700	40,200	127,062	95,296
Rainfed corn	24,100	144,600	177,288	132,960
Subtotal				
Rice	30,800	184,800	320,070	240,052
Corn	30,800	184,800	304,350	228,256
Upland				
Rice	4,250	25,500	397,056	297,792
Corn	4,250	25,500	411,390	308,542
Total				
Rice	31,250	210,300	717,126	537,844
Corn	31,250	210,300	715,740	536,798

Source: Cabrido, 1988

Where: C-C = carrying capacity at subsistence level
 NFI = net farm income
 L = average landholdings
 CI = cropping intensity
 SE = subsistence level expenditures or poverty threshold
 by region plus a 15% savings
 i,t = province and technology

Intuitively, if the C-C ratio is greater than one, it implies that the subsistence level was met. Failure to meet subsistence level will result to impoverishment, impelling the population to exhaust the productivity of the ecosystem.

Preliminary results of the estimations are shown in **Tables 2.5 to 2.11** for rice and **Tables 2.12 to 2.14** for corn.

Table 2.4 Population-Supporting Capacity of the Different Agroecosystems of Palawan Province: Real and Effective Demand

Agroecosystem	Population-supporting capacity (no. of persons)				
	Real demand*		Effective demand**		
			Present	Projected	
Lowland					
Irrigated rice	1)	1,203,904	1)	2,268,818	2,224,384
	2)	573,287	2)	1,251,818	1,059,230
Rainfed rice	1)	1,679,757	1)	3,667,881	3,103,592
	2)	511,924	2)	1,117,827	945,853
Irrigated corn	1)	500,996	1)	275,400,000	68,850,000
	2)	200,398	2)	110,160,000	27,540,000
Rainfed corn	1)	699,020	1)	384,255,000	96,063,750
	2)	209,705	2)	115,276,000	28,819,000
Subtotal					
Rice	1)	2,883,661	1)	6,296,699	5,327,976
	2)	1,085,211	2)	2,369,645	2,005,083
Corn	1)	1,200,016	1)	659,655,000	164,913,750
	2)	410,103	2)	225,436,000	56,359,000
Upland					
Rice	1)	3,589,996	1)	7,839,036	6,633,030
	2)	820,567	1)	1,791,772	1,516,115
Corn	1)	1,568,649	1)	862,294,000	215,573,500
	2)	448,184	2)	246,369,000	61,592,250
TOTAL					
Rice	1)	6,473,657	1)	14,135,735	11,961,006
	2)	1,905,778	2)	4,161,417	3,521,198
Corn	1)	2,768,665	1)	1.52x10 ⁹	3.8x10 ⁸
	2)	858,287	2)	4.72x10 ⁸	1.79x10 ⁸

1) Potential or attainable yield

2) Existing yield level

* Calorie basis

** Present actual per capita consumption per year: rice -110 kg; corn - 1 kg.

Projected consumption of rice is estimated to be 130 kg/capita/year; corn - 4 kg/capita/year.
 Calorie values used: rice= 341 kilocalories per 100 grams; corn= 149 kilocalories per 100 grams.
 Protein values used: rice= 6.9 grams per 100 grams; corn=4.2 grams per 100 grams.

Source: Cabrido, 1988

Table 2.5. Rice Carrying Capacity In terms of Subsistence Level, Ilocos Norte, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^d	2,666	1.50	2.00	59,905	0.15
Medium Yield ^e	6,827	1.50	2.00	59,905	0.39
High Yield ^f	21,557	1.50	2.00	59,905	1.24
All Yield Levels	10,350	1.50	2.00	59,905	0.60
<i>Direct</i>					
Low Yield ^d					
Medium Yield ^e					
High Yield ^f					
All Yield Levels					
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^d	112	1.50	1.00	59,905	0.00
Medium Yield ^e	12,880	1.50	1.00	59,905	0.37
High Yield ^f	24,194	1.50	1.00	59,905	0.70
All Yield Levels	12,395	1.50	1.00	59,905	0.36
<i>Direct</i>					
Low Yield ^d					
Medium Yield ^e					
High Yield ^f					
All Yield Levels					

a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

d with palay yield of less than 3.0 mt/ha/season

e with palay yield of 3.0 but less than 5.0 mt/ha/season

f with palay yield of greater than 5.0 mt/ha/season

Rice

Six rice producing provinces (Ilocos Norte, Pangasinan, Isabela, Nueva Ecija, Iloilo, and North Cotabato) were subjected to the C-C analysis here. The rice production systems during the main crop year 1998-1999, were classified into water regimes (irrigated, rainfed) crop establishments (transplanted and direct seeded) and levels of technology (low, medium and high). The survey also provided the data on average landholdings per household and cropping intensity. Finally, the regional poverty

threshold level, i.e., the minimum household income to satisfy nutritional requirement of 2,000 calories per capita for a household size of five, came from NEDA.

Results from the estimates showed that in Ilocos Norte (Table 2.5), only those households with high yields from irrigated and transplanted rice had income that can sustain their minimum household subsistence requirements. This can be attested by the ratio of 1.24.

This same pattern was demonstrated in Pangasinan, except that direct seeded irrigated and transplanted technology rice were also economically sustainable with ratio of annual net farm income to poverty threshold of 1.28 (Table 2.6).

Table 2.6. Rice Carrying Capacity In terms of Subsistence Level, Pangasinan, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holdings ^a (ha)	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	4,999	1.84	2.00	59,905	0.35
Medium Yield ^d	11,457	1.84	2.00	59,905	0.81
High Yield ^e	17,426	1.84	2.00	59,905	1.23
All Yield Levels	11,294	1.84	2.00	59,905	0.80
<i>Direct</i>					
Low Yield ^c					
Medium Yield ^d	18,137	1.84	2.00	59,905	1.28
High Yield ^e					
All Yield Levels					
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	304	1.84	1.00	59,905	0.01
Medium Yield ^d	12,241	1.84	1.00	59,905	0.43
High Yield ^e					
All Yield Levels	6,273	1.84	1.00	59,905	0.22
<i>Direct</i>					
Low Yield ^c					
Medium Yield ^d					
High Yield ^e					
All Yield Levels					

a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

c $(\text{net farm income} \times \text{average landholding} \times \text{cropping intensity}) / (\text{regional poverty threshold} + 15\% \text{ savings})$

d with palay yield of less than 3.0 mt/ha/season

e with palay yield of 3.0 but less than 5.0 mt/ha/season

f with palay yield of greater than 5.0 mt/ha/season

In Isabela, the irrigated, transplanted rice production systems from medium to high yields, had ratios of 1.5 and 2.26 respectively (Table 2.7). Incomes from non-irrigated transplanted rice were not sufficient to sustain expenditures higher than the household poverty threshold of P49,365 per annum.

Nueva Ecija (Table 2.8) on the other hand, had high yield irrigated rice technology incomes that can cover subsistence level expenditures; Iloilo incomes from medium and high technology direct seeded irrigated and transplanted rainfed rice production had ratio greater than one; North Cotabato, only high yield irrigated transplanted had

Table 2.7. Rice Carrying Capacity In terms of Subsistence Level, Isabela, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	2,164	2.50	2.00	49,365	0.25
Medium Yield ^d	13,208	2.50	2.00	49,365	1.54
High Yield ^e	19,406	2.50	2.00	49,365	2.26
All Yield Levels	11,593	2.50	2.00	49,365	1.35
<i>Direct</i>					
Low Yield ^c					
Medium Yield ^d					
High Yield ^e					
All Yield Levels					
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	2,909	2.50	1.00	49,365	0.17
Medium Yield ^d	11,075	2.50	1.00	49,365	0.65
High Yield	17,019	2.50	1.00	49,365	0.99
All Yield Levels	10,334	2.50	1.00	49,365	0.60
<i>Direct</i>					
Low Yield ^c					
Medium Yield ^d					
High Yield ^e					
All Yield Levels					

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with palay yield of less than 3.0 mt/ha/season

^e with palay yield of 3.0 but less than 5.0 mt/ha/season

^f with palay yield of greater than 5.0 mt/ha/season

Table 2.8. Rice Carrying Capacity In terms of Subsistence Level, Nueva Ecija, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	(3,720)	2.50	2.00	64,185	(0.33)
Medium Yield ^d	2,457	2.50	2.00	64,185	0.22
High Yield ^e	24,531	2.50	2.00	64,185	2.20
All Yield Levels	7,756	2.50	2.00	64,185	0.69
<i>Direct</i>					
Low Yield ^c	(2,101)	2.50	2.00	64,185	(0.19)
Medium Yield ^d	5,132	2.50	2.00	64,185	0.46
High Yield ^e					
All Yield Levels	1,516	2.50	2.00	64,185	0.14
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	240	2.50	1.00	64,185	0.01
Medium Yield ^d	8,787	2.50	1.00	64,185	0.39
High Yield ^e					
All Yield Levels	4,514	2.50	1.00	64,185	0.20
<i>Direct</i>					
Low Yield ^c	283	2.50	1.00	64,185	0.01
Medium Yield ^d					
High Yield ^e					
All Yield Levels					

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with palay yield of less than 3.0 mt/ha/season

^e with palay yield of 3.0 but less than 5.0 mt/ha/season

^f with palay yield of greater than 5.0 mt/ha/season

ratio greater than one; while South Cotabato's net farm incomes from medium technology irrigated and non-irrigated rice production, and high technology irrigated production system were higher than subsistence level expenditures.

In summary, from the rice data analyzed, it appears that only adoptors of the rice high technology yield in favorable areas (irrigated) had higher chance to generate net farm incomes to cover poverty threshold expenditures.

Corn

For corn, the same pattern demonstrated by the rice production systems across provinces was also manifested by the corn household samples. It was relatively more feasible to generate net farm incomes higher than the poverty threshold incomes, if the corn producing households adopt the production technology which can provide them with higher per hectare yield (Tables 2.12 to 2.14).

Table 2.9. Rice Carrying Capacity In terms of Subsistence Level, Iloilo, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	(321)	3.00	2.00	52,790	(0.04)
Medium Yield ^d	7,555	3.00	2.00	52,790	0.99
High Yield ^e					
All Yield Levels	3,617	3.00	2.00	52,790	0.47
<i>Direct</i>					
Low Yield ^c	2,213	3.00	2.00	52,790	0.29
Medium Yield ^d	10,281	3.00	2.00	52,790	1.34
High Yield ^e	18,246	3.00	2.00	52,790	2.38
All Yield Levels	10,247	3.00	2.00	52,790	1.34
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c					
Medium Yield ^d	7,131	3.00	1.50	52,790	0.70
High Yield ^e	14,381	3.00	1.50	52,790	1.41
All Yield Levels	10,756	3.00	1.50	52,790	1.05
<i>Direct</i>					
Low Yield ^c	1,814	3.00	1.50	52,790	0.18
Medium Yield ^d					
High Yield ^e					
All Yield Levels					

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with palay yield of less than 3.0 mt/ha/season

^e with palay yield of 3.0 but less than 5.0 mt/ha/season

^f with palay yield of greater than 5.0 mt/ha/season

Table 2.10. Rice Carrying Capacity In terms of Subsistence Level, North Cotabato, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	2,273	1.50	2.00	55,775	0.14
Medium Yield ^d	8,697	1.50	2.00	55,775	0.54
High Yield ^e	16,495	1.50	2.00	55,775	1.02
All Yield Levels	9,155	1.50	2.00	55,775	0.57
<i>Direct</i>					
Low Yield ^c	53	1.50	2.00	55,775	0.00
Medium Yield ^d	12,716	1.50	2.00	55,775	0.79
High Yield ^e	15,119	1.50	2.00	55,775	0.94
All Yield Levels	9,296	1.50	2.00	55,775	0.58
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	(2,343)	1.50	1.00	55,775	(0.07)
Medium Yield ^d					
High Yield ^e					
All Yield Levels					
<i>Direct</i>					
Low Yield ^c					
Medium Yield ^d					
High Yield ^e	20,584	1.50	1.00	55,775	0.64
All Yield Levels					

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with palay yield of less than 3.0 mt/ha/season

^e with palay yield of 3.0 but less than 5.0 mt/ha/season

^f with palay yield of greater than 5.0 mt/ha/season

Table 2.11. Rice Carrying Capacity In terms of Subsistence Level, South Cotabato, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c	222	2.50	2.00	52,445	0.02
Medium Yield ^d	11,076	2.50	2.00	52,445	1.21
High Yield ^e	21,129	2.50	2.00	52,445	2.32
All Yield Levels	10,809	2.50	2.00	52,445	1.19
<i>Direct</i>					
Low Yield ^c	1,011	2.50	2.00	52,445	0.11
Medium Yield ^d	8,619	2.50	2.00	52,445	0.94
High Yield ^e	19,487	2.50	2.00	52,445	2.14
All Yield Levels	9,706	2.50	2.00	52,445	1.06
NON-IRRIGATED					
<i>Transplanted</i>					
Low Yield ^c					
Medium Yield ^d	18,075	2.50	1.50	52,445	1.49
High Yield ^e					
All Yield Levels	18,075	2.50	1.50	52,445	1.49
<i>Direct</i>					
Low Yield ^c	2,887	2.50	1.50	52,445	0.24
Medium Yield ^d					
High Yield ^e	24,005	2.50	1.50	52,445	1.97
All Yield Levels	13,446	2.50	1.50	52,445	1.11

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with palay yield of less than 3.0 mt/ha/season

^e with palay yield of 3.0 but less than 5.0 mt/ha/season

^f with palay yield of greater than 5.0 mt/ha/season

Table 2.12. Corn Carrying Capacity in Terms of Subsistence Level, Isabela, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
OPEN POLLINATED					
Low Yield ^d	2,851	3.00	1.40	49,365	0.28
Medium Yield ^e	11,222	3.00	1.40	49,365	1.10
High Yield ^f					
All Yield Levels	7,037	3.00	1.40	49,365	0.69
HYBRID					
Low Yield ^d	2,142	3.00	1.40	49,365	0.21
Medium Yield ^e	11,534	3.00	1.40	49,365	1.13
High Yield ^f	17,257	3.00	1.40	49,365	1.69
All Yield Levels	10,346	3.00	1.40	49,365	1.01

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with corn yield of less than 3.0 mt/ha/season

^e with corn yield of 3.0 but less than 5.0 mt/ha/season

^f with corn yield of greater than 5.0 mt/ha/season

3. CARRYING CAPACITY: GLOBAL TRENDS

Since the middle of the century, three factors have contributed most directly to the excessive pressures now being placed on the earth's natural systems: the doubling of the world population, the quintupling of global economic output, and the widening gap in the distribution of income (Postel, 1994).

3.1 The Population Challenge

During the 1950s, the world population was estimated at 2.5 billion. This increased to 5.9 billion in 1998 and projected to reach 9.4 billion by the year 2050 (Table 3.1).

This unprecedented increase in population (using the UN medium assumption) accompanied by rising individual consumption of goods and services is pushing the carrying capacity of mother earth beyond its natural limits.

The 3.6 billion population from 1950 to 2000 was a combined contribution of both developed and developing countries. The projected half century population increment of 3.3 billion in the next millenium, however, was projected to be attributed mainly to the developing countries, many of which are hard-pressed to satisfy even existing demands on resources (Brown et al, 1998).

Table 2.13. Corn Carrying Capacity in Terms of Subsistence Level, Bukidnon 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
OPEN POLLINATED					
Low Yield ^d	(1,167)	3.00	1.40	55,775	(0.10)
Medium Yield ^e					
High Yield ^f					
All Yield Levels					
HYBRID					
Low Yield ^d	53	3.00	1.40	55,775	0.00
Medium Yield ^e	15,067	3.00	1.40	55,775	1.30
High Yield ^f					
All Yield Levels	7,650	3.00	1.40	55,775	0.66

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with corn yield of less than 3.0 mt/ha/season

^e with corn yield of 3.0 but less than 5.0 mt/ha/season

^f with corn yield of greater than 5.0 mt/ha/season

Given the variances in population growth rates among individual countries, the world can be demographically divided into two groups: countries that have achieved population stability and those that have not. The first group is composed mainly of nations from Europe and the industrial countries. On the other hand, the second group is composed of developing countries (e.g. Ethiopia, Pakistan, Nigeria) which are projected to triple their population over the next half century. The twenty largest countries ranked according to population are shown in Table 3.2.

3.1.1 Some dimensions of the population challenge

In the latest publication of the World Watch Institute, *Beyond Malthus: Sixteen Dimensions of the Population Problem*, Brown (Gardner and Halweil, 1998), enumerated at least sixteen development indicators affected by the population growth. Some of these indicators as projected by the above-mentioned authors, especially those relating to food and the environment, are discussed here.

3.1.1.1 Trends in resources/environment

Table 2.14. Corn Carrying Capacity in Terms of Subsistence Level, South Cotabato, 1998.

TECHNOLOGY	Net Farm Income ^a (P/ha/season)	Average Land-holding ^a	Cropping Intensity ^a	Regional Poverty Threshold ^b (Annual)	Carrying Capacity in Terms of Subsistence Level ^c
OPEN POLLINATED					
Low Yield ^d	5,273	3.00	1.40	52,445	0.49
Medium Yield ^e	8,777	3.00	1.40	52,445	0.81
High Yield ^f					
All Yield Levels	7,025	3.00	1.40	52,445	0.65
HYBRID					
Low Yield ^d	5,632	3.00	1.40	52,445	0.52
Medium Yield ^e	9,791	3.00	1.40	52,445	0.90
High Yield ^f	17,873	3.00	1.40	52,445	1.65
All Yield Levels	15,525	3.00	1.40	52,445	1.43

^a Source: SIKAP/STRIVE Rice-Based Farming Systems Survey, December 1998 to March 1999

^b annual per capita threshold x family household size of 5; Source: Statistical Yearbook, 1998

^c (net farm income x average landholding x cropping intensity)/(regional poverty threshold + 15% savings)

^d with corn yield of less than 3.0 mt/ha/season

^e with corn yield of 3.0 but less than 5.0 mt/ha/season

^f with corn yield of greater than 5.0 mt/ha/season

Fresh Water

Population growth affects the supply of fresh water. As population increases, the per capita availability of fresh water declines. The World Watch Institute estimates that water availability per person from the hydrological cycle will fall by 74 percent between 1950 to 2050. As the growing demand for water collides with the limits of supply, countries typically satisfy rising urban and residential demands by diverting water from irrigation. To substitute for water, countries import grains, the cheapest way to import water. The water scarcity would affect agriculture output in terms of lower irrigation water supply. Already China and India are feeling the pinch. If total irrigated areas remain at roughly 263 million hectares until 2050, the figure is projected to fall to 0.0280 hectares per person in 2050 - declining by 38 percent (Figure 3.1)

Biodiversity

As human population has surged during the century, populations of other numerous species have tumbled almost at the point of extinction. The leading causes of today's species losses such as habitat alteration, invasion by exotic species, pollution and over hunting/fishing are all function of human activities. These activities have pushed the percentage of mammals, amphibians, and fish that are in immediate danger of extinction into double digits (Table 3.3).

Table 3.1 World Population, 1950, with projections to 2050.

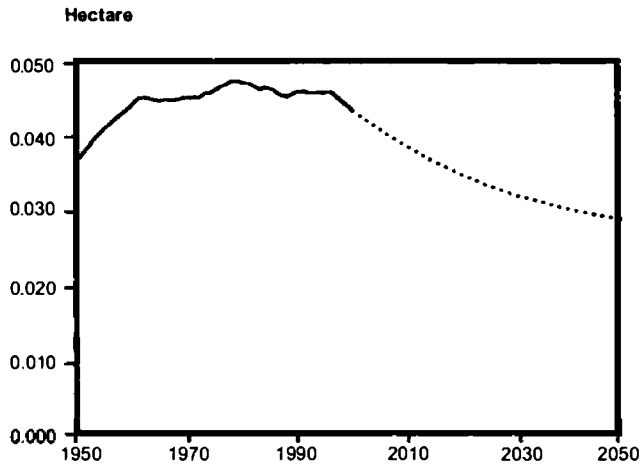
Year	World Population	Half-Century Increase (billion)
1950	2.5	
200	6.1	3.6
2050	9.4	3.3

Source: Postel, N. (1998) as cited by Brown, Gardner and Halweill (1998)

Table 3.2. The 20 largest Countries Ranked According to Population Size, 1998. with Projections to 2050

Rank	1998		2050	
	Country	Population (million)	Country	Population (million)
1	China	1,255	India	1,533
2	India	976	China	1,517
3	United States	274	Pakistan	357
4	Indonesia	207	United States	348
5	Brazil	165	Nigeria	339
6	Pakistan	148	Indonesia	318
7	Russia	147	Brazil	243
8	Japan	126	Bangladesh	218
9	Bangladesh	124	Ethiopia	213
10	Nigeria	122	Iran	170
11	Mexico	96	The Congo	165
12	Germany	82	Mexico	154
13	Viet Nam	78	Philippines	131
14	Iran	73	Viet Nam	130
15	Philippines	72	Egypt	115
16	Egypt	66	Russia	114
17	Turkey	64	Japan	110
18	Ethiopia	62	Turkey	98
19	Thailand	60	South Africa	91
20	France	59	Tanzania	89

Source: United Nations, World Populations Prospects 1996.



Source: From Sandra Postel (1998) as cited by Brown, Gardner, and Halweil (1998).

Figure 3.1 Global Irrigated Area Per Person, 1950-96, with Projections to 2050.

Climate Change

Carbon emissions from fossil fuel burning have expanded at nearly twice the rate of population. The destabilization of the world's climate threatens more intensive heat wave, more severe droughts and floods, storms, and intensive forest fires. The atmospheric concentrations of carbon dioxide, the principal greenhouse gas are projected to increase 30 percent over their pre-industrial level (Figure 3.2).

Energy

In the past half-century, global demand for energy grew twice as fast as population as industrial nations burned coal, oil and natural gas to fund their economies. Over the next half century of the third millenium, energy demands are projected to continue expanding beyond population growth, as developing countries try to catch up with industrial nations (Figure 3.3).

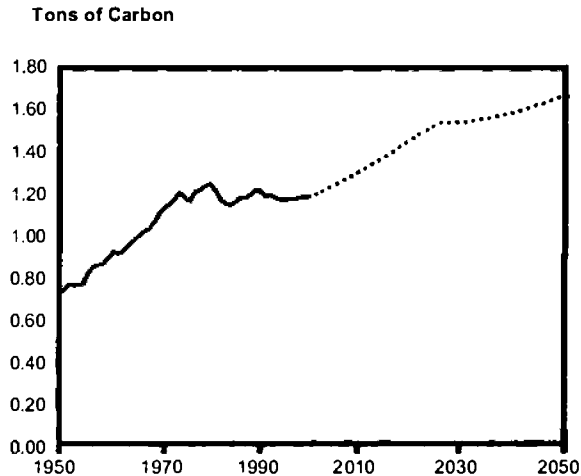
Waste

Another dimension of population growth is its implication to waste. Disposal of garbage and industrial wastes will become a problem with increases in population. The estimate of half kilo of municipal waste per day, at today's population, implies a total of 824 million tons of waste to be disposed off annually in developing countries.

Table 3.3. Share of Species Worldwide Classified as Threatened

Species	Share of Species That is		Total Share of Species Threatened with Extinction
	In Immediate Danger of Extinction	Vulnerable to Extinction	
Birds	4	7	14
Mammals	11	14	25
Reptiles	8	12	20
Amphibians	10	15	25
Fish	13	21	34

Source: Postel N. (1998) as cited by Brown, Gardener and Halweil (1998)



Source: From Marland et. al. as cited by Brown, Gardner, and Halweil (1998).

Figure 3.2 Global Carbon Emissions Per Person, 1950-95, with Projections to 2050.

3.1.1.2 Output

Ocean Fish Catch

From 1950 to 1988, fish catch reached its peak in 1988 at 88 million tons. However, since 1988, growth in the catch has slowed down falling behind population, and projected to decline in 2050 (Figure 3.4). As we end the 20th century, over-fishing has become the rule, not the exception. The fivefold growth in the human appetite for seafood, has pushed the catch of most oceanic fisheries to their sustainable limits. Marine biologists estimate that the oceans cannot sustain an annual catch of greater than 93 million tons, at the current take (FAO, 1996).

Grain Production

From 1950 to 1984, growth of grain production exceeded population growth raising the harvest per capita from 247 kg to 342, a gain of 38 percent (Figure 3.5). The slower growth in the world grain harvest since 1984 is due to the lack of new land and

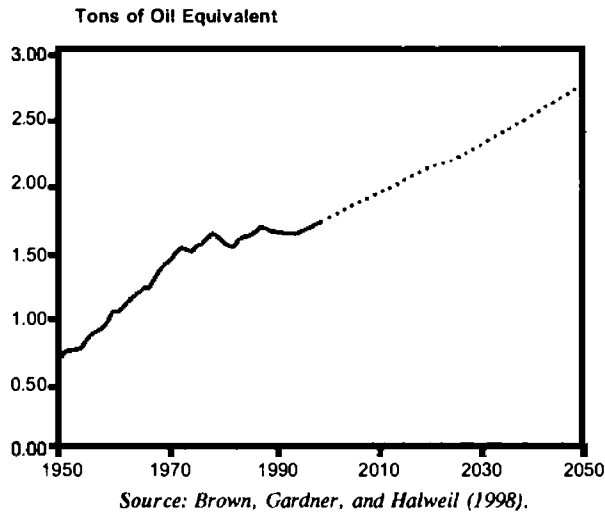


Figure 3.3 Global Energy Use Per Person, 1950-95, with Projections to 2050.

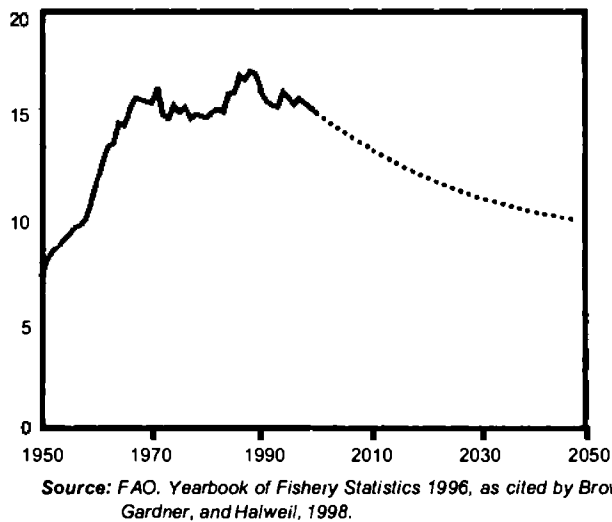


Figure 3.4 Global Fish Catch Per Person, 1950-95, with Projections to 2050.

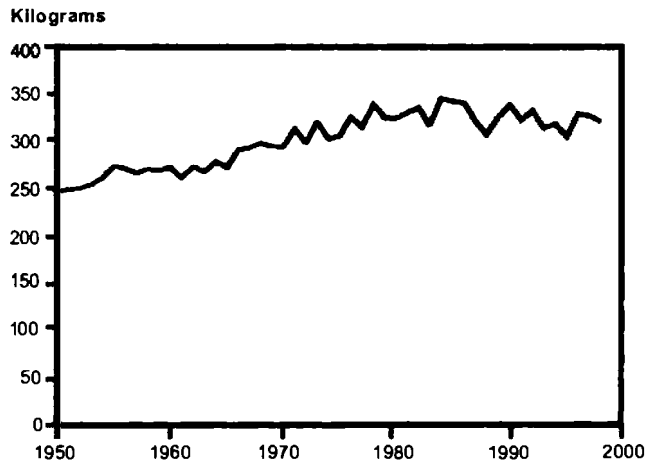


Figure 3.5 Global Grain Production Per Person, 1950-98

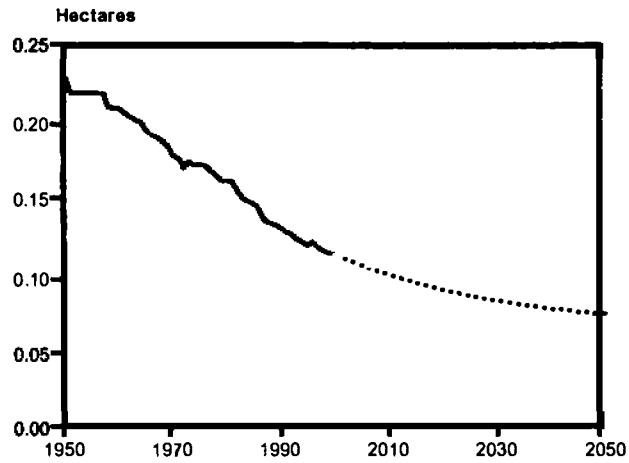
to slower growth in irrigation and fertilizer use. As a result of population increase, grain area per person has fallen half since 1950, from 0.24 to 0.12 hectares (Figure 3.6).

Meat Production

World meat production increased from 44 million tons in 1950 to 211 million tons in 1997. In per capita terms, world meat production expanded from 17 kilograms in 1952 to 36 kilograms in 1997. Expanding meat production in the future would depend on the expansion of grain production and to some extent soybean production. Assuming a feed conversion ratio of 3 kilograms of grain per kilogram of meat produced, this would require more than 900 million tons of additional grain for feeds in 2050, an amount equal to half of current world grain consumption. The expansion therefore of meat production in the future will be limited by volume of grains produced.

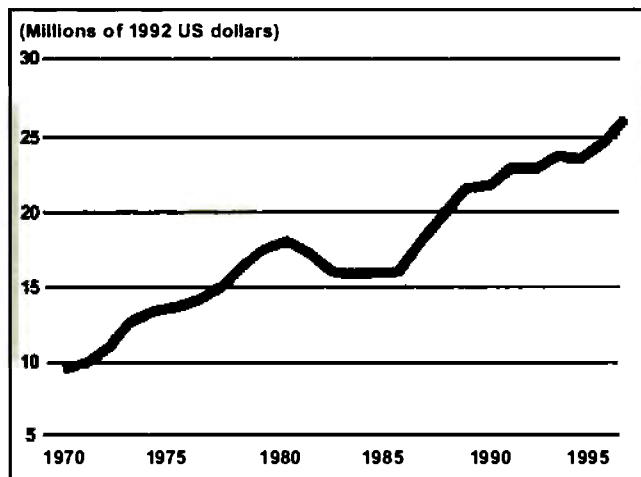
3.1 Quantum Leap in Economic Output

Since the past three decades, total global output or Gross domestic product of the world has expanded from roughly US \$9.4 trillion to more than US \$ 25 trillion (Figure 3.7). Although the industrial countries account for a major share in this output, economic growth in the developing countries has likewise followed the trend. This growth is expected to continue well in the middle of the next century (World Resource Institute (WRI), 1998-1999). The liberalization of both trade and investment across borders has helped fuel this economic growth. International trade alone increased from US \$308 million in 1950 (UNDP, 1994) to US \$ 6,225 trillion in 1995 (WRI, 1998-1999).



Source: USDA 1998, cited by Brown, Gardner and Halweil (1998).

Figure 3.6 Global Harvested Area Per Person, 1950-95, with Projections to 2050.



Source: The World Bank, World Development Indicators 1997, on CD-ROM (The World Bank, Washington D.C. 1997), as cited by WRI, (1998)

Figure 3.7 Gross World Product, 1970-95.

Along with this quantum leap in output was the corresponding heavy increases in energy consumption accelerating two-fold from 3,230 trillion kilograms of oil equivalent in 1965 to 6,490 trillion in 1991.

3.3 The Widening Gap in Incomes Between the Rich and the Poor

The final driving force that is currently putting excessive pressure on planet earth is the disparity in incomes among nations.

In 1960, the richest 20 percent of the world's people absorbed 70 percent of global income; by 1991, the wealthy's share had climbed to nearly 85 percent. The poorest 20 percent, meanwhile, saw their share of global income drop from an already meager 2.3 percent to just 1.4 percent. The ratio of the richest fifth's share to the poorest thus grew from 30 to 1 in 1960 to 61 to 1 in 1991.

4. CARRYING CAPACITY INDICATORS: PHILIPPINES AND SELECTED ASIAN COUNTRIES

The Asian region occupies a special place, in any discussions related to carrying capacity. The region as a whole comprises 60 percent of the current world population (China and India alone accounted for 38 percent of the world's population in 1998) and will continue to share a substantial percentage even in 2050.

The green revolution in rice, the staple food of majority of the people of the world and characterized by technology induced crop intensification occurred in Asia. Due to population pressure, the region is no exception in facing the challenges of deteriorating soil and aquatic resources, declining per capita crop land and fertilizer use, and increasing urbanization.

Technology likewise has reached its plateau. Although production from agricultural biotechnology adoption is already an acceptable reality in the West, it has not yet permeated the Asian economies. Likewise, Asia is not homogenous in terms of culture, religion as well as political governance. It is therefore of great interest for scientists, agriculturists, demographers and policy makers to examine closer the carrying capacity trends in Asian countries and see how individual countries in the region are coping up with the challenge of population growth in relation to their efforts in sustaining their resource endowments given their development goals.

For our analysis, the selected countries of Asia under study are divided into two groups based on levels of income according to the recent classification of the World Bank (WB). The middle income Asian countries include Indonesia, Malaysia, Philippines, and Thailand. On the other hand, those considered low-income countries include Cambodia, China, Lao PDR, Myanmar, Vietnam, Bangladesh, India, Pakistan, and Sri Lanka. The C-C trend indicators being compared across countries include GNP, population, food security, index of food production, land use and cropland, indicators of the environment and human development indicators.

4.1 GNP

In the 1998 Asian Development Bank (ADB) Annual Report, the 1997 data on gross national product (GNP) per capita for the countries under study, were reported as follows: Malaysia had the highest at US\$4,530; Thailand US\$2,740; Indonesia and the Philippines with GNP/capita of US\$1,110 and US\$1,200, respectively; China and Sri Lanka at US\$800 range; Pakistan US\$500; while the others had GNP/capita ranging from US\$300 to US\$ 400 (Table 4.1)

The gross domestic products (GDPs) in these countries were also growing robustly between 1985 to 1995 (no available data yet for comparison after the 1997 financial crisis) with China and Thailand topping the list with 9.6 and 9.0 percent growth per year, respectively; Malaysia, Indonesia and Vietnam, within 6-7% range per year; Lao PDR, India, Pakistan and Bangladesh, from 4-5% range; while Sri Lanka (3.8%) and the Philippines (3.4%) had the lowest GDP growth rates (Table 4.1).

In terms of how the per capita income is distributed using the Gini ratio by country, Sri Lanka and Lao PDR had the lowest (most evenly distributed income) Gini ratio of 30. This was followed by Pakistan, India, Bangladesh, Vietnam, Indonesia and China – all within the range of 31 to 38 Gini ratios. Thailand, Malaysia and the Philippines had the most unevenly distributed per capita income with Gini ratios ranging from 52-45 (Table 4.1).

4.2 Population

Asian population is projected to reach 5.4 billion in 2050. China, India, Pakistan, Indonesia and Bangladesh belong to the top ten countries with high population growth in this projection. The population of India, China, Pakistan and Indonesia would account for 68 percent of the Asian population and 40 percent of the world in 2050 (Table 4.2).

4.3 Food Security

The indicators of food security, as used in this analysis are calorie and protein availabilities. This seems to be overly simplistic because effective purchasing power, instead of supply availability is a more powerful indicator. Superimposing the recommended daily allowance (RDA) of the Philippines of 2052 kilocalories and 50 grams for protein, as divisors in the supply available calorie and protein data would yield us a rough national picture of calorie and protein adequacy.

The analysis showed that from 1982-84, only Cambodia (87%) and Bangladesh (95%) had inadequate calorie intakes. In terms of protein nutrient adequacy, Cambodia, Bangladesh, Sri Lanka and Indonesia had protein inadequacy in their diets. For the period 1992-1994, most of Asian countries had improved their nutrient supply availability. However, Cambodia and Bangladesh deteriorated (Table 4.3).

Caution should be noted at this stage in the estimation of percent nutrient adequacy by country. The first point is relative to the method in estimating supply availability. The method is a straight supply-disappearance method using the food

Table 4.1. Per Capita GNP of Selected Asian Countries, 1997.

	Per Capita GNP ^a	Annual GDP ^b Growth 1985-1995	GINI Coefficient ^c
	(US\$)	(%)	
Middle Income			
Indonesia	1,110	7.2	32
Malaysia	4,530	7.4	48
Philippines	1,200	3.4	45
Thailand	2,740	9.0	52
Low Income			
Cambolia	300	.	.
China	860	9.6	38
Lao PDR	400	5.2	30
Myanmar	—	.	.
VietNam	310	6.3	36
Bangladesh	360	4.0	35
India	370	5.2	32
Pakistan	500	5.1	31
Sri Lanka	800	3.8	30

...Data not available.

^a Source: Country sources; ADB data file; and World Bank, official communications, February 1999, as published by ADB Annual Report, 1999.

^b WRI, 1998-1999.

^c Gini coefficients measure the equality of distribution (0, perfectly equal; 100, perfectly unequal). From WRI, 1998-1999.

balance analysis. It simply is the arithmetic of food production plus imports, minus export, minus waste and non-food uses. The net effect is total food supply available for human consumption. Divide this by population size and we get per capita availability per year. Then convert this into daily per capita calorie and protein availability and divide it by the RDA to calculate the food supply adequacy (Figure 4.1).

There is nothing wrong with the methodology per se. However, the caution lies in the interpretations of food supply adequacy as an absolute indicator of nutrient adequacy, because this data indicator does not reflect actual consumption. A better indicator should be the actual food consumed from food nutrition consumption surveys.

To illustrate our point, let's take the Philippine data in Table 4.3 which all indicated that the Philippines was adequate in caloric intakes (1982-1984, 105 percent and 1992-1994, 115 percent) and protein intakes, 105 percent for 1982-1984 and 112 for 1992-1994. Data from the Food Nutrition Research Institute (FNRI) during the period 1982 to 1993 would indicate that in terms of calorie intakes, the Filipinos had more than 100

Table 4.2 Population Trends and Projections, World, Asia and Selected Asian Countries, 1950-2050

	Population (thousands)			
	1950	1998	2025	2050
World	2,523,878	5,929,839	8,039,130	9,366,724
Asia	1,402,021	3,588,877	4,784,833	5,442,567
Middle Income				
Indonesia	79,539	206,522	275,245	318,264
Malaysia	6,110	21,450	31,577	38,089
Philippines	20,988	72,164	105,194	130,511
Thailand	20,010	59,612	69,089	72,969
Low Income				
Cambodia	4,346	10,751	16,990	21,394
China	554,760	1,255,091	1,480,430	1,516,664
Lao PDR	1,755	5,358	10,202	13,889
Myanmar	17,832	47,625	67,643	80,896
Vietnam	29,954	77,896	110,107	129,763
Bangladesh	41,783	124,043	179,980	218,188
India	357,561	975,772	1,330,201	1,532,674
Pakistan	39,513	147,811	268,904	357,353
Sri Lanka	7,678	18,840	23,934	26,995

Source: United Nations Population Division and International Labour Organization, as cited by the World Resources Institute, 1998

percent adequacy from 1987 to 1989 but not in 1993 which was only 87.8 percent adequacy (Table 4.4).

Variances of percent adequacy would also differ once the data are disaggregated into urban, and rural (Table 4.5); by region (Table 4.6); by educational attainment of meal planner (Table 4.8); and by household size (Table 4.9).

The point made here is, national level data when it comes to interpreting food security using the disappearance approach has no meaning. It has to be balanced by actual consumption nutrition surveys and must be disaggregated at different levels of intervention points.

4.4. Food Production Index

Using the 1989-1991 period as the base, the indices of both agricultural and food production had improved from 1984 to 1996, both in terms of total and per capita indices. In terms of food import dependency ratio, Malaysia had the highest at 53.1

Table 4.3 Food Security Status, Per Capita Calorie and Protein Supply Availability, Selected Asian Countries.

COUNTRY	Average Daily Per Capita Calorie Supply (kilocalories)		Average Daily Per Capita Protein Supply (grams)		Calorie Supply-RDA Ratio ¹ (Percent Adequacy)		Protein Supply-RDA Ratio ¹ (Percent Adequacy)	
	(1982-84)	(1992-94)	(1982-84)	(1992-94)	(1982-84)	(1992-94)	(1982-84)	1992-94)
Low Income								
Indonesia	2,331	2,609	49	62	114	127	98	124
Malaysia	2,706	2,782	58	65	132	136	116	130
Philippines	2,161	2,370	51	56	105	115	102	112
Thailand	2,215	2,365	49	53	108	115	98	106
Low Income								
Cambodia	1,777	1,805	43	43	87	88	86	86
China	2,681	3,082	59	68	131	150	118	136
Lao PDR	2,148	2,106	55	55	105	103	110	110
Myanmar	2,563	2,619	65	66	125	128	130	132
Vietnam	2,246	2,302	50	55	109	112	100	110
Bangladesh	1,954	2,023	42	44	95	99	84	88
India	2,157	2,397	54	58	105	117	108	116
Pakistan	2,177	2,399	53	61	106	117	106	122
Sri Lanka	2,295	2,242	47	48	112	109	94	96

¹ based on an RDA of 2052 for calorie and 50 grams for protein

Basic Source of Data: Food and Agriculture Organization of the United Nations, as cited by the World Resources Institute, 1998.

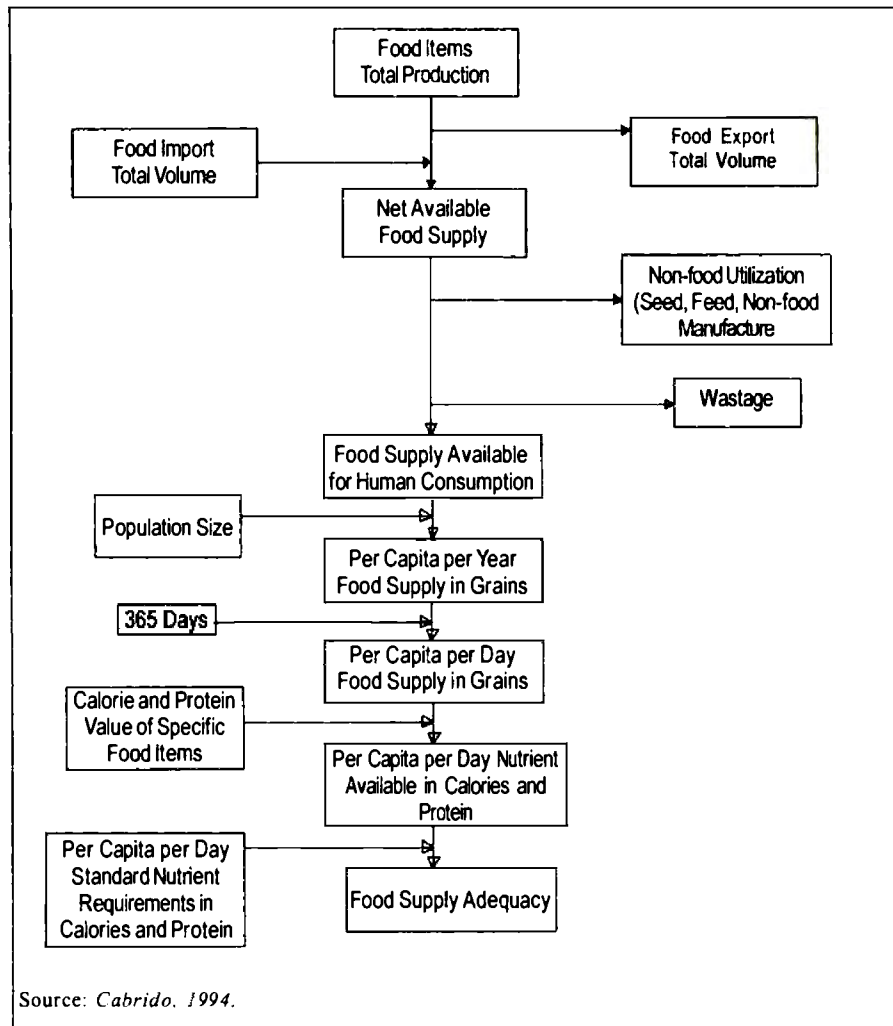


Figure 4.1. Schematic Outline of the Food Balance of the Food Balance Analysis Methodology

%, followed by Sri Lanka (30.4%); Pakistan (14.1%); Bangladesh (12.3%); and the Philippines (11.4%). The others had less than 6% food import dependency ratios (Table 4.10.)

These food production trends appear very optimistic. The latest projections by the International Food Policy Research Institute (IFPRI) for Asia by 2020 are more pessimistic. In its original base projections, IFPRI (Impact, 1995) reported a positive net trade of rice for Asia in 2020. This supply source would come from Thailand, Vietnam, Myanmar, India and China. On the other hand, Philippines, Bangladesh,

Table 4.4 Per capita daily calorie and protein intake and percent adequacy (national average), Philippines, 1982-1993

ITEM	1982	1987	1989	1993
Total Calories (Kcal) Consumed	2,152.0	2,089.0	2,123.0	1,684.0
Recommended Daily Allowance (RDA)	1,919.0	1,919.0	1,919.0	1,919.0
Percent Adequacy	112.0	108.8	110.6	87.8
Total Protein (grams) Consumed	54.5	53.8	54.9	49.9
Recommended Daily Allowance (RDA)	47.0	47.0	47.0	47.0
Percent Adequacy	116.0	114.0	116.8	106.2

Source: FNRI, 1995.

Table 4.5 Mean one-day per capita energy and protein nutrient intake and percent adequacy by urbanization: Philippines, 1993.

Group	ENERGY			PROTEIN		
	Intake (kcal)	Recommended Dietary Allowance	Percent Adequacy	Intake (g)	Recommended Dietary Allowance	Percent Adequacy
Philippines	1684	1919	87.8	49.9	47.0	106.2
All Urban	1673	1922	87.0	50.8	47.2	107.6
Metro Manila	1651	1926	85.7	52.2	47.2	110.6
Other Urban	1681	1921	87.5	50.2	47.2	106.4
Rural	1696	1915	88.6	49.1	46.8	104.9

Source: FNRI, DOST Fourth National Nutrition Survey: Philippines, 1993.

Malaysia and Indonesia would be importers of rice ranging from 224,000 m.t. to 1.5 million mt (Table 4.11).

In cereals trade, IFPRI's revised projections were more pessimistic with Asia as a net importer of around 117 million mt of cereals. China, Pakistan and Indonesia will be the major importers of cereals ranging from 41 million mt (China) to 11 million mt (Indonesia). In the medium category, cereal imports of 4 to 7 million mt will be imported by Bangladesh, Philippines and Malaysia (Table 4.12).

These revised projections of IFPRI support what Lester Brown calls the "old" and "new era" of food security (Brown, 1996). Brown argues that earlier projections made by IFPRI, the World Bank and the FAO were optimistic because they have not included the 'S-curve effects' of technical change and resource endowments (IFPRI, 2020 vision, 1995). Indicators for the "new era" (from 1990 into indefinite future) of food security would include among others, declining per capita

Table 4.6 Mean one-day per capita energy and protein nutrient intake and percent adequacy by region: Philippines, 1993.

Region	ENERGY			PROTEIN		
	Intake (kcal)	Recommended Dietary Allowance	Percent Adequacy	Intake (g)	Recommended Dietary Allowance	Percent Adequacy
NCR	1651	1926	85.7	52.2	47.2	110.6
Ilocos	1732	1925	90.0	49.4	47.8	103.3
CAR	1839	1945	94.6	50.8	48.1	105.6
Cagayan Valley	1741	1928	90.3	47.4	47.5	99.8
Central Luzon	1758	1933	90.9	51.0	48.0	106.2
Southern Tagalog	1709	1910	89.5	48.9	46.8	104.5
Bicol	1618	1875	86.3	46.0	45.1	102.0
Western Visayas	1587	1903	83.4	47.2	46.5	101.2
Central Visayas	1640	1905	86.1	54.2	46.0	117.8
Eastern Visayas	1696	1923	88.2	49.4	47.2	104.7
Western Mindanao	1699	1945	87.4	53.0	47.8	110.9
Northern Mindanao	1652	1926	85.8	49.4	47.2	104.7
Southern Mindanao	1679	1947	86.2	50.2	47.5	105.7
Central Mindanao	1688	1910	88.4	49.6	46.3	107.1
ARMM	1759	1901	92.5	46.9	46.9	100.0

Source: FNRI, DOST Fourth National Nutrition Survey: Philippines, 1993.

production of grain and seafoods, inadequate grain stocks, rising grain prices, shrinking irrigated area and fertilizer used per person, diminished backlog of unused technology and a new politics of food from surpluses before 1990 to scarcity and competition among importers from 1990 and beyond (Table 4.13).

4.5 Land Use

Trends in land use from 1982 to 1994 by countries are shown in Table 4.14. In terms of population density and cropland percentage to total land area, Bangladesh had the highest at 9,224 people per 1000 hectares of land and 71 percent of cropland, respectively. However, in terms of absolute hectareage of cropland across countries,

Table 4.7 Mean one-day per capita energy and protein nutrient intake and percent adequacy by annual per capita income: Philippines, 1993.

Annual Per Capita Income (In Pesos)	Distribution of Households	ENERGY		PROTEIN	
		Intake (kcal)	Percent Adequacy	Intake (g)	Percent Adequacy
Less than P3000	22.6	1559	82.6	44.0	96.5
3000-5999.99	25.7	1622	85.0	47.0	101.3
6000-8999.99	16.1	1680	87.2	50.2	106.6
9000-11999.99	10.7	1725	88.7	51.8	107.5
12000-14999.99	7.2	1746	90.3	53.9	112.8
15000-17999.99	4.5	1822	93.7	55.7	115.3
18000 and over	13.2	1956	100.0	61.6	125.2

Source: FNRI, DOST Fourth National Nutrition Survey: Philippines, 1993.

Table 4.8 Mean one-day per capita energy and protein nutrient intake and percent adequacy by education of meal planner: Philippines, 1993.

Education of Meal Planner	ENERGY		PROTEIN	
	Intake (kcal)	Percent Adequacy	Intake (g)	Percent Adequacy
No Formal Schooling	1802	94.0	49.1	100.6
1-7 Years	1634	84.8	48.0	101.5
8-11 years	1658	87.0	49.2	106.7
12 and over	1862	96.8	57.1	120.5

Source: FNRI, DOST Fourth National Nutrition Survey: Philippines, 1993.

Table 4.9 Mean one-day per capita energy and protein nutrient intake and percent adequacy by household size: Philippines, 1993.

Household Size	ENERGY		PROTEIN	
	Intake (kcal)	Percent Adequacy	Intake (g)	Percent Adequacy
1-2	2165	109.0	67.0	121.8
3-4	1882	97.2	57.0	118.0
5-6	1734	91.0	51.4	111.0
7-8	1601	83.4	47.0	100.4
9 and above	1544	80.4	45.0	96.2

Source: FNRI, DOST Fourth National Nutrition Survey: Philippines, 1993.

Table 4.10 Index of Agricultural and Food Production, and Food Import Dependency Ratio, Selected Asian Countries, 1986-1996.

COUNTRY	Index of Agricultural Production (1989-91=100)				Index of Food Production (1989-91=100)				Food Import Dependency
	Total		Per Capita		Total		Per Capita		Ratio (%)
	(1984-86)	(1994-96)	(1984-86)	(1994-96)	(1984-86)	(1994-96)	(1984-86)	(1994-96)	(1988/90)
<i>Medium Income</i>									
Indonesia	84	115	91	107	91	107	83	115	5.7
Malaysia	78	115	88	102	79	109	70	122	51.3
Philippines	90	117	100	105	100	106	90	119	11.4
Thailand	91	110	99	105	100	101	92	106	3.8
<i>Low Income</i>									
Cambodia	73	119	85	103	85	102	73	118	3.2
China	82	140	88	136	88	136	81	144	4.1
Lao PDR	91	114	106	98	107	98	92	114	5.6
Myanmar	111	139	123	127	121	127	110	139	0.9
Vietnam	82	126	98	87	97	86	82	112	1.8
Bangladesh	89	104	98	96	96	96	87	104	12.3
India	83	114	92	105	92	104	83	114	1.8
Pakistan	79	119	92	104	94	109	80	125	14.1
Sri Lanka	105	108	112	103	113	103	107	108	30.4

Source: Food and Agriculture Organization of the United Nations, as cited in World Resources, 1998.

Table 4.11 IFPRI Projections of Rice, 2020.

	Area/No. (000 ha)	Yield (kg)	Production	Demand	Food	Feed	Net Trade
			-----	000, mt	-----		
World	149,995	3,258	488,727	488,727	438,867	5,272	0
Developed	4,253	4,669	19,856	19,304	16,365	9	552
Developing	145,742	3,217	468,871	469,423	422,502	5,263	(552)
Asia	127,250	3,303	420,293	410,434	369,998	5,263	9,858
Middle Income							
Indonesia	11,216	3,756	42,126	43,590	38,553	856	(1,464)
Malaysia	659	2,560	1,687	2,943	2,804	58	(1,256)
Philippines	3,466	3,009	10,428	10,652	9,419	796	(224)
Thailand	8,707	1,787	15,559	8,193	8,325	326	7,366
Low Income							
Cambodia	...	...	...	...	...	...	...
China	30,039	4,905	147,341	145,004	131,593	2,443	1,336
Lao PDR	...	...	...	...	...	...	...
Myanmar	5,943	2,776	16,496	13,516	13,516	0	2,980
Viet Nam	6,507	3,268	21,398	18,527	15,926	214	2,871
Bangladesh	10,027	2,586	25,931	27,026	24,881	0	(1,095)
India	42,030	2,743	115,283	112,798	101,817	454	2,486
Pakistan	2,384	2,603	6,205	4,737	4,230	0	1,459
Sri Lanka	...	...	...	...	...	...	...

Source: (Rosegrant, Sombilla and Perez, 1995) Impact Model, IFPRI.

Table 4.12 IFPRI Projections of Cereals, 2020.

	Area/No. (000 ha)	Yield (kg)	Production	Demand	Food	Feed	Net Trade	
			----- 000, mt -----					
World	739,284	3,369	2,490,722	2,490,722	1,269,838	926,691	0	
Developed	273,117	4,047	1,105,401	877,214	192,932	536,428	228,187	
Developing	466,167	29,172	1,385,321	1,613,508	1,076,907	390,263	(228,187)	
Asia	269,399	3,435	925,501	1,042,781	729,822	236,322	(117,282)	
Middle Income								
Indonesia	14,534	3,631	52,766	63,554	49,217	9,266	(10,788)	
Malaysia	681	2,558	1,742	9,091	4,481	4,009	(7,349)	
Philippines	6,839	2,908	19,886	25,072	15,111	9,213	(5,186)	
Thailand	10,141	2,171	22,018	17,760	7,373	8,597	4,259	
Low Income								
Cambodia	...	...	...	...	...	...	...
China	89,137	5,037	448,949	490,053	293,716	170,653	(41,104)	
Lao PDR	...	...	...	...	...	...	...
Myanmar	6,529	2,638	17,221	14,364	14,094	211	2,858	
Viet Nam	7,055	3,231	22,798	20,515	17,324	709	2,283	
Bangladesh	10,747	2,569	27,606	31,865	29,356	19	(4,260)	
India	101,242	2,480	251,044	251,888	218,723	8,325	(846)	
Pakistan	12,747	2,636	33,599	49,865	44,320	2,885	(16,266)	
Sri Lanka	...	...	...	...	...	...	...

Source: (Rosegrant, Sombilla and Perez, 1995) Impact Model, IFPRI., Revised Projections.

Table 4.13 Indicators of Food Security in Old and New Eras

Indicator	Old Era (roughly 1950 to 1990)	New Era (roughly 1990 into indefinite future)
Grain production per person	Rising: up 40 percent from 1950 to 1984	Failing: down 15 percent from 1984 to 1995
Seafood catch per person	Rising: double from 1950 to 1989	Falling: down 7 percent 1989 to 1995; will fall as long as population growth continues
Grain prices	Declining in real terms from 1950 through 1993	Rising: will fluctuate, but around rising trend 1993 onward
Grain stocks	Abundant, often excessive	Low, often inadequate
Idled cropland	Cropland idled throughout this period	Little or no cropland idled after mid-nineties
Grainland per person	Shrinking slowly until 1981, then more rapidly	Shrinking rapidly as long as population growth continues
Irrigated area per person	Expanding: up 28 percent 1950 to 1979	Shrinking since 1979: will continue as long as population growth continues
Fertilizer use per person	Rising: up fivefold 1950 to 1989	Shrinking since 1989: will not rise much as both grainland and irrigation water per person shrink
Effect of climate change	Effect beginning to show as temperatures rise	More intense heat waves likely to plague efforts to expand output
Backlog of unused technologies	Huge at beginning of era, but diminishing over time	Greatly diminished: no dramatic advance in prospect
Politics of water	Gradually intensifying as period progressed	Intense competition among countries and between countryside and city
Politics of food	Dominated by surpluses; competition among exporters for access to markets	Dominated by scarcity; competition among importers for access to supplies

Source: Lester Brown, *Tough Choices*, 1996.

Table 4.14 Trends in Land Use, Selected Asian Countries, 1982-1994

COUNTRY	Land area (000 ha)	Pop'n Density per 1,000 hectares	Domes- ticated as a % of land area (a)	Land Use (000) hectares							
				Crop		Permanent Pasture		Forest & Woodland		Other Land	
				1992-94	Percent Change Since 1982-84	1992-94	Percent Change Since 1982-84	1992-94	Percent Change Since 1982-84	1992-94	Percent Change Since 1982-84
		1996	1994	1992-94	1982-84	1992-94	1982-84	1992-94	1982-84	1992-94	1982-84
Medium Income											
Indonesia	181,157	1,107	23	31,146	19.9	18,800	1.2	111,516	-2.6	26,695	-8.1
Malaysia	32,855	625	24	7,536	46.6	281	8.9	22,428	0.0	2,790	-46.4
Philippines	29,817	2,324	36	9,320	5.0	1,280	14.3	13,600	15.6	5,617	-30.3
Thailand	51,089	1,149	42	20,488	6.7	800	14.3	14,833	-3.7	14,968	-5.1
Low Income											
Cambodia	17,652	582	30	3,832	81.9	1,500	158.5	12,200	-7.3	120	-93.4
China	929,100	1,321	53	95,145	-3.6	400,000	12.5	128,630	-1.1	305,324	-11.4
Lao PDR	23,080	218	7	900	18.5	800	0.0	12,560	-4.1	8,820	4.7
Vietnam	32,549	2,310	22	6,738	2.3	328	5.1	9,650	-3.9	15,833	1.4
Bangladesh	13,017	9,224	71	8,849	-3.1	600	0.0	1,891	-1.3	1,677	45.2
India	297,319	3,177	61	169,569	0.5	11,424	-4.8	68,173	1.2	48,136	-2.1
Pakistan	77,088	1,817	34	21,323	4.7	5,000	0.0	3,477	15.1	47,288	-2.9
Sri Lanka	6,463	2,801	36	1,889	1.3	440	-1.8	2,100	20.2	2,034	-15.6

Source: Food and Agriculture Organization of the United Nations and United Nations Population Division, as cited in World Resources, 1998

India had the highest at around 170 million hectares. From 1982 to 1994, cropland areas had generally increased with the exception of China, Bangladesh and Myanmar. The highest percent expansion in cropland during the same period was Cambodia followed by Malaysia and Lao PDR. In terms of permanent pasture, Cambodia had also the highest percentage increase. However, in terms of magnitude of permanent pasture and forest and woodland, China had the highest at 400 million hectares and 129 million hectares, respectively (Table 4.14).

In terms of per capita cropland hectareage during the period 1982-1994, the trend was generally declining, with the exception of Malaysia and Cambodia. Irrigation trends as a percentage of cropland, were slightly increasing during the period, except for Indonesia, Malaysia and Cambodia (Table 4.15).

4.6 Environmental Trends

Average annual rate of deforestation was highest in the Philippines at 3.5%; followed by Pakistan, 2.9%; Thailand, 2.6% and Malaysia, 2.4%. The other countries

Table 4.15 Trends in Per Capita Cropland vs. Irrigation, Selected Asian Countries, 1984-1992

COUNTRY	Cropland				Irrigated Land as a Percentage of Cropland	
	Total Hectares (000)	Hectares Per Capita	Total Hectares (000)	Hectares Per Capita	1982-84	1992-94
	1984	1984	1994	1994		
<i>Middle Income</i>						
Indonesia	25,934	0.16	30,171	0.16	17	15
Malaysia	5,300	0.35	7,604	0.39	6	5
Philippines	8,920	0.17	9,370	0.14	16	17
Thailand	19,331	0.38	20,445	0.35	18	22
<i>Low Income</i>						
Cambodia	2,110	0.29	3,838	0.39	5	4
China	98,746	0.09	95,782	0.08	45	52
Lao PDR	810	0.23	900	0.19	16	16
Myanmar	10,061	0.27	10,076	0.23	10	11
Vietnam	6,590	0.11	6,758	0.09	26	28
Bangladesh	9,132	0.09	8,700	0.07	20	37
India	169,078	0.22	169,700	0.19	24	29
Pakistan	20,330	0.21	21,510	0.16	76	80
Sri Lanka	1,872	0.12	1,883	0.11	29	29

Source: Food and Agricultural Organization of the United Nations, United Nations Population Division

with deforestation rate of slightly one percent per annum, include Sri Lanka, Vietnam, Myanmar, Cambodia and Indonesia (Table 4.16).

As a percentage of total land area, Cambodia, Thailand and Sri Lanka had the highest protected areas ranging from 13 to 16%. Those with percentage range of 3.0 to 10 percent include Indonesia, Malaysia, Philippines, China, India and Pakistan. The others had national protected areas less than three percent of total land area (Table 4.16).

There is also a growing trend in the increase of Carbon Dioxide (CO₂) emission in Asian countries. In 1995, Malaysia had the highest per capita CO₂ emission at 5.3 mt, followed by Thailand and China with 3.0 m.t. and 2.7 m.t., respectively. The other countries had relatively low CO₂ emissions per capita ranging from 0 to 1.5 m.t. (Table 4.16).

Table 4.16 Environmental Indicators of Selected Asian Countries, 1990-1995.

	Average Annual Rate of Deforestation ^a (as % of forest area)	National Protected Areas ^b (as % of total land area)	Per Capita Carbon Dioxide Emissions ^c (metric ton)
	1990 - 1995	1994 ^d	1995
Middle Income			
Indonesia	1.0	9.7	1.5
Malaysia	2.4	4.5	5.3
Philippines	3.5	4.9	0.9
Thailand	2.6	13.1	3.0
Low Income			
Cambolia	1.6	16.2	0.0
China	0.1	6.4	2.7
Lao PDR	■	■	0.1
Myanmar	1.4	0.3	0.1
Viet Nam	1.4	3.1	0.4
Bangladesh	0.8	0.8	0.2
India	0.0 ^d	4.8	1.0
Pakistan	2.9	4.8	0.6
Sri Lanka	1.1	13.3	0.3

... Data not available.

^a Positive figures indicate deforestation rates while negative figures indicate reforestation rates.

^b Refers to all protected areas at least 1,000 hectares listed in categories I-V of the International Union for Conservation of Nature and Natural Resources.

^c Refers to carbon dioxide emissions from fossil fuel burning and cement manufacturing.

^d The number 0.0 means the magnitude is zero or less than half of the unit employed and not known more precisely.

4.7. Human Development Index

One of the most innovative approaches initiated by the UNDP, measuring a people-centered development, was the human development index (HDI). The HDI value is an aggregate measure of life expectancy, access in safe water, infant mortality, daily calorie supply, child malnutrition, adult literacy, mean years of schooling, possession of radios, real GDP percapita and GNP percapita (UNDP, 1994).

Table 4.17 shows some selected indicators and HDI value by country. Of the Asian countries studied, Thailand and Malaysia had the highest HDIs close to 0.800, followed by Sri Lanka, China and the Philippines with over 0.600. (Figure 4.2). The other Asian countries had HDI not higher than 0.450.

Table 4.17 Human Development Indicators of Selected Asian Countries, 1998.

	Adult Literacy Rate ^a %		Life Expectancy at Birth (years)		Population In Poverty ^b %	HDI ^c
	Female	Male	Female	Male		
Middle Income						
Indonesia	78	90	66	63	39	0.586
Malaysia	78	89	74	69	10	0.794
Philippines	94	95	69	64	38	0.621
Thailand	92	96	72	67	13	0.798
Low Income						
Cambolia	53	80	55	52	30	...
China	73	90	71	67	7	0.664
Lao PDR	44	69	52	50	46	...
Myanmar	78	79	63	60	....	0.406
Viet Nam	91	97	69	66	51	...
Bangladesh	26	49	58	58	36	0.309
India	38	66	65	62	36	0.382
Pakistan	24	50	62	63	34	0.393
Sri Lanka	87	93	75	70	35	0.665

... Data not available.

^a Refers to population of 15 years old and over.

^b Refers to the headcount or proportion of the households (population) falling below the poverty line to total households (population). Data relate to years 1990 through 1998.

^c HDI, human development index, an overall measure of the quality of life. See UNDP, 1994.

Sources: United Nations Educational, Scientific and Cultural Organization, Statistical Yearbook 1996 and past issues; World Bank, World Development Indicators 1998; Economic and Social Commission for Asia and the Pacific, Asia-Pacific in Figures 1997; Directorate-General of Budget, Accounting and Statistics, Statistical Yearbook; and country sources.

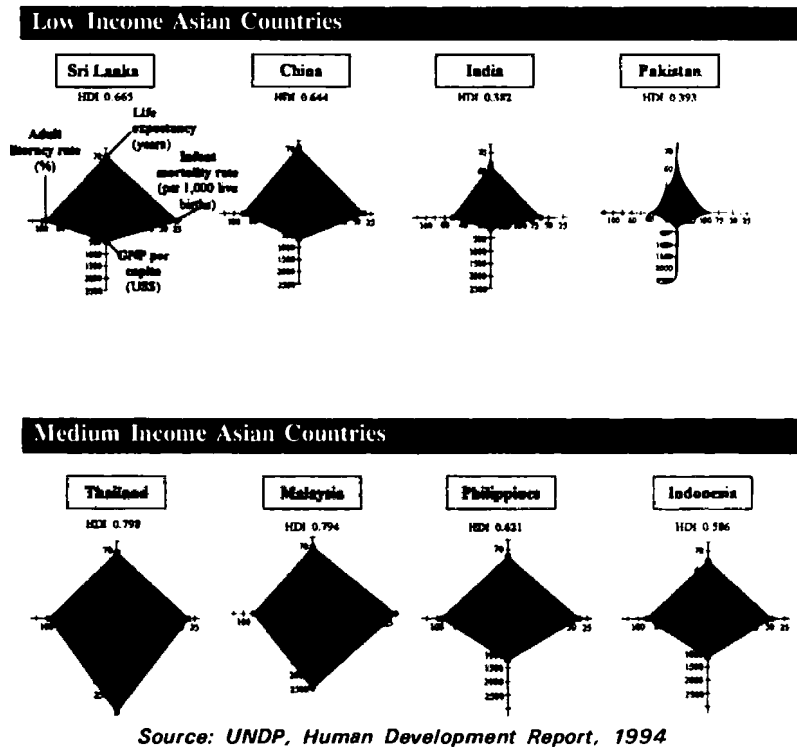


Figure 4.2 Levels of Income and Human Development, Selected Asian Countries.

5. INTEGRATING MULTICARRYING-CAPACITY CONCERNS: THE ROLE OF PUBLIC POLICY AND GOVERNANCE

5.1 Suggested Development Framework

The interactions of population pressure with the environment, natural resource endowments and the stakeholders of the development process are dynamic and complex warranting the need for integration within the context of human and sustainable development. A suggested development framework that links the multi C-C concerns of population, technology, socio-economic factors, management of the environment/natural resources, government policy and governance is schematically shown in Figure 5.1. This framework which was first introduced in 1990 (ADB, Economic Policies for Sustainable Agriculture, 1990) was modified to accentuate the role of government policies and governance.

The framework identifies several distinct but interrelated factors that determine the nature and strength of the linkages of population and environment with the other determinants of human and sustainable development.

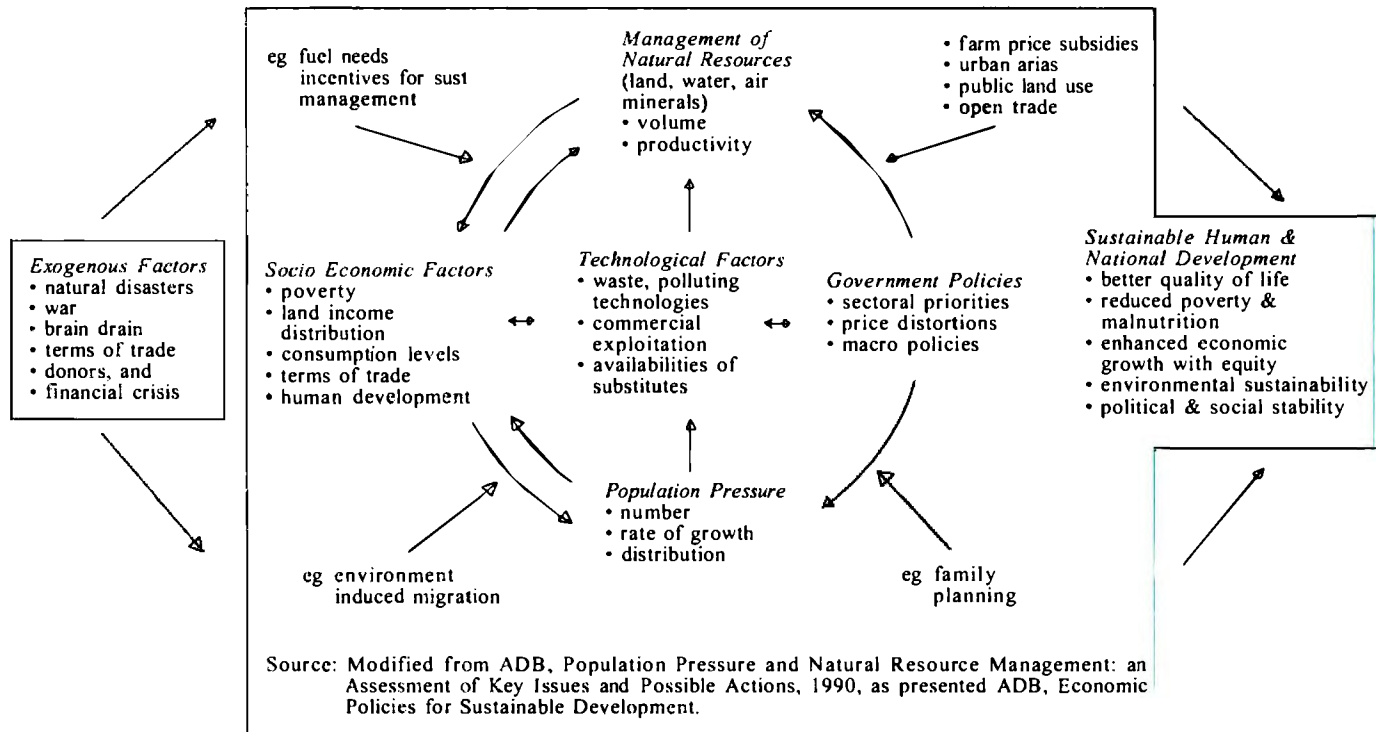


Figure 5.1 A Development Framework Linking Population, Technology and Natural Resources with other factors of Human and Sustainable Development

5.1.1 Exogenous factors

Largely, exogenous factors are those related to natural disasters (floods, storms, droughts among other), war, donors, and assistance from other countries. It can also include those of economic in nature, such as exodus of professionals (brain drain) in search for better employment opportunities; deteriorating terms of trade because of fluctuations of supply-demand conditions in external trade; and economic recession brought forth by external factors such as the Asian financial crisis of 1997.

5.1.2 Socio-economic factors

Within the context of human and sustainable development, the socio-economic factors summarize man's state of development: his/her levels of income, socio-cultural aspirations, poverty levels, level of distribution of assets and incomes, access to opportunities in education, jobs, access to basic support services, pattern of consumption and socio-cultural-religious values as a society. The socio-economic factors are the driving force (demand) in the dynamic interactions of population growth and the environment.

5.1.3 Technological factors

Technology can be simply defined as the state of art in doing things. The supply and availabilities of technologies that can shift the production function curves of most economic activities can, at the extreme, have indirect effects or negative externalities detrimental to the environment and the major stakeholders of the development process. The prevalence of waste from pollution producing technologies of industrial countries are examples of these. On the other hand, technologies that are environment friendly can prolong and sustain the life span of some environmental resources thus, creating the external economies whose benefits can be internalized by the same stakeholders.

5.1.4 Population

The dimensions of the population issue such as fertility, mortality, spatial mobility, the labor force and family formation are part of the demographic factors that should be incorporated in the process of demographic transmission and the analysis of the dynamics of population-environment/resources-sustainable development interface. In most C-C models, population is often considered as a stock variable (e.g. cattle population in a ranch) rather than a flow variable (e.g. human being with socio-cultural aspirations). In a human-sustainable developed paradigm, population should be treated beyond the concept of simply a biological organism that simply needs food but a homo sapiens with basic multiple socio-cultural needs.

5.1.5 Management of resource

Mankind has a bad history of managing his natural resources (land, water, air and minerals). Monitoring the level of productivity and degree of preservation and conservation should be part of resource and environmental management. Largely, most governments in the world assign the public sector to manage their natural resource endowments and the environment. The major argument for this is that natural resources and the environment are public goods and therefore should be managed by the public sector. However, the public sector, especially in the developing countries, had dismal records in efficiently managing their natural resources and environment. This brings to focus the need for new modalities (e.g. greater participation of endogenous people in natural resource management) in managing the natural resources and the environment.

5.1.6 Government policies

In the early stage of development, the public sector assumes the major function of defining developmental goals, allocating resources across sectors, and prescribing policies to sustain economic growth. Policies prescribed by the government can be sectoral in nature (those related to a particular sector such as agriculture, industry, or specific commodities) or the macroeconomic types (e.g. trade, monetary, and fiscal policies) dealing with national aggregates.

There is a special and unique role of government policies in the population-natural resource and environment interactions. Government policies provide the directional mechanism and legal framework by which the dynamic interactions of stakeholders take place. Macroeconomic policies, which define resource allocation across sectors, may or may not lead to efficient management of natural resources sector.

Some of the current policies adopted by most Asian countries whose impact on the exploitation of natural resources/environment need to be monitored and analyzed. Some of those are those related to openness in trade like: the General Agreement on Tariff (GATT), World Trade Organization (WTO), Asian Pacific Economic Conference (APEC) and the ASEAN Free Trade Agreement (AFTA) for ASEAN member countries.

To accentuate the role of government policies in the population-environment/natural resources, a closer look at the GATT-WTO provisions on Agreement on Agriculture; Agreement on Application of Sanitary and Phytosanitary Measures; and Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). General provisions of these agreements (Serenio, 1999) are expanded below:

a) Agreement on Agriculture

The Agreement on Agriculture consists of three major obligations:

- 1) the obligation to reduce domestic subsidies or support and to reduce current export subsidies as well as to refrain from granting new export subsidies,

- 2) the obligation to tariffy products previously subject to quotas; and
- 3) obligation to observe due notice and transparency requirements in imposing allowable export prohibition and restrictions.

b) Agreement on Application of Sanitary and Phytosanitary (SPS) Measures

The intent of the agreement is to ensure that sanitary and phytosanitary measures are not used as disguised form of non-tariff barriers. Members are encouraged to harmonize sanitary and phytosanitary measures by applying international standards and guidelines whenever applicable. Members may apply more than the international standards if there are scientific justification for such higher standards. International standards are defined as follows

- 1) for food safety, the standards, guidelines and recommendations established by the Codex Alimentarius Commission;
- 2) for plant health, the international standards, guidelines and recommendations developed under the auspices of the International Office of Epizootics;
- 3) for animal health and zoonoses, the standards, guidelines and recommendations developed under the auspices of the Secretariat of the International Plant Protection Convention in cooperation with regional organizations operating within the framework of the International Plant Protection Convention; and
- 4) for matters not covered by the above organizations, appropriate standards, guidelines and recommendations promulgated by other relevant international organizations open for membership to all members, as identified by the WTO's Committee on Sanitary and Phytosanitary Measures.

c) Agreement on Trade-Related Aspects of Intellectual Property Rights

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) requires the Members to make available:

“... patent protection for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step, and are capable of industrial application.”

Members may exclude from patentability inventions, the prevention within their territory of the commercial exploitation of which is necessary to protect ordre public or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, provided that such exclusion is not made merely because the exploitation is prohibited by law.

Members may also exclude from patentability:

- a) diagnostics therapeutic and surgical methods for the treatment of humans and animals;
- b) plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than the protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof.”

5.1.7 Governance

Governance is incorporated in the model because it is the most notable operational link that can facilitate and direct the dynamic and complex linkages and interactions of population, the environment and natural resources sector with the various stakeholders to a sustainable human and national development of a country. Given the dismal performance record of less developed countries in management of the natural resource endowments, the role of a good government cannot be overemphasized.

Governance simply means the quality of relationship between the government and its citizens whom it exists to serve. Another definition, is the “manner in which power is exercised in the management of a country’s social and economic resources for development. Put more simply, governance means the way those with power use that power” (ADB, 1998).

Governance has both political and economic dimensions. The economic dimension of governance, sound development management (e.g. in the natural resource sector) is “the core of sustainable development”. The four key components of governance (in natural resource management) need to be taken into account. These are accountability, transparency, predictability and participation. (ADB, 1998).

Accountability is the capacity to call officials of government to account for their actions. Effective accountability includes answerability and consequences. Government officials are answerable for their actions. They should respond whenever some citizens question their actions. These responses should be followed by predictable and meaningful consequences . . . not simply for compliance but for effective interactions.

Transparency entails low-cost access to relevant information, which are reliable and relevant. Economic and financial information is a must for the public to have access to.

Predictability results from laws and regulations that are clear, known in advance and uniformly and effectively enforced. Predictability of government economic actions is also needed as an indicator on which the private sector can rely to make its own production, marketing and investment decisions.

Participation is needed to obtain reliable information and to serve as a reality check and watchdog for government action. Past experience has shown that a strong civil society plays a critical role in advancing good governance. In natural resource

management, for example, there are positive results in allowing positive results in allowing wider participation of indigenous people in natural resource conservation.

6. CONCLUSIONS AND RECOMMENDATIONS

As the next millennium unfolds, we see a new world with an endangered future: a world entangled with the pressing challenges of population growth, deteriorating natural resource base and environment, technology plateaus, widening gaps of incomes between the rich and the poor and accelerated urbanization. This global scenario is likewise pervasive in developing countries, particularly Asia, whose indicative carrying-capacity trends have also already reached their limits.

Unlike in the old world where natural resources were still in abundance, stock of technologies readily available and human inhabitants of planet earth relatively smaller, we have to face the future with the greatest challenge of providing food security, the most basic quality of life indicator, to the human inhabitants of mother earth. This demographic transition for the next century is central to the survival of humankind.

Given the pessimistic scenario reviewed by this paper, the following recommendations are made.

6.1 The Establishment of Futures Center

This recommendation was earlier made by DAP/UPSE/UPPI in the PREPF study, to set up a national office (and probably an Asian Regional Office) to coordinate futures oriented studies at the national and Asian level. This idea should be brought across the ASEAN member countries for adoption considering that some negative impacts of population-natural resource interfaces (e.g. industrial pollution, global warming, forest fires) respect no political boundaries.

6.2 Emphasis on the Role of Technology

Appropriate environment friendly technologies have a major role in enhancing carrying capacities of less developed countries. First, technology, in the long term, if properly adopted and managed, lowers the per unit cost of food production. This will enable the poorer segments of society afford food supplied in the market. Since food commodities (e.g. rice) are wage goods in most developing countries of Asia, lower food prices, in effect, augment the effective purchasing power of the poor. This is regardless of where the food supply comes from.

The second point to be made on the role of technology is that anybody who is opposed to the generation, adoption and commercialization of appropriate technology is also anti poor. Technology and poverty alleviation are two sides of the same coin. Given the current depletion of the backlogs of technologies, in contrast to their availability and abundance in the past, developing countries have to fast track technology generation and commercialization if they want to eradicate hunger and poverty.

6.3 Incorporation of Carrying-Capacity Methodologies into the Main Stream of Planning, Policy Analysis and Formulation

Methodologies on carrying developed over the years, are rich in scope and approaches. Yet they are isolated and fragmented and not incorporated in main stream development planning and policy formulation. These methodologies should be applied not only to the global and national levels but also at the local levels, considering that some C-C concerns are local-specific in nature. Indicators should be disaggregated at the local levels for a better treatment of their specific solutions.

6.4 Setting Up Congruent Policies

Macroeconomic and sectoral policies provide the prioritization guides in the development process. Since policies have general resource allocation mechanisms, they should be set in a consistent manner to avoid unnecessary sectoral imbalances and negative effects in their implementation. As the world becomes a global village, much is expected for more congruence and consistencies of government policies. Although the dynamic features of policy setting (e.g. the GATT-WTO Agreement) makes it difficult at times for developing countries to anticipate, still LDCs should devote vigorous research efforts in the understanding the likely consequences of these policies (laws, agreements, Executive and Administrative Orders) across sectors.

6.5 The Need for an Integrative Development Framework

Considering the complexities of the interactions of the concerns on population, natural resources and environment, an integrative development framework is imperative to link all these concerns more consistently. An indicative integrative framework (suggested earlier) that incorporates, socio-economic factors, demography, management of resources, set of policies and governance within the context of a sustainable human and national development, should be examined more closely.

6.6 Special Role of Political Governance

Political governance as discussed earlier, describes the quality of relationship between the governed (citizens) and their government. With a strengthening of its four pillars of transparency, accountability, predictability and participation, policy and administrative reforms related to carrying-capacity issues will have higher probability of being implemented more efficiently. In particular, economic governance, or sound development management is at the core of sustainable human and national development.

REFERENCES

- Asian Development Bank. 1990. *Economic Policies for Sustainable Development*. ADB, Mandaluyong City, M.M., Philippines.
- _____. 1999. *Annual Report 1998*. ADB, Mandaluyong City, M.M., Philippines.
- Baillie, J. and Brian Groombridge, eds. 1996. *1996 IUCN Red List of Threatened Animals*. (Gland, Switzerland: World Conservation Union-IUCN)
- Brown, L.R. 1996. *Tough Choices: Facing the Challenge of Food Scarcity*. Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC, USA.
- _____. 1997. *The Agricultural Link: How Environmental Degradation could Disrupt Economic Progress*. Washington, DC, USA.
- _____. 1998. *Beyond Malthus: Sixteen Dimensions of Population Problem*. Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC, USA.
- Brown L. R. and Hal Kane. 1994. *Full House: Reassessing the Earth's Population Carrying Capacity*. Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC, USA.
- Brown, L.R., G. Gardner, B. Halweil. 1999. *Beyond Malthus: Nineteen Dimensions of the Population Challenge*. W.W. Norton & Co., 167 pp.
- Cabrido, C. A., Jr. 1988. *Methods for Determining the Population-Supporting Capacity of Ecosystems: Palawan Province*. Population/Development Planning and Research Project and National Economic and Development Authority. Quezon City.
- _____. 1994. *Integration of Population Dimension in the Environment and Natural Resource Management Sector: Planning Framework, Tools and Techniques, and Illustrative Cases*. Integrated Population and Development Planning Project and National Economic and Development Authority. Quezon City. 60 pp.
- Davis, K. and Bernstam, M.S. (eds) 1991. *Resources, Environment, and Population: Present Knowledge, Future Options*. The Population Council, Inc. Oxford University Press, N.Y., USA.
- Development Academy of the Philippines, UP School of Economics and UP Population Institute. 1980. *Probing Our Futures: The Philippines 2000 A.D. Population, Resources, Environment and the Philippine Futures*. M.M. , Philippines.
- Duncan, O.D. 1964. "Social Organization and the Ecosystems." (in Robert E. L. Faris, ed., *Handbook of Modern Sociology*. Rand McNally. Chicago, Illinois, USA.
- FAO. 1995. *World Agriculture: Towards 2010*. (Alexandratos, N. ed.) FAO-United Nations and John Wiley and Sons, Ltd. England.
- _____. 1997. *The State of World Fisheries and Aquaculture, 1996*. Rome.
- _____. Various years. *Yearbook of Fishery Statistics: Catches and Landings*. Rome.
- _____. 1998. *FAO Yearbook, 1997. Production*. Rome.
- Food and Agriculture Organization (FAO). 1996. *Food Production and Environmental Impact. World Food Summit: Technical Background Documents, vol. 2*. Rome.
- Food and Nutrition Research Institute. 1993. *Fourth National Nutrition Survey Philippines, 1993*. FNRI-DOST, M.M., Philippines.
- Hayley, A. 1950. *Human Ecology*. Rand McNally Press, NY, USA.
- International Conference on Population and Development. 1994. *Summary of the Programme of Action of the International Conference on Population and Development*. United Nations, NY, USA.
- International Food Policy Research Institute (IFPRI) and the National Geographic Society. 1995. *A 2020 Vision for Food, Agriculture, and the Environment: The Vision, challenge, and recommended actions*. Washington, DC, USA.
- Lee, R.D., W.B. Arthur, A.C. Kelly, G. Rodgers, T.N. Srinivasan. 1998. *Population, Food and Rural Development*. Oxford: Clarendon Press.

- Marland, et. al. 1998. Global, Regional, and National CO2 Emission Estimates from Fossil Fuel Burning, Cement Production and Gas Flaring: 1751-1995. Oak Ridge Library, <http://cdiac.esd.ornl.gov>.
- Nebel B.J. and R. T. Wright. 1998. Environmental Science (6th Edition). Prentice-Hall, Inc., Simon and Schuster/Aviacom Co., Upper Saddle River, N.J., USA.
- Ness, G.D. 1994. Population and the Environment: Framework for Analysis. Environmental and Natural Resources Policy and Training Project—EPAT/MUCIA-Research and Training (USA.ID), Michigan, USA.
- Postel, S. 1994. Carrying Capacity: Earth's Bottom Line. State of the World. Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC, USA.
- _____. 1997. Last Oasis (rev.ed.). W.W. Norton & Company, N.Y., USA.
- _____. 1998. Water for Food Production: Will there be Enough in 2025? Bioscience, USA.
- Preston, S.H. 1994. Population and the Environment: The Scientific Evidence. Population—The Complex Reality: A Report of the Population Summit of the World's Scientific Academies. (Francis Graham-Smith, ed). The Royal Society, North American Press, USA.
- Rosegrant, M.W., M. Sombilla and N. Perez. 1995. Impact Model. IFPRI, Washington, DC.
- Sereno, L. 1999. The Impact of WTO and AFTA Obligations on Philippine Agriculture. Paper presented at the National Forum on Agricultural Issues: WTO, AFTA and AFMA. June 10, 1999. Bureau of Soils and Water Management. Diliman, Quezon City.
- Srinivasan, T.N. 1988. Population Growth and Food—an Assessment of Issues, Models, and Projections. In: Lee, R.D., W.B. Arthur, A.C. Kelly, G. Rodgers, T.N. Srinivasan. 1998. Population, Food and Rural Development. Oxford: Clarendon Press, pp. 11-39.
- The World Resource Institute, The United Nations Environment Programme, The United Nations Development Programme and the World Bank. 1998. World Resources: 1998-1999. Oxford University Press, NY, USA.
- The World Bank. 1999. Knowledge for Development: World Development Report. Oxford University Press, NY, USA.
- The United Nations Development Programme. 1994. Human Development Report 1994. Oxford University Press, NY, USA.
- Umali, D. L. 1990. A Bill for a Lost Generation. Paper presented at the conference jointly sponsored by the Population Commission and the College of Human Ecology, during the celebration of Population and Development Week. SEARCA, UP Los Baños.
- United Nations. 1995. Copenhagen Declaration on Social Development. United Nations Department of Public Information. NY, USA.
- U.S. Department of Agriculture (USDA). 1998. Production, Supply, and Distribution (PS&D). Electronic Database, Washington, DC.
- USDA. 1991. World Grain Database. Unpublished Printout. Washington, DC.