Proceedings of the Fifth Agriculture Sector Symposium

Population and Food

Ted J. Davis, editor
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SYMPOSIUM ORGANIZATION
These proceedings will be the fifth in a series of records of Agriculture Sector Symposia presented at the World Bank beginning in 1980.

In planning this fifth program, the Symposium Working Group reviewed the evaluations by participants of the previous Symposium. The choice of overall theme for the Symposium was recommended by the Working Group and confirmed in plenary meeting with the agricultural Division Chiefs representing all of the six operating regions of the Bank.

The theme for this Symposium was "Population and Food" and it was jointly sponsored by the Agriculture and Rural Development Department, Population, Health and Nutrition Department, and Personnel Management Department. This principle theme was chosen to reflect the current internal work being done by the Bank on this and related subjects. The World Development Report 1984, published the previous summer, has as a theme, "Population Change and Development". A major work by the Agriculture and Rural Development Department has been underway for some time entitled, "The Bank's Food Security Policy". Coincidentally, the Food and Agriculture Organization of the UN has recently completed a long term study, "Potential Population Supporting Capacities of Lands in the Developing World".

In addition to these major papers, Bank internal research resulted in specific presentations including, "Population Growth and Technological Change", "Population Growth and Agricultural Productivity in Sub-Saharan Africa". In addition, the subject of nutrition was covered by two speakers on, "Bank Interventions in Nutrition" and "Nutrition Considerations in Agriculture Sector Work and Project Design".

These papers relating to population and food were presented during two days of the Symposium. At the request of the agricultural Division Chiefs one session of the Symposium was devoted to a review of the Bank's growing work in Policy Based Lending in Agriculture. This session is reflected by five country case studies and a summary of the discussions.

1/ Messrs. Donald C. Pickering, Chairman, Agriculture and Rural Development Department
John Cole, West Africa Projects Department
J. Clive Collins, Agriculture and Rural Development Department
Ted Davis, Agriculture and Rural Development Department
Samir Bhatia, Europe, Middle East and North Africa Projects Department
Robert Milford, Latin America and Caribbean Projects Department
Frank Thornley, South Asia Projects Department
Dennis Parsons, East Asia Projects Department
Bernard Masters, Personnel Management Department
This year's Symposium differed from previous Symposia in two major respects. It relied almost exclusively on the use of World Bank staff as authors and presenters of papers (the exception being papers by FAO and IFPRI). In addition the Symposium was limited to three days rather than five. This reflected the more highly focussed theme of this year's Symposium.

Continuing the practice of recent Symposia, a top Bank manager is a final featured speaker. In this Symposium the final speaker was Mr. Shahid Husain, Vice President Operational Policy Staff, who spoke on "Thoughts on the Future Product of the Bank".

This volume contains the papers presented by the speakers, the Chairpersons' statements and the summaries of the discussions prepared by the rapporteurs. It is designed as a permanent record to further enhance the knowledge of the Bank staff working in agriculture and rural development, and this year, working in population, health and nutrition, and as a means of exchanging knowledge with other readers working in these fields.
OPENING REMARKS

by

G. Edward Schuh*

I would like to begin by welcoming each and every one of you to the Symposium. It is a pleasure for me to be here with you, not only to benefit from what promises to be a stimulating symposium, as we have already seen, but to join you as Director of Agriculture and Rural Development.

I look forward to working with each of you in the years ahead as we work at developing the capacity to feed the world's ever burgeoning population and attempt to improve the income of the masses of poverty stricken people that are concentrated in agriculture. This is the first time that the Agriculture Symposium has been offered joint with another department of the Bank. I laud this joint sponsorship between the Population, Health and Nutrition Department and the Agriculture and Rural Development Department. This is obviously one of the more important interactions in our work and I would argue that there's probably no more important interaction than that between agriculture and population in all of its various dimensions.

There are a number of points that surface as we take this particular perspective to our problems. It might be worth mentioning some of these points at the very beginning. Perhaps this will help set a little bit of the tone for Nancy Birdsall's presentation which will follow.

One of the first points I would like to emphasize is that a concern with population reminds us that the development of agriculture is a means to an end and not an end in itself. Those of us in agriculture need to remind ourselves of that occasionally. We develop agriculture so that it can make a greater contribution to the development of the economy as a whole. That means that we view this effort as a means to raising per capita income of the society as a whole.

Second, thinking about population reminds us that it is women and men who are the ultimate goal of our efforts. It is their welfare and income that we want to improve, and the key to that, of course, is to raise their productivity. We seek to raise the productivity of land and other resources only as a means to raising the productivity of labor. Again, this is a terribly important point that we often lose sight of; we get all caught up in raising land productivity and raising livestock productivity and that sort of thing - and forget what the ultimate goal really is.

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Third, the concern with population and its various dimensions eventually brings up a concern with nutrition, with health, and with food security. Together with formal schooling, nutrition and health are important forms of human capital, and thus important means of raising the productivity of labor and eventually the income of farm and non-farm people.

Finally, a concern with numbers of people necessarily comes up in any discussion of population. It is important to remind ourselves why numbers are important. After all, when a country has a large cattle herd, a large swine herd, or a large poultry flock, we generally think that country is better off than other countries that have smaller herds and flocks. One can logically ask then, "Why don't we have the same views about human population?"

The answer, of course, is that we have a concern with the quantity of the population primarily because of a concern with the quality of that population. To raise the productivity of labor and eventually the per capita incomes of population requires the development of human capital. That is, of course, essentially an investment issue. For given investment resources we can have a rise in per capita investment only with a reduction in the population base itself. Those of you familiar with the household economics recognize that one is always making trade-offs on the quantity versus quality frontier.

There is one final set of comments I would make. The Agriculture Symposium is the keystone to the Structured Training Program of AGR in the Bank. It represents a significant commitment of financial and human resources in terms of program delivery. It is also the event to which most training days of agricultural staff are committed. As in all educational ventures, it is the participants who are the key to success. Ted Davis and his colleagues have put together an excellent program for us. The success of the program will ultimately be determined by you in the audience. I hope you'll make the commitment to make it a success so that we can all learn from this very important sharing experience. I look forward to meeting those of you whom I haven't met and may we have a very productive three days. Thank you.
OPENING REMARKS

by

Emmerich M. Schebeck*

Thank you for this opportunity to join you in discussing this important subject of Population and Agriculture. As we have been so clearly reminded in this year's World Development Report, the dynamics of population growth and agricultural growth interactions are of serious concern in most developing countries. Rapid population growth erodes much of the progress made in agriculture, progress which, as you in this auditorium all know too well, is often painstakingly achieved in the first place. Over the twelve year period from 1970 to 1982, for example, the average annual growth of agricultural production for all developing countries combined was 2.9 percent. During the same period, population grew at an average of 2.2 percent per year. As much as three-fourths of the gains in agriculture during those years were lost to population growth.

In the poorer countries, population growth has outstripped growth in agriculture to the point where per capita food production has declined over the last decade. In sub-Saharan Africa, for example, agriculture grew at 1.5 percent per year during the 1970-82 period while population grew at 2.9 percent per year. Agricultural output grew only half as fast as population during those twelve years, causing increased numbers of Africans to suffer deteriorating living conditions.

Population growth does not only affect agriculture by increasing the need to produce more food for a growing dependent population. In a more direct way, it affects productivity in agriculture when growth in the rural population leads to more intensified use of fixed land resources and hence to deterioration in the quality of land. In its most extreme form, as we see in drought-stricken Africa today, these pressures on land have led to increased vulnerability to climactic fluctuations and uncertainties about the long-term population supporting capacities of marginal areas.

Despite these close interactions between agriculture and population, there has been little exchange of ideas between the two sectors. Population planners have not considered agricultural variables in setting national demographic targets; agriculture planners have not considered closely the effects of population growth in assessing the investment options appropriate to also meet nutritional and income requirements of largely impoverished population groups. While we recognize that each sector affects the other, we don't know enough about the nature of these interactions or how to treat these interactions in sectoral planning. Of particular importance are the dynamics of the relationship,

* Acting Director, Population, Health and Nutrition Department, World Bank.
the short versus the long run. We plan for the long-run food output and fertility reduction but increases in food production are needed in the short run, as population size mushrooms at current growth rates. The issue then becomes one of time and cost not theoretical possibilities. We need to learn more about time constraints (e.g., savings/investment potential, research generation), cost constraints (e.g., irrigation, soil conservation, resettlement schemes) as well as constraints to the demand for food and juxtapose those findings with projections of population growth.

And then there is the whole issue of the link between agriculture and nutrition. While our agricultural sector work focuses predominantly on the important production issues, seldom does it adequately address the broader issues of food consumption and improved nutrition. Flowing from this, the projects themselves in their design more often than not lack consideration of the consumption dimension. On the other hand, the nutrition sector work in the Bank is not adequately communicated to and coordinated with what goes on in the Bank's agricultural divisions; similarly PHN projects generally lack the necessary links with the agricultural sector which is so fundamental to nutrition.

Within the Bank, there has not been enough exchange between agriculture staff and PHN staff. This is the reason why this meeting is so important. This joint symposium is an important first step but, hopefully, only the beginning of continuing cooperation. I suggest that we follow up on this meeting with joint attempts to tackle the many areas in which agriculture and population planning come together. Among these, we should include efforts to:

First, examine the implications of population growth for agricultural planning in different settings. The major area to be explored here is the interrelation among agriculture, population, and the environment, a subject that should receive closer attention in both agriculture and population sector analysis.

Second, improve country-specific estimates of population-supporting capacities of land, building upon the substantial attempts already made by the FAO, and paying special attention to the timing and cost constraints imposed by rapid population growth; and

Third, figure out ways for better incorporation of consumption considerations in agriculture sector and project work—including addressing consumer food marketing issues—and, conversely, making greater use of agricultural sector insights in identifying needs for PHN work.

Having laid these suggestions on the table, I leave you now to proceed with this symposium, hoping for fruitful discussions and looking forward to continued interaction beyond these three days.

Thank you.
SESSION I: POPULATION AND FOOD

LAND, FOOD AND POPULATION
IN THE DEVELOPING WORLD

by


INTRODUCTION

According to UN projection (Salas, 1981), world population could reach a stable level of 10.5 billion by 2110, compared with 4.4 billion at present and 6.2 billion projected for the year 2000. The bulk of the increase is projected to take place in the middle of the 21st century, with world population reaching 9.3 billion in the year 2055.

The significance of these projections for future requirements of food and other agricultural commodities is that world demand could increase by 50 percent in the next 20 years and would more than double again in the first half of the next century. Requirements will actually grow faster than world population since almost all the population increases - 95 percent - will take place in the developing countries which, at present, and on average, have low per capita consumption levels. Hence, by the time the world was getting reasonably close to population stability, demand for food and agricultural products could be three times its present level (FAO, 1981).

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Within this context national (and international) planners are rightly demanding quantified information on specific aspects of national land resource endowments, such as:

- where are the cultivable areas, what is their extent, for what types of use are they most suited and what is the range in their potentials under different input/management systems
- what inputs are necessary (and where) to meet future food demands; where are the deficit and surplus areas given various input/management levels and movement of surplus assumptions
- what is the risk of degradation and what control measures are required to ensure sustainable production
- where and on what crops should limited inputs be applied to obtain maximum returns, and what is the cost.

This paper reports on two recent FAO activities which shed some new light on such land, food and population issues and which, we believe, point the way for more detailed studies in this subject area at the national level.

In particular, reference is made to two studies, namely the "Agro-ecological Zone Study" (FAO 1978-81) and the "Potential Population Supporting Capacity Study" (FAO 1982). The latter, carried out by FAO, in collaboration with the International Institute for Applied Systems Analysis and with the support of the United Nations Fund for Population Activities, makes a first approximation of the potential population supporting capacities of lands of the Developing World in comparison with their 1975 and projected (year 2000) populations.

**METHODOLOGY**

A basic theme in these two activities is that the ability of land to produce is limited and any attempts to produce food in excess of these limits results in a vicious cycle of degradation and ever-reducing yields. Without food imports, malnutrition and hunger inevitably follow.

Limits to production are set by soil conditions, climatic conditions and the use and management applied to land. Accordingly, in attempting to quantify potential productivity and potential food production, it is necessary first to define the use and management being considered.

Is the assessment for productivity of wheat or productivity of rice? Is it potential productivity under rainfed conditions or under irrigated conditions? Is cultivation to be
undertaken with mechanization or with unimproved handtools? Most importantly, is the quantification of potential productivity under a low-input management level, or with application of a high-input management level? Equally important, is the quantification of long-term production potentials, with conservation measures or without?

For the presently reported potential population supporting capacity study, three input-levels/management circumstances have been considered, namely:

- A low-input management level, with currently grown mixture of crops and local cultivars, no fertilizers, no chemical control of pest, disease or weed, no conservation measures, and manual labour with handtools.

- An intermediate-input management level, with half optimum mixture of crops and improved varieties, some fertilizer application, some chemical control of pest, disease and weed, some conservation measures and manual labour with improved handtools or animal traction with improved implements.

- A high-input management level, with optimum mixture of crops and high yielding varieties, optimum fertilizer use, optimum pest, disease and weed control, complete conservation measures and mechanization.

A summary of the assumptions used in these three input/management scenarios is presented in Table 1.

Given such input definitions, soil conditions have been taken into account in the assessment by using the soils data available from the FAO/Unesco Soil Map of the World (FAO 1971-81). This data quantifies the location and extents of 106 soil units, mapped as soil associations and also provides information on dominant slope and texture classes of the mapping units. Additionally, where applicable, information on the occurrence of twelve phases with important management implications, is provided. Information available from this map is summarized in Table 2.

Interpretation of this soils data provides an insight to existing soil conditions with regard to rainfed cultivation potentials and management requirements, as shown in Table 3 for the Developing World.

Soils having some form of constraint to rainfed crop production comprise nearly 80 percent of the area in the Developing World. Fertility limitations and coarse textures are among the major constraints.
Climatic conditions have been taken into account in the assessment through compilation and use of a specifically created climatic inventory. This climatic inventory characterizes both temperature and moisture conditions through the concept of length of growing period - the duration (in days) when both moisture and temperature permit crop growth. A moisture supply from rainfall of half (or more than half) potential evapotranspiration and mean daily temperatures greater than 5°C have been considered as conducive to growth. Quantification of the temperature attributes, during the period when moisture is available, has been achieved by classifying major climates, defining the actual temperature regime during the growing period.

Interpretation of the climatic inventory provides a general summary of climatic conditions for rainfed cultivation in the Developing World as presented in Table 4.

The areas which are climatically suitable, in some degree, for rainfed crop production are those with short, long and year-round humid growing periods with no severe temperature constraints, as follows:

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest Asia</td>
<td>17.9 percent</td>
</tr>
<tr>
<td>Africa</td>
<td>53.3 percent</td>
</tr>
<tr>
<td>Central America</td>
<td>63.7 percent</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>84.2 percent</td>
</tr>
<tr>
<td>South America</td>
<td>85.5 percent</td>
</tr>
</tbody>
</table>

More than 80 percent of Southwest Asia is climatically not suitable for rainfed crop production. In contrast more than 85 percent of South America is climatically suitable for rainfed crop production.

Overlay of the climatic inventory on the Soil Map results in an inventory of land units each with its own unique soil and climatic conditions, and provides the computerized climatic and soil resource data base created by the study and now available for all developing world countries (FAO 1978-81).

This data base quantifies the total extents of each soil unit, broken down by texture class, slope class and phase (where present) as they occur in each major climate and in each length of growing period zone, on a country by country basis.

This resource data base is the foundation of both studies and, from it, the potential yield of major food crops has been calculated. Inherent in this methodology is an initial crop and input-level specific determination of agro-climatic suitabilities for rainfed cultivation. These agro-climatic suitabilities are subsequently modified by appropriate and specially compiled soil, slope, texture and phase ratings to provide crop and level of input specific land suitability assessments in terms of potential crop yields.
Land areas capable of yielding 80 percent or more of the maximum yield attainable are classified as very suitable (VS); areas yielding less than 80 to 40 percent are suitable (S); areas yielding less than 40 to 20 percent are marginally suitable (MS) and areas yielding less than 20 percent are classified as not suitable (NS). Not suitable does not necessarily mean that the crop will not grow, but rather that its yield will be such that the crop is not considered economically exploitable on a field scale.

This land suitability classification allows calculation of the total extents of potentially cultivable land as well as the extents of individual crop suitabilities, as presented in Table 5 for some selected crops in Africa. The results show that the area suitable for maize is extensive (424 million ha) but the area suitable for wheat is small (38 million ha).

The total extent of potentially cultivable rainfed land in the developing world is 2,028 million hectares compared with a presently cultivated area of 670 million hectares, as shown in Table 6 (Dudal, Higgins and Kassam, 1982).

Such basic data, from FAO’s Agro-ecological Zone Project (FAO 1978-81), allows calculation of the potential food production and, subsequently, estimates of potential population supporting capacities.

The estimates are obtained by analysing separately each area of the land inventory to ascertain which of 16 major crops have the highest calorie-protein production potential under the unique soil and climatic conditions of the area. Prior to this analysis, deductions are made for land required for non-agricultural use, for irrigation and for fallow period requirements. Limitations imposed by degradation hazards are also taken into account.

After selection of the land use giving the highest potential calorie-protein production, results are totalled to arrive at calorie-protein potentials for each length of growing period zone. Once the maximum potential calorie-protein production combination is ascertained, including the present and projected contribution from irrigated areas (FAO 1981), application of country-specific per capita calorie-protein requirements allows computation of the potential population supporting capacities, in each zone in each country. This data is computed as potential density in terms of persons per hectare, and is subsequently compared with present and projected population densities. Critical zones are identified where, according to the level of input envisaged, potential production from land resources is insufficient to meet the food needs of the populations either at present and/or projected to be living in these areas.
Two time-frames are employed, namely, the 'present' as represented by the year 1975, and the 'projected' as represented by the year 2000. Choice of the year 1975, as representing the present time-frame, is dictated by the need to employ population and crop mix data at a sub-national level.

It is important to bear in mind some limitations (FAO 1983) of this first assessment, particularly that the results imply the use of all potentially cultivable land for 16 food crops and grassland for livestock production. The 16 food crops do, however, provide more than 80 percent of the total dietary intake of populations in 90 developing countries.

The study has not yet taken account of fish production, cash crops, nor fully accounted for fuelwood requirements or timber requirements, and neither does it deal with specialized crops and techniques, which might be more productive in specific environments than the 16 food crops and three input levels considered. Additionally, it does not assume major land improvements such as flood control measures.

RESULTS

The smallest unit of analysis in the study is the individual-country length of growing period zone. If the results from the individual zones are aggregated on a regional basis, it depicts the situation of each region acting as one entity with massive and unrestricted movement of surplus potential and labour throughout the entire extent of the region. Under this extreme assumption, the results appear promising.

Regional ratios of potential to present population (year 1975) and potential to projected population (year 2000), at the three levels of inputs circumstances, are presented in Table 7.

These data show that the land of the five regions together could, even with low level of inputs, meet the food needs of 2.0 times the year 1975 population and 1.6 times the food needs of the projected year 2000 population.

The individual regional values show that the lands of each region (with one exception) could more than meet the food needs of their year 2000 populations, even with low level of inputs; i.e. South America - 3.5 times, Africa - 1.6 times, Central America - 1.4 times and Southeast Asia - 1.1 times.

The exception, to these potentially regional self-sufficient food situations, is Southwest Asia where the ratios for the year 2000 are 0.7, 0.9 and 1.2 at the low, intermediate and high levels of inputs respectively, i.e. this region (as a whole) will need to apply more than intermediate level of inputs, to all its cultivable land, if it is to attain food
self-sufficiency for its year 2000 population. These aggregated
results however involve the extreme assumption of massive
movement of surplus potential throughout the continents.

At the other end of the spectrum, namely each one of the
\textit{many individual zones} within a given country attempting to attain
food self-sufficiency from its own land resources, the situation
is drastically different.

Under this equally extreme assumption, there are vast
areas of critical zones where land resources are already
insufficient to meet the food needs of populations presently
living on them. Under the low-input level, Africa represents the
most serious challenge for critical zones extend right throughout
almost the whole of the Sahel through southern Sudan into the
drier parts of Ethiopia, Somalia, Kenya, Tanzania, the highlands
of Rwanda and Burundi, and into the drier parts of southern
Africa. Large parts of Southwest Asia and India are critical
under this assumption as are highlands in South America and the
island of Java.

Results for the five regions in the Developing World for
the present (year 1975) situation are presented in Table 8 and
show that the total area involved is nearly 2.5 billion hectares
where more than 1.1 billion people, one-half of the total
population, are living at the present time. Over 560 million of
these people cannot be fed from the land resources of these
areas, should cultivation with low level of inputs be practised.

Under an intermediate-input level, the extent of these
critical zones reduces but large parts of arid and semi-arid
Africa and Southwest Asia remain critical and some parts stay so
even under high-levels of inputs. The area affected with
intermediate inputs is 1.7 billion hectares (387 million people)
and 1.4 billion hectares with high inputs (212 million people).
The excess populations are 176 and 102 million people
respectively.

As previously stated, these two sets of results are
extremes, namely aggregation to regional level and disaggregation
to individual-zone level.

A more practical guide to the true impact of the problem
is provided by the results aggregated to the \textit{individual-country}
level, that is the assumption of movement of surplus within
individual countries.

These results, presented in Table 9 (year 1975) and Table
10 (year 2000), show that, if low-input levels would prevail by
year 2000, the number of critical countries in the five
developing regions that could not feed themselves from their own
national land resources, will rise from 54 in 1975 to 64 in year
2000.
Increasing the level of input is vital to reducing the number of critical countries by year 2000, but even at intermediate level of input, the study assesses that 36 countries, with a total population of more than 1.2 billion, would remain in a critical situation by that year, as compared with 24 in 1975 (651 million people).

The importance of attainment of projected expansions in irrigated area and production therefrom cannot be over emphasized. The anticipated contribution of irrigation production to total production potential in Africa by the year 2000 is no less than 20 percent of the total potential, under low input level. Regional figures vary from an exceptional high of nearly 90 percent in Southwest Asia to a low of 13 percent in the dominantly high rainfall South America region (Table 11).

Equally important is the need for conservation measures by that year. The assessment indicates that, as shown in Table 12, nearly 20 percent of the total rainfed crop potential could be lost in the developing regions if soil conservation measures are not introduced (Table 12).

The results are striking. Over the five regions as a whole, the area of potential rainfed cropland reduces by 17.7 percent if soil erosion is allowed to remain unchecked. Even more striking is the estimate that sustainable potential rainfed crop productivity reduces by 28.9 percent if erosion is allowed to continue at its full rate. The larger decrease in rainfed productivity reflects the degradation of very productive land to productive or marginally productive land, while still remaining in the category of rainfed cropland. Additionally, land which degrades into not-suitable cropland, continues to have a productive potential through grassland/livestock production.

SOME MANAGEMENT POLICY IMPLICATIONS

While the findings of the study are the results of a broad brush assessment, they do bring to light some important considerations in the land, food and population issue, namely:

- That land resources and their potentials are very unevenly distributed both within and between countries.

- That increasing input/management levels in the developing regions is absolutely essential if present and future populations are to be adequately fed.

- That there are very considerable areas where land resources are insufficient to meet the food needs of populations presently and projected to be dependent on them by the end of the century.
The question "what can be done?" is a consequence. There is no doubt that the assessed food deficits can be met from the resources of other areas and countries. However, such solutions involve major considerations on aid, trade liberalization, price orientation and stabilization, foreign exchange earnings, food reserves, regional collaboration and many other issues which are an integral part of the world food security problem, but subjects which are outside the scope of this paper. The present discussion centres on means for attainment of the objectives of food self-sufficiency and self-reliance.

Firstly, the areas which are critical with low level of inputs, i.e., those areas where low-input use of all potentially cultivable land will not meet food needs. Here horizontal expansion of production is not possible and the priority is to raise input levels. Such increases in input levels involve not only fertilizer use, but also changes in presently grown mixtures of crops, conservation measures and measures to reduce post-harvest losses. Intermediate level of input use is estimated to equate with a fertilizer use figure approximating to around 80 kg of nutrient per crop per hectare; some estimates (FAO 1984) of current fertilizer use on food crops in Africa, for example, are some 6 percent of this requirement. Such increased mineral fertilizer use must, where possible, be combined with increased use of organic materials to provide an integrated and optimum nutrient package. Changes in crop mixes, to concentrate on crops most suited to particular environments, are included in the increased input use; increased cultivation of upland rice and soybean, for example, in Africa would markedly contribute to raised productivity in the environments particularly suited to those crops and currently growing sorghum as a staple food. Implementation of 'farm' conservation measures would prevent assessed average rainfed crop productivity losses of 20 percent, rising to maximums of more than 60 percent in specific hazardous environments.

Coupled with these necessary input-level increases, and of particular importance in areas which would be critical with intermediate and even high levels of inputs, are implementation of major land improvements to enhance the land resource base. Such measures include increased irrigation development, reclamation of saline and/or alkaline lands, drainage and flood protection measures. The economics of major land improvement schemes however requires special economic consideration vis-a-vis development of other resources as foreign exchange earners with which to buy food. Consideration of development of these other resources, e.g., tourism, mineral resources, is of particular importance in those areas estimated as critical even under high level of inputs and can include development of areas of particular environmental advantage for high valued cash crops.

For areas which are not critical with low level of inputs, there is obviously a wider choice for obtaining increased productivity, namely expansion of the area under cultivation as
well as increased yields from presently cultivated areas. The problems of successful developments of new lands must not, however, be underestimated. Much of the land remaining for horizontal expansion is in the humid tropics with special clearing, fertility and conservation requirements. The reasons why human populations have previously avoided these areas, e.g. lack of infrastructure and services and poor health conditions, also need close attention. However, the potential for such crops as rice, cassava and tree crops, is high and can be exploited in the future. The time required for such development, however, should also not be underestimated.

The foregoing point to one of the most important, but insufficiently recognized, needs for increasing productivity in the developing regions, namely long-range and sound land use planning. Food requirements need to be determined on a country by country basis, not only for the present but also for the long range future and certainly well past the year 2000. Indeed, not until the year 2100 will populations be stabilized (three to five times present populations) within the five developing regions (Salas 1981). Ecologically-sound plans need to be formulated to meet these future needs. The plans should include provision for optimum socio-economic use of limited resources and incentives and policies designed to ensure their sustained use by the farming communities. Provisions for monitoring of progress should be an integral part of the plan.

To achieve these necessary long-range plans, and the most efficient use of available resources, it is vital to "have to hand" a clear inventory of the physical resource base and its potential. "We must know what we are dealing with" is perhaps one of the most important conclusions to be reached by policy makers in the agricultural field.
REFERENCES


### Definition of levels of inputs and associated management circumstances

<table>
<thead>
<tr>
<th>Crops of the assessment</th>
<th>pearl millet, sorghum, maize, rice, wheat, barley, phaseolus bean, soybean, groundnut, sweet potato white potato, cassava, banana/plantain, sugarcane, oil palm, grassland</th>
</tr>
</thead>
</table>

#### Table 1

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>LOW INPUT LEVEL</th>
<th>INTERMEDIATE INPUT LEVEL</th>
<th>HIGH INPUT LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production system</td>
<td>Rainfed cultivation of presently grown mixture of crops</td>
<td>Rainfed cultivation with part change to optimum mixture of crops</td>
<td>Rainfed cultivation of optimum mixture of crops</td>
</tr>
<tr>
<td>Technology employed</td>
<td>Local cultivars. No fertilizer or chemical pest, disease and weed control. Rest (fallow) periods. No long-term soil conservation measures</td>
<td>Improved cultivars as available. Limited fertilizer application. Simple extension packages including some chemical pest, disease and weed control. Some rest (fallow) periods. Some long-term conservation measures</td>
<td>High yielding cultivars. Optimum fertilizer application. Chemical pest, disease and weed control. Minimum rest (fallow) periods. Complete conservation measures</td>
</tr>
<tr>
<td>Power sources</td>
<td>Manual labour with hand tools</td>
<td>Manual labour with hand tools and/or animal traction with improved implements</td>
<td>Complete mechanization including harvesting</td>
</tr>
<tr>
<td>Labour intensity</td>
<td>High, including uncosted family labour</td>
<td>High, including part costed family labour</td>
<td>Low, family labour costed if used</td>
</tr>
<tr>
<td>Capital intensity</td>
<td>Low</td>
<td>Intermediate with credit on accessible terms</td>
<td>High</td>
</tr>
<tr>
<td>Market orientation</td>
<td>Subsistence production</td>
<td>Subsistence production plus commercial sale of surplus</td>
<td>Commercial production</td>
</tr>
<tr>
<td>Infrastructure requirements</td>
<td>Market accessibility not necessary. No advisory services</td>
<td>Some market accessibility necessary. Access to demonstration plots and advisory services</td>
<td>Market accessibility essential. High level of advisory services and application of research findings</td>
</tr>
<tr>
<td>Land holdings</td>
<td>Fragmented</td>
<td>Sometimes consolidated</td>
<td>Consolidated</td>
</tr>
</tbody>
</table>
Soils data: FAO/Unesco Soil Map of the World

| FAO/Unesco Soil Map: 106 soil units mapped as soil associations: 1:5 million scale |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 Major soil units | Fluvisols (J) | Arenosols (Q) | Solonchaks (Z) | Kastanozems (K) | Gleysols (G) | Rendzinas (E) | Solonetzs (S) | Chernozems (C) | Regosols (R) | Rankers (U) | Yermosols (Y) | Phaeozems (H) | Lithosols (I) | Andosols (T) | Xerosols (X) | Greyzems (M) | Cambisols (B) | Vertisols (V) | Acrisols (A) | Histosols (O) | Luvisols (L) | Podzoluvisols (D) | Nitosols (N) | Ferralsols (F) | Podzols (P) | Planosols (W) |
| 3 Texture classes | Coarse, Medium and Fine |
| 3 Slope classes | 0 - 8%, 8 - 30%, > 30% |
| 12 Phases | Stony, Lithic, Petric, Petrocalcic, Petrogypsic, Petroferric, Phreatic, Fragipan, Duripan, Saline, Sodic, Cerrado |
### Table 3

**Dominant soils in developing regions**
**(extent - million hectare)**

<table>
<thead>
<tr>
<th>Soils with no inherent fertility limitations</th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(T,C,B,J,R,L,H,N,D,K)</td>
<td>535.2</td>
<td>51.5</td>
<td>359.8</td>
<td>118.9</td>
<td>324.4</td>
<td>1389.8</td>
</tr>
<tr>
<td>(18.6)</td>
<td>(7.6)</td>
<td>(20.3)</td>
<td>(43.8)</td>
<td>(36.2)</td>
<td>(21.4)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soils with severe fertility limitations</th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A,F,P)</td>
<td>419.1</td>
<td>2.1</td>
<td>722.3</td>
<td>16.2</td>
<td>219.9</td>
<td>1379.6</td>
</tr>
<tr>
<td>(14.6)</td>
<td>(0.3)</td>
<td>(40.8)</td>
<td>(6.0)</td>
<td>(24.5)</td>
<td>(21.2)</td>
<td></td>
</tr>
</tbody>
</table>

| Cracking heavy clay soils (V)               | 98.8   | 5.7            | 24.9          | 13.2            | 57.9           | 200.5 |
| (3.4)                                       | (0.8)  | (1.4)          | (4.9)         | (6.5)           | (3.1)          |       |

| Salt affected soils (Z,S)                   | 64.3   | 53.2           | 56.5          | 2.3             | 20.0           | 196.3 |
| (2.2)                                       | (7.9)  | (3.2)          | (0.8)         | (2.2)           | (3.0)          |       |

| Poorly drained soils (G,O,W)                | 152.9  | 2.6            | 179.9         | 12.7            | 75.8           | 423.9 |
| (5.3)                                       | (0.4)  | (10.2)         | (4.7)         | (8.4)           | (6.5)          |       |

| Shallow soils (I,U,E)                       | 376.3  | 180.4          | 193.6         | 60.6            | 98.7           | 909.6 |
| (13.1)                                      | (26.6) | (10.9)         | (22.3)        | (11.0)          | (14.0)         |       |

| Coarse textured soils (Q,R)                 | 567.5  | 126.9          | 132.4         | 15.9            | 52.3           | 895.0 |
| (19.7)                                      | (18.7) | (7.5)          | (5.8)         | (5.8)           | (13.9)         |       |

| Semi-desert and desert soils (X,Y)         | 459.2  | 230.9          | 93.9          | 31.8            | 42.7           | 858.5 |
| (16.0)                                      | (34.1) | (5.3)          | (11.7)        | (4.8)           | (13.2)         |       |

| Miscellaneous land units                   | 204.8  | 24.1           | 6.9           | -               | 5.9            | 241.7 |
| (7.1)                                       | (3.6)  | (0.4)          |              | (0.6)           | (3.7)          |       |

**TOTAL**                                    | 2878.1 | 677.4          | 1770.2        | 271.6           | 897.6          | 6494.9 |

Figures in parenthesis are percentages of regional totals.

Letters in parenthesis are the major soil symbols referred to in Table 2.

Some soils exhibit several of the above listed characteristics and only the main limitation has been considered in the above generalized interpretation.

\(1/\) Excludes South Africa
Dominant climates in developing regions  
(extent - million hectare)

<table>
<thead>
<tr>
<th></th>
<th>AFRICA(^1)</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COLD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(severe temperature constraints)</td>
<td>9.1 (0.3)</td>
<td>113.7 (16.8)</td>
<td>60.8 (3.4)</td>
<td>0.7 (0.3)</td>
<td>47.7 (5.3)</td>
<td>232.0 (3.6)</td>
</tr>
<tr>
<td><strong>WARM/COOL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(no severe temperature constraints)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry (0 days)</td>
<td>846.7 (29.4)</td>
<td>369.7 (54.6)</td>
<td>81.2 (4.6)</td>
<td>35.6 (13.1)</td>
<td>39.2 (4.4)</td>
<td>1372.4 (21.1)</td>
</tr>
<tr>
<td>Inadequate growing periods (1-74 days)</td>
<td>487.9 (17.0)</td>
<td>72.6 (10.7)</td>
<td>114.6 (6.5)</td>
<td>62.2 (22.9)</td>
<td>54.6 (6.1)</td>
<td>791.9 (12.2)</td>
</tr>
<tr>
<td>Short growing periods (75-179 days)</td>
<td>545.4 (19.0)</td>
<td>98.9 (14.6)</td>
<td>230.4 (13.0)</td>
<td>63.2 (23.3)</td>
<td>201.9 (22.5)</td>
<td>1398.8 (17.5)</td>
</tr>
<tr>
<td>Long growing periods (180-365(^1) days)</td>
<td>969.2 (33.6)</td>
<td>22.5 (3.3)</td>
<td>163.5 (65.7)</td>
<td>109.9 (40.4)</td>
<td>467.8 (52.1)</td>
<td>2732.9 (42.1)</td>
</tr>
<tr>
<td>Year-round humid (365(^1) days)</td>
<td>19.8 (0.7)</td>
<td>-</td>
<td>119.7 (6.8)</td>
<td>-</td>
<td>86.4 (9.6)</td>
<td>225.9 (3.5)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2878.1</td>
<td>677.4</td>
<td>1770.2</td>
<td>271.6</td>
<td>897.6</td>
<td>6494.9</td>
</tr>
</tbody>
</table>

Figures in parenthesis are percentages of regional totals.

\(^1\) Excludes South Africa
Land suitable for some rainfed crops in Africa
(extent - million hectare)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Input Level</th>
<th>VS+S</th>
<th>VS+S+MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>Low</td>
<td>137</td>
<td>348</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>244</td>
<td>384</td>
</tr>
<tr>
<td>Maize</td>
<td>Low</td>
<td>193</td>
<td>424</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>291</td>
<td>459</td>
</tr>
<tr>
<td>Wheat</td>
<td>Low</td>
<td>24</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>Phaseolus bean</td>
<td>Low</td>
<td>156</td>
<td>357</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>284</td>
<td>461</td>
</tr>
<tr>
<td>Cassava</td>
<td>Low</td>
<td>37</td>
<td>399</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>238</td>
<td>376</td>
</tr>
<tr>
<td>Cotton</td>
<td>Low</td>
<td>55</td>
<td>266</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>218</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>not additive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total potential</td>
<td>Low</td>
<td>445</td>
<td>789</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>576</td>
<td>750</td>
</tr>
<tr>
<td>Land use in the Developing World</td>
<td>Africa</td>
<td>Southwest Asia</td>
<td>Southeast Asia</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Land area</td>
<td>2 878</td>
<td>677</td>
<td>898</td>
</tr>
<tr>
<td>% of world's total</td>
<td>(22)</td>
<td>(5)</td>
<td>(7)</td>
</tr>
<tr>
<td>Potentially cultivable</td>
<td>789</td>
<td>48</td>
<td>297</td>
</tr>
<tr>
<td>% of land area</td>
<td>(27)</td>
<td>(7)</td>
<td>(33)</td>
</tr>
<tr>
<td>% of world's total</td>
<td>(26)</td>
<td>(2)</td>
<td>(10)</td>
</tr>
<tr>
<td>Presently cultivated</td>
<td>167</td>
<td>69</td>
<td>274</td>
</tr>
<tr>
<td>% of potential</td>
<td>(21)</td>
<td>(144)</td>
<td>(92)</td>
</tr>
<tr>
<td>% irrigated</td>
<td>(4)</td>
<td>(16)</td>
<td>(24)</td>
</tr>
</tbody>
</table>

1/ Excludes South Africa
Table 7

Population ratios in developing regions

<table>
<thead>
<tr>
<th>LEVEL OF INPUTS</th>
<th>YEAR 1975 POTENTIAL: PRESENT POPULATION RATIOS</th>
<th>YEAR 2000 POTENTIAL: PROJECTED POPULATION RATIOS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AFRICA 1/ SOUTHWEST ASIA SOUTH AMERICA CENTRAL AMERICA SOUTHEAST ASIA AVERAGE</td>
<td>1/ Excludes South Africa</td>
</tr>
<tr>
<td>Low</td>
<td>3.0 0.8 5.9 1.6 1.1 2.0</td>
<td>1.6 0.7 3.5 1.4 1.1 1.6</td>
</tr>
<tr>
<td>Intermediate</td>
<td>11.6 1.3 23.9 4.2 3.0 6.9</td>
<td>5.8 0.9 13.3 2.6 2.3 4.2</td>
</tr>
<tr>
<td>High</td>
<td>33.9 2.0 57.2 11.5 5.1 16.6</td>
<td>16.5 1.2 31.5 6.0 3.3 9.3</td>
</tr>
</tbody>
</table>

1/ Excludes South Africa
## Extents and Populations of Critical Individual-Country Lengths of Growing Period (LGP) Zones (Year 1975)

(million hectare and million person)

<table>
<thead>
<tr>
<th></th>
<th>Africa 1/</th>
<th>Southwest Asia</th>
<th>South America</th>
<th>Central America</th>
<th>Southeast Asia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Extent of All LGP Zones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,494.9</td>
</tr>
<tr>
<td><strong>Extents of Critical LGP Zone Areas at:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>1,354.7 (47.1)</td>
<td>505.9 (74.7)</td>
<td>212.5 (12.0)</td>
<td>67.3 (24.8)</td>
<td>312.5 (34.8)</td>
<td>2,452.9 (37.8)</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>1,029.0 (35.7)</td>
<td>455.9 (67.2)</td>
<td>138.8 (7.8)</td>
<td>22.1 (8.1)</td>
<td>62.3 (6.9)</td>
<td>1,702.2 (26.3)</td>
</tr>
<tr>
<td>High Inputs</td>
<td>881.2 (30.6)</td>
<td>427.9 (63.2)</td>
<td>77.0 (4.3)</td>
<td>2.1 (0.8)</td>
<td>45.3 (5.0)</td>
<td>1,433.5 (22.1)</td>
</tr>
<tr>
<td><strong>Total Population of All LGP Zones</strong></td>
<td>380.2</td>
<td>136.3</td>
<td>215.8</td>
<td>106.6</td>
<td>1,117.7</td>
<td>1,956.6</td>
</tr>
<tr>
<td><strong>Total Population of Critical LGP Zone Areas at:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>183.7 (48.3)</td>
<td>98.5 (72.3)</td>
<td>56.4 (26.1)</td>
<td>59.1 (55.4)</td>
<td>766.9 (68.6)</td>
<td>1,164.6 (59.5)</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>73.5 (19.3)</td>
<td>72.7 (53.3)</td>
<td>36.6 (17.0)</td>
<td>28.7 (26.9)</td>
<td>175.8 (15.7)</td>
<td>387.3 (19.8)</td>
</tr>
<tr>
<td>High Inputs</td>
<td>44.3 (11.7)</td>
<td>61.1 (44.8)</td>
<td>15.1 (7.0)</td>
<td>9.2 (8.6)</td>
<td>82.2 (7.4)</td>
<td>211.9 (10.8)</td>
</tr>
<tr>
<td><strong>Size of Population Exceeding Potential Supporting Capacity in Critical LGP Area at:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>104.8</td>
<td>65.8</td>
<td>36.7</td>
<td>40.1</td>
<td>315.8</td>
<td>563.2</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>42.5</td>
<td>42.0</td>
<td>21.7</td>
<td>14.3</td>
<td>56.0</td>
<td>176.4</td>
</tr>
<tr>
<td>High Inputs</td>
<td>26.5</td>
<td>26.3</td>
<td>9.6</td>
<td>8.0</td>
<td>31.3</td>
<td>101.7</td>
</tr>
</tbody>
</table>

Figures in parenthesis are percentages of regional totals.

1/ Excludes South Africa
Number, extents and populations of critical countries - year 1975

<table>
<thead>
<tr>
<th></th>
<th>AFRICA</th>
<th>SOUTHWEST</th>
<th>SOUTH</th>
<th>CENTRAL</th>
<th>SOUTHEAST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of countries</td>
<td>51</td>
<td>16</td>
<td>13</td>
<td>21</td>
<td>16</td>
<td>117</td>
</tr>
<tr>
<td>Number of critical countries with:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>22</td>
<td>15</td>
<td>-</td>
<td>11</td>
<td>6</td>
<td>54</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>7</td>
<td>12</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>High Inputs</td>
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<td>9</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
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<td>1770.2</td>
<td>271.6</td>
<td>897.6</td>
<td>6494.9</td>
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<td>Extent (million ha)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>of all countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
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<td>800</td>
<td>8.0</td>
<td>388.5</td>
<td>220.9</td>
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<tr>
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<td>373.7</td>
<td>55.2</td>
<td>1.1</td>
<td>0.1</td>
<td>651.4</td>
</tr>
<tr>
<td>High Inputs</td>
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<td>0.1</td>
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<td>106.5</td>
<td>117.7</td>
<td>1956.5</td>
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<tr>
<td>Extent (million ha)</td>
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</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
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<td>96.2</td>
<td>70.6</td>
<td>17.1</td>
<td>770.5</td>
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<td>2.3</td>
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<td>0.2</td>
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<tr>
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<td>34.0</td>
<td>24.9</td>
<td>8.6</td>
<td>168.2</td>
<td>277.7</td>
</tr>
<tr>
<td>Extent (million ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of critical countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>51.1</td>
<td>18.7</td>
<td>13.7</td>
<td>0.4</td>
<td>2.3</td>
<td>26.5</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>5.1</td>
<td>18.7</td>
<td>13.7</td>
<td>0.4</td>
<td>2.3</td>
<td>26.5</td>
</tr>
<tr>
<td>High Inputs</td>
<td>0.4</td>
<td>8.2</td>
<td>6.0</td>
<td>0.2</td>
<td>2.3</td>
<td>11.1</td>
</tr>
<tr>
<td>Size of population (million)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>exceeding the potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of supporting capacity with:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Inputs</td>
<td>66.9</td>
<td>34.0</td>
<td>24.9</td>
<td>8.6</td>
<td>168.2</td>
<td>277.7</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>5.1</td>
<td>18.7</td>
<td>13.7</td>
<td>0.4</td>
<td>2.3</td>
<td>26.5</td>
</tr>
<tr>
<td>High Inputs</td>
<td>0.4</td>
<td>8.2</td>
<td>6.0</td>
<td>0.2</td>
<td>2.3</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Figures in parenthesis are percentages of regional totals.

1/ Excludes South Africa
### Number, extents and population of critical countries - year 2000

<table>
<thead>
<tr>
<th></th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of countries</td>
<td>51</td>
<td>16</td>
<td>13</td>
<td>21</td>
<td>16</td>
<td>117</td>
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</tbody>
</table>

**Number of critical countries with:**

- **Low Inputs**
  - AFRICA: 29
  - SOUTHWEST ASIA: 15
  - SOUTH AMERICA: -
  - CENTRAL AMERICA: 14
  - SOUTHEAST ASIA: 6
  - TOTAL: 64

- **Intermediate Inputs**
  - AFRICA: 12
  - SOUTHWEST ASIA: 15
  - SOUTH AMERICA: -
  - CENTRAL AMERICA: 7
  - SOUTHEAST ASIA: 2
  - TOTAL: 36

- **High Inputs**
  - AFRICA: 4
  - SOUTHWEST ASIA: 12
  - SOUTH AMERICA: -
  - CENTRAL AMERICA: 2
  - SOUTHEAST ASIA: 1
  - TOTAL: 19

**Total Extent (million hectare) of all countries**

- TOTAL: 2878.1
  - SOUTHWEST ASIA: 677.4
  - SOUTH AMERICA: 1770.2
  - CENTRAL AMERICA: 271.6
  - SOUTHEAST ASIA: 897.6
  - TOTAL: 6494.9

**Extent (million hectare) of critical countries with:**

<table>
<thead>
<tr>
<th></th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Inputs</strong></td>
<td>1302.2 (45.2)</td>
<td>600.5 (88.6)</td>
<td>-</td>
<td>24.6 (9.1)</td>
<td>88.7 (9.9)</td>
<td>2015.9 (31.0)</td>
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<tr>
<td><strong>Intermediate Inputs</strong></td>
<td>623.2 (21.7)</td>
<td>600.5 (88.6)</td>
<td>-</td>
<td>6.0 (2.2)</td>
<td>14.5 (1.6)</td>
<td>1244.2 (19.2)</td>
</tr>
<tr>
<td><strong>High Inputs</strong></td>
<td>29.7 (1.0)</td>
<td>373.8 (55.2)</td>
<td>-</td>
<td>0.1 (&lt;0.1)</td>
<td>0.1 (&lt;0.1)</td>
<td>403.7 (6.2)</td>
</tr>
</tbody>
</table>

**Total population (million) of all countries**

- TOTAL: 780.1
  - SOUTHWEST ASIA: 264.7
  - SOUTH AMERICA: 392.6
  - CENTRAL AMERICA: 215.2
  - SOUTHEAST ASIA: 1937.1
  - TOTAL: 3597.7

**Total population (million) of all critical countries**

<table>
<thead>
<tr>
<th></th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Inputs</strong></td>
<td>465.8 (59.7)</td>
<td>195.3 (73.8)</td>
<td>-</td>
<td>51.6 (24.0)</td>
<td>341.3 (17.6)</td>
<td>1054.0 (29.4)</td>
</tr>
<tr>
<td><strong>Intermediate Inputs</strong></td>
<td>110.1 (14.1)</td>
<td>195.3 (73.8)</td>
<td>-</td>
<td>24.1 (11.2)</td>
<td>156.4 (8.1)</td>
<td>485.9 (13.5)</td>
</tr>
<tr>
<td><strong>High Inputs</strong></td>
<td>11.0 (1.4)</td>
<td>89.3 (33.7)</td>
<td>-</td>
<td>0.7 (0.3)</td>
<td>3.1 (0.2)</td>
<td>104.1 (2.9)</td>
</tr>
</tbody>
</table>

**Size of population (million) exceeding the potential supporting capacity with:**

<table>
<thead>
<tr>
<th></th>
<th>AFRICA</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Inputs</strong></td>
<td>256.8 (32.9)</td>
<td>107.6 (40.7)</td>
<td>-</td>
<td>18.0 (8.4)</td>
<td>70.7 (3.7)</td>
<td>503.1 (14.0)</td>
</tr>
<tr>
<td><strong>Intermediate Inputs</strong></td>
<td>48.2 (6.2)</td>
<td>78.5 (29.7)</td>
<td>-</td>
<td>6.9 (3.2)</td>
<td>7.7 (0.4)</td>
<td>141.3 (3.9)</td>
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<tr>
<td><strong>High Inputs</strong></td>
<td>2.3 (0.3)</td>
<td>41.9 (15.8)</td>
<td>-</td>
<td>0.5 (0.2)</td>
<td>3.1 (0.2)</td>
<td>47.8 (1.3)</td>
</tr>
</tbody>
</table>

Figures in parenthesis are percentages of regional totals.

1/ Excludes South Africa.
Table 11

Contribution\(^1\) of irrigated production to total potential population supporting capacities by region

<table>
<thead>
<tr>
<th></th>
<th>AFRICA(^2)</th>
<th>SOUTHWEST ASIA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTH AMERICA</th>
<th>SOUTHEAST ASIA</th>
</tr>
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<tbody>
<tr>
<td>1975</td>
<td></td>
<td></td>
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<tr>
<td>LOW INPUTS</td>
<td>9</td>
<td>80</td>
<td>38</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>INTERM. INPUTS</td>
<td>&lt;5</td>
<td>49</td>
<td>14</td>
<td>&lt;5</td>
<td>14</td>
</tr>
<tr>
<td>HIGH INPUTS</td>
<td>&lt;5</td>
<td>32</td>
<td>5</td>
<td>&lt;5</td>
<td>8</td>
</tr>
<tr>
<td>2000</td>
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<td></td>
<td></td>
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<tr>
<td>LOW INPUTS</td>
<td>20</td>
<td>89</td>
<td>64</td>
<td>13</td>
<td>73</td>
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<tr>
<td>INTERM. INPUTS</td>
<td>5</td>
<td>66</td>
<td>33</td>
<td>&lt;5</td>
<td>41</td>
</tr>
<tr>
<td>HIGH INPUTS</td>
<td>&lt;5</td>
<td>49</td>
<td>14</td>
<td>&lt;5</td>
<td>28</td>
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</table>

1/ Percent of total potential population supporting capacity

2/ Excludes South Africa
### Table 12

Effects of unchecked soil erosion on productivity

<table>
<thead>
<tr>
<th></th>
<th>AFRICA&lt;sup&gt;1/&lt;/sup&gt;</th>
<th>SOUTHWEST ASIA</th>
<th>SOUTH AMERICA</th>
<th>CENTRAL AMERICA</th>
<th>SOUTHEAST ASIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in area of rainfed cropland (percent)</td>
<td>16.5</td>
<td>20.0</td>
<td>9.7</td>
<td>29.7</td>
<td>35.6</td>
<td>17.7</td>
</tr>
<tr>
<td>Decrease in rainfed crop productivity (percent)</td>
<td>29.4</td>
<td>35.1</td>
<td>22.6</td>
<td>44.5</td>
<td>38.6</td>
<td>28.9</td>
</tr>
<tr>
<td>Decrease in total land productivity (percent)</td>
<td>24.9</td>
<td>4.9</td>
<td>20.6</td>
<td>24.6</td>
<td>12.4</td>
<td>18.5</td>
</tr>
</tbody>
</table>

<sup>1/</sup> Excludes South Africa
A POPULATION PERSPECTIVE ON AGRICULTURAL DEVELOPMENT

by

Nancy Birdsall*

This note discusses the population problem as it affects the agricultural sector. The note begins with a brief general discussion of the consequences of rapid population growth for structural change in a developing economy as a whole, summarizing the argument in the World Development Report 1984. It then elaborates on the argument as it bears on agriculture. The main message is the following: a population perspective on agricultural issues (that is, a concern for agricultural development that is mindful of the population problem) requires a focus not so much on land yields in agriculture (and thus not on natural resources or "carrying capacity") as on labor productivity in agriculture.

Section I: The consequences of rapid population growth for overall development

Two facts summarize the demographic situation in most developing countries today. First, a combination of continued high fertility and much reduced mortality has led to postwar population growth that is extraordinarily rapid and historically unprecedented: between 2 and 4 percent a year in most low- and middle-income countries (compared with 1 percent and less in most developed countries today, and only for brief periods exceeding 1.5 percent in the past). Though for developing countries as a group, population growth rates have recently slowed somewhat (from a peak of 2.4 percent in 1965 to about 2 percent today, with much of that decline due to China), further declines will not come automatically. Most families in developing countries (apart from China) now have at least four children, and rural families have five or more. Given current death rates and age structure in developing countries, an average of 4 children per couple assures a population growth rate of at least 2 percent a year. Growth at 2 percent a year means that in 100 years a population grows to almost 8 times its original size; at 3 percent a year it grows to 20 times its original size.

Second, despite the fact that the standard population projections of the World Bank build in the assumption of continuing fertility declines in all developing countries (and the initiation of fertility decline where it has not begun yet, in Africa, parts of South Asia and parts of Central America), the population of developing countries is likely to continue to grow rapidly for another three decades at least, in many countries at above 2 percent a year into the next century, and increases in population size will be very large. Even with the assumption that fertility will fall reaching replacement level of about two children in China by 2000, throughout East Asia, most countries of Latin America, and India by 2010,

* Chief, Policy and Research Division, Population, Health and Nutrition Department, World Bank.
and in Bangladesh and much of Africa by 2035 — the population of the developing countries is projected to rise from about 3.6 billion today to 8.4 billion by the year 2050. Kenya's population will increase from 18 million to 120 million by 2050, and Bangladesh's from about 90 million to 430 million. Rapid growth will continue in part because of population "momentum": young people entering childbearing age over the next several decades will be a large proportion of the total population, outnumbering previous generations. So birth rates will remain high even as the number of births per couple declines.

Why is this continuing rapid population growth a problem? Rapid population growth is associated, at household and national levels, with slower progress in raising living standards, especially of the poor. There are two reasons. First is the investment problem. At the national and the family level, rapid population growth exacerbates the difficult choice between higher levels of living now and investment to bring higher levels of living in the future. One example is children's schooling. Still rapid population growth in most countries means 40 to 50 percent of populations are under age fifteen, and schoolage populations will have increased sixfold between 1950 and 2000. Although most countries have managed to raise enrollment rates, quality of schooling remains low. It is the poor who have many children and whose children are least likely to go to school; caught by the poverty of their parents, those children carry their disadvantages into the next generation. A second example comes from agriculture. High fertility means extra resources must go into agriculture just to keep pace with food requirements. In some countries still largely dependent on agriculture, there is little or no unused land that can be cheaply brought under cultivation; raising production means increasing yields on existing land, which in turn means new investments just to maintain per capita output. In these and even in land-rich countries, rapid population growth slows the transfer of labor out of low-productivity agriculture into modern agriculture and other modern jobs. In most of Africa and South Asia, much of the huge projected increases in the size of the labor force will have to be absorbed in agriculture, a difficulty which today's developed countries never faced. The population problem for agriculture is treated more below.

The second reason why rapid population growth slows development has to do with the problem of managing rapid change, i.e. of managing efficiently what investment there is under conditions of more rapid growth than societies have heretofore experienced. In cities in the developing world, rapid population growth (caused primarily by high birth rates, and only secondarily by migration) combined with unprecedented size, poses enormous new problems of management even to maintain -- let alone improve -- living conditions for city residents. In rural areas, as discussed in the next section, continued rapid increases in the size of the labor force (growing at 2 percent a year, higher in Africa, even taking outmigration into account) mean that management-intensive innovations and adjustments in agricultural research, technology, and extension will be critical and must come rapidly, if labor productivity is to increase. This is true even in those parts of land-rich Africa where rural labor supply now is low, but labor productivity is also low. Though in the next five to ten years, total production can be increased merely by improving the incentives farmers face, over the longer run, product per worker-hour will remain low unless management-intensive investment in the sector is substantial.
Section 2: The population problem for the agricultural sector

Despite the huge projected increases in population size, note that the population problem is explained above in terms of a rapid rate of population growth, not in terms of absolute size or numbers or density (in relation say to cultivable land). The fundamental problem, thus described, is not a Malthusian one. A Malthusian analysis would emphasize the problem of large numbers and large absolute size relative to scarce natural resources. But at the global level, there is no imminent problem of limited carrying capacity of mother earth (as the FAO study also presented at this Symposium amply demonstrates). Future population growth will be extraordinary -- but so too has been the population growth of the last three decades. World population has grown faster, to higher numbers, than Malthus would have imagined -- but so too have world production and income grown. In the very long run, history may seem to vindicate Malthus and the problem of population may indeed be one of numbers outrunning world resources. But for the next five or six decades, the problem is not one of global resources, and is less easily amenable to any technological fix.

The traditional Malthusian concern, that population growth will sooner or later run up against the limits of the earth's finite stock of resources, can easily be criticized. It fails to recognize that as resources are depleted, rising prices reduce consumption and speed the search for substitutes, stimulating technological change.

1/ In the twentieth century this argument has been extended to the availability of energy and minerals, the effects of rising environmental pollution, and so on. A related view is that some resources--land, forests, fisheries--though fixed, are renewable, but that their sustainable yields do have a maximum limit. Some harvests may exceed this maximum, but they lead to a permanent reduction in the long-run productivity of land. The argument is that a population whose needs (subsistence and commercial) exceed sustainable yields will have lower per capita incomes in the long run. As noted below, however, overuse of renewable resources is usually not a result only or even primarily of overpopulation, but of commercialization, poor distribution of resources, etc.

2/ This criticism, extended, leads to the argument, propounded recently by Simon, that there are no real natural resource limits, because population growth itself brings the adjustments that continually put off doomsday. As noted below, this counterargument itself is flawed, since there is no evidence that population growth itself inspires the science-based technological innovations rapidly enough to save millions from poverty. Even with the assumption of technological change built into Simon's model, there are "shortrun" difficulties. His short run is thirty to eighty years, and in that period he finds even moderate population growth to be detrimental to human welfare.
The Green Revolution provides an obvious and compelling example. More generally, the fact that most developing countries, with the exceptions of Korea and Egypt, still have yields only one-quarter to one-half the yields in industrial country agriculture suggests natural resource scarcity is not the fundamental problem.

Even the argument that overpopulation contributes to desertification and deforestation, and ultimately to loss of agricultural resources, must be tempered. Rapid population growth undoubtedly exacerbates these problems and means that more people suffer the consequences. But the fundamental causes of environmental stress are usually nondemographic. Unequal distribution of farmland, by restricting access to better soils, helps to push growing numbers of people onto ecologically sensitive areas -- erosion-prone hillsides, semiarid savannas, and tropical forests. One example is the migration to the Amazon rainforests from rural areas of northeastern Brazil, where 6 percent of the landholdings account for more than 70 percent of the land area. Social changes often underlie ecological threats: in Kenya and Uganda pastoral groups, whose political power was destroyed under colonial rule, have seen their closed system of communal management converted into open access to their land. Commercialization can induce misuse of natural resources even in the absence of an obvious population problem, as the soil erosion problem in the United States demonstrates. And political and economic failures can induce agricultural disaster even where population density is low, as in Ethiopia. The solution to these problems must often come not only or even primarily from a slowdown in population growth or a reduction in density, but from policy reforms that alter economic and institutional incentives.

What then is the population problem in agriculture? A population perspective requires a focus not so much on land yields in agriculture (and thus not on natural resources), as on labor productivity in agriculture, on raising per worker income even as labor supply is increasing. Where the land frontier is exhausted as in much of South Asia, and parts of Africa and Central America, the options for increasing labor productivity are obviously fewer, but are still the proper focus of concern under conditions of rapid population growth. Where land is still plentiful, as in parts of Africa, it cannot be assumed that labor productivity will increase automatically, particularly given the rapid pace with which labor supply is increasing and the current low levels of inputs, poor transport, etc., all of which make absorption at increasing productivity levels a challenge.

The remainder of this section has two parts. The first presents a simple accounting identity for describing and projecting the size of a country's agricultural labor force, and applies the identity to selected developing countries. The second presents evidence regarding the links among labor scarcity in agriculture, investment in the sector, and innovation of two types: farmer-based and "management-intensive". A concluding section then summarizes the implications of the discussion in terms of a population perspective on the agricultural sector.

An accounting identity for the rate of growth of the agricultural labor force.

The rate of growth of the agricultural labor force can be expressed as a simple identity, determined "exogenously" by three factors: the rate of growth of the total labor force ($L'_t$), the rate of growth of the nonagricultural labor force ($L'_n$), and the initial share of agriculture in the total ($L'_a/L_t$):  

$$L'_a = (L'_t - L'_n) \left[1/(L'_a/L_t)\right] - L'_n$$

This formulation allows hypothetical calculations of the turning point, that is the point when growth ends and the absolute number of workers in agriculture begins to decline. Britain and Japan reached the turning point in the nineteenth century, and the U.S. early in the twentieth. Korea reached this point in about 1955 and Brazil in 1975. Bangladesh, Egypt, and Kenya are unlikely to reach it until the next century. The critical difference between developing countries in the present period (1950-2000) and developed countries at the turn of the century (1880-1920) lies in the difference in $L'_t$, total labor force growth. Consider each component of the identity above one at a time.

Growth of nonagricultural employment ($L'_n$). Developing countries have experienced since 1960 much faster increases in nonagricultural employment than developed countries did around the turn of the century (see Table 1) — in industry, rates of growth ranging between 2.3 and 8 percent a year for the period 1960-82, compared to 2.1 percent a year in developed countries, 1880-1900. In services, rates of growth have also been higher, though these growth rates may include to some extent increases in low-productivity jobs producing income per worker comparable to income in agriculture. The rapid growth of industrial employment is due largely to industrial output growth that has been twice as great (value added has increased by over 8 percent a year, 1960-70, compared to 4 percent a year for developed countries, 1880-1900). Labor absorption in industry, or the employment elasticity (that is, the ratio of industrial labor force growth to industrial output growth), has been comparable.  

In this respect at least the development process is proceeding very quickly in the developing countries; education is spreading faster, and of course as latecomers, developing countries are able to exploit

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4/ Johnston and Clark suggest and illustrate this formulation, pp. 39-41. Of course this is a simplification, to the extent that the labor force in agriculture is not actually a residual but is determined simultaneously with the labor force in other sectors, by initial endowments, technology, substitution possibilities, policy interventions that distort factor prices, etc.

5/ Squire, Table 6, p. 20. Squire estimates the employment elasticity to have been 0.45 in the developing countries, 1960-70, compared with 0.51 in the developed countries, 1880-1900 (p. 24).
technological advances more quickly. There is, in fact, little to complain of in terms of the performance of developing countries in absorbing labor in the industrial sector, at least compared to the historical experience of developed countries.

Share of labor force in agriculture (La/Lt). The turning point is sensitive to the initial share in agriculture. For example, assuming a 4 percent growth of nonagricultural employment and a 2.5 percent growth of the total labor force, the turning point comes after 50 years if the initial share of the labor force in agriculture is 70 percent—compared with after only 15 years if the initial share is 50 percent.

| TABLE 1 |
|------------------|------------------|------------------|------------------|
| **Average annual rates of growth of the labor force by sector for developed countries, 1880-1900, and developing countries, 1960-82** | **Agriculture** | **Industry** | **Services** | **Total** |
| Developed countries, 1880-1900 | 0.4 | 2.1 | 2.1 | 1.2 |
| Developing countries, 1960-70 | 1.1 | 3.8 | 3.9 | 2.0 |
| 1960-82 | | | | |
| Pakistan | 1.7 | 2.3 | 3.6 | 2.3 |
| Korea | -0.2 | 8.1 | 4.6 | 2.8 |
| Kenya | 2.6 | 6.1 | 4.3 | 3.0 |
| India | 1.6 | 2.7 | 2.6 | 1.9 |
| Egypt | 1.6 | 6.5 | 0.5 | 2.3 |
| Colombia | -0.1 | 3.5 | 5.7 | 3.0 |
| Bangladesh | 1.8 | 8.4 | 4.3 | 2.5 |
| Brazil | -0.01 | 4.8 | 3.9 | 2.5 |
| Thailand | 2.0 | 6.1 | 3.4 | 2.4 |

**Sources:** Squire, p. 23 for developed; World Bank for developing.

Table 2 shows the share of the labor force in agriculture for selected countries and years. By 1880, Great Britain already had only about 13 percent of its labor force in agriculture, and the U.S., despite its large land endowment, had only about 50 percent. (Although the absolute size of the labor force in agriculture in the U.S. continued to grow, the share in agriculture never rose above 50 percent). However, Japan in 1880 still had 75 percent of its labor force in agriculture; it is
one of the few developed countries (Spain and to some extent Sweden and Finland are others6/) where the absolute numbers in agriculture stopped increasing while more than half the labor force was still in that sector.

By 1960, the middle-income countries as a group already had only 58 percent of their labor force in agriculture (Table 2)—in that sense they were "ahead" of Japan in 1880. The low-income countries, with about 77 percent in agriculture in 1960 were not much different from Japan 80 years earlier. However, compared to Japan, progress for both groups of developing countries since 1960 has been slower. Between 1880 and 1900, in 20 years, the share of the Japanese labor force in agriculture fell from 75 to 51 percent, a decline of 33 percent; in the 20 years from 1960 to 1980, the share in middle-income countries fell from 62 to 46 percent, a decline of 26 percent, and in low-income countries from 77 to 72 percent, a decline of only 6 percent.

**TABLE 2**

<table>
<thead>
<tr>
<th>Share of the labor force in agriculture, selected countries and years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed countries, 1880</td>
</tr>
<tr>
<td>Great Britain, 1880</td>
</tr>
<tr>
<td>United States, 1880</td>
</tr>
<tr>
<td>Japan, 1880</td>
</tr>
<tr>
<td>Japan, 1900</td>
</tr>
<tr>
<td>Low-income countries, a/, 1960</td>
</tr>
<tr>
<td>Low-income countries, 1980</td>
</tr>
<tr>
<td>Middle-income countries, a/ 1960</td>
</tr>
<tr>
<td>Middle-income countries, 1980</td>
</tr>
</tbody>
</table>

\[a/\] Defined as in World Bank, 1984.

Sources: Squire, p. 23; Porter, Table 3.2; World Bank, 1984, Table 21.

**Total labor force growth (L\(_r\)).** This is the factor where the difference between developed and developing countries is most marked, explaining the slower progress toward the turning point in developing countries. Table 3 shows long-term rates of growth of total population and total labor force for selected countries and groups of countries and years (see also the last column of Table 1). Rates of growth of total labor force have been just below rates of growth of total population in the twentieth century, because of declines in labor force participation

### TABLE 3

Long-term rates of annual population growth and labor force growth, selected countries, groups of countries and years (percentage)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Britain</td>
<td>1.4</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>...</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>...</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>...</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>0.9</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>0.9</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>1.3</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>0.5</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>0.6</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>0.4</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>3.0</td>
<td>2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USSR</td>
<td>1.2</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>...</td>
<td>1.1\textsuperscript{a}/</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All developing 2.4 2.2
Low-income Asia 2.2 2.1
Sub-Saharan Africa \textsuperscript{b}/ 2.5 2.7
Middle East and North Africa\textsuperscript{c}/ 2.6 2.4
East Asia and Pacific 2.6 1.8
Latin America and Caribbean 2.8 2.3
Southern Europe 1.5 1.1

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>1.9</td>
<td>2.1</td>
</tr>
</tbody>
</table>

\textsuperscript{a}/ 1870-1913. \textsuperscript{b}/ Excludes South Africa. \textsuperscript{c}/ Excludes high-income oil exporters.

In developing countries, labor force growth relative to total population growth is likely to increase during the rest of this century, as the share of children in the total population declines due to falling fertility. There is also the possibility that female labor force participation rates will rise as fertility falls.

Table 3 shows that postwar population growth rates and labor force growth rates in developing countries have been at least 1 and for some countries 2 percentage points greater than in the developed countries 100 years ago.

More rapid growth of the total labor force is the critical reason for the slower approach to a turning point in many developing countries. The comparison to Japan is useful since in 1880 Japan still had 75 percent of its labor force in agriculture. In 1880, Japan's total rate of labor force growth was only about 1 percent. As a result its 3.5 percent rate of growth of nonagricultural employment absorbed all the increase in labor force size. The share of labor outside agriculture thus grew, providing the stimulus on the demand side for increases in output per worker in agriculture at the same time as technical changes in agriculture (increased use of second cropping etc.) raised the demand for labor and spurred labor-saving innovations. The contrast to Kenya today is noteworthy. Were current trends to persist, with the labor force growing at 3 percent a year, about 75 percent of the labor force in agriculture (comparable to Japan in 1880) and a 4 percent growth of nonagricultural employment (above the rate of growth in Japan in 1880), it would take close to 100 years before the labor force in agriculture would begin to decline. The longer period is due entirely to the higher rate of growth of the total labor force. With labor force growth reduced to 2 percent a year, about 25 years would be required to reach this turning point. The difference of 1 percentage point in total labor force growth delays considerably the turning point.

Country turning points. Table 4 shows the absolute increase in the size of the potential agricultural labor force between 1980 and the turning point, under various assumptions for selected countries. The countries are arranged in descending order, according to the percentage of their labor force in agriculture in 1980 (or in the case of countries already beyond the turning point, according to the percentage in agriculture in the year the turning point was reached). Two sets of assumptions are used. The first set has to do with population

7/ In developed countries, declines have occurred as rising income led to increased schooling rates for young people and earlier retirement. In developing countries, declines in participation also reflect the increasing share of inactive children in the total population.
### TABLE 4

**Growth of agricultural labor force under various assumptions**  
*(index 1980=100)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Nonagricultural Employment Growth at 4 percent a year</th>
<th>Nonagricultural Employment Growth at 2 percent a year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Rapid</td>
</tr>
<tr>
<td><strong>Kenya (78% of labor force in agriculture, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>947</td>
<td>475</td>
</tr>
<tr>
<td>Turning point&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2045</td>
<td>2040</td>
</tr>
<tr>
<td><strong>Thailand (76%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>158</td>
<td>151</td>
</tr>
<tr>
<td>Turning point</td>
<td>2010</td>
<td>2005</td>
</tr>
<tr>
<td><strong>Bangladesh (74%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>263</td>
<td>188</td>
</tr>
<tr>
<td>Turning point</td>
<td>2030</td>
<td>2010</td>
</tr>
<tr>
<td><strong>India (69%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>136</td>
<td>135</td>
</tr>
<tr>
<td>Turning point</td>
<td>2005</td>
<td>2005</td>
</tr>
<tr>
<td><strong>Malaysia (50%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>111</td>
<td>113</td>
</tr>
<tr>
<td><strong>Egypt (50%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>102</td>
<td>104</td>
</tr>
<tr>
<td>Turning point</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td><strong>Brazil (47%, 1980)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>112</td>
<td>n.a.</td>
</tr>
<tr>
<td>Turning point</td>
<td>1970</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>Korea (66%, 1960)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>109</td>
<td>n.a.</td>
</tr>
<tr>
<td>Turning point</td>
<td>1960</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

<sup>a</sup> The year when the agricultural labor force starts to decline.

n.a. Not applicable.

.... Not available.
projections. The World Bank's "standard" set of country-level projections are used to project the increase in the size of the total working-age (15-64) population (not shown). An alternative population projection is also used—assuming more "rapid" fertility and mortality decline. The two projections are explained in more detail in the 1984 World Development Report.8/

The second set of assumptions has to do with the rate of increase in the rate of nonagricultural employment growth: the alternatives shown are 4 percent a year (close to that achieved for developing countries as a whole in the past several decades—see Table 1) and 2 percent a year.

The identity above is then used to calculate the increase in the agricultural labor force up to the year when its size stabilizes, under the various assumptions.

Several conclusions emerge. First, for countries near the bottom of the table, with a smaller proportion of their labor force in agriculture now, the difference between the standard and rapid projections is not important to the timing of the turning point. This is because there is virtually no difference between the two population projections for change in the working age population (not shown) over the next two decades, and differences remain negligible for another two decades after that as the smaller cohorts are only gradually added to the existing working-age population. It is also true that most countries near the bottom of the table have lower average fertility already than those near the top; thus the difference between the two population projections is relatively smaller.

However, for countries near the top of the table, there is a substantial difference between the standard and rapid projections. The difference emerges not only in the timing of the turning point (for Kenya, 2045 vs 2040; for Bangladesh, 2030 vs 2010) but in the absolute amount of growth in the agricultural working-age population. In Bangladesh, for example, assuming a 4 percent annual growth of employment outside agriculture, there is likely to be under the standard population projection

8/ The "standard decline" projection was built into it the assumption that fertility decline will continue (or begin in the case of Africa), such that most developing countries will reach replacement-level fertility by the year 2020, in Latin America and Asia sooner, in the Middle East and Africa later. The "rapid" decline projection builds in fertility (and mortality) decline for all countries at the pace equivalent to that attained by a set of developing countries in the past two decades which had rapid declines; in the case of fertility, the pace of decline in eleven such countries, including Korea, Colombia, China and Thailand, was such as to reduce the total fertility rate by 0.2 points a year. See also Bulatao and Elwan, and for a discussion of the standard projections, Demeny.
a two- to three-fold increase in the number of people working in agriculture in the next four decades. Although yields are still low in Bangladesh (compared to Egypt and China for example), an increase of this magnitude does raise the spectre of diminishing returns to labor in agriculture, unless other inputs are increased very rapidly indeed, or nonagricultural employment increases by more than 4 percent per year. Even with rapid fertility decline, the numbers working in agriculture are likely to increase by almost 90 percent in the next twenty years.

Kenya is a more extreme example. Assuming the standard projection of population increase is correct, the labor force in agriculture will be more than nine times its present size (947 percent) before it begins declining in 2045. Though the turning point, 2040, is not much sooner with rapid fertility decline, the absolute increase in the size of the agricultural working-age population is much smaller; the agricultural working-age population would be not quite five times its present size (475 percent).

Kenya and Bangladesh are countries where there is still a large share of the labor force in agriculture and where fertility and population growth are still very high. For Thailand, India, Malaysia, and Egypt, the increases in agricultural populations will be much smaller and the turning point is likely to come in the next several decades -- at least if nonagricultural employment grows at 4 percent a year. Note this is true even for Thailand, where the share in agriculture was still 76 percent in 1980. These countries will thus reap the benefits soon—after about forty years—of a slowdown in population growth that began about two decades ago.

Other supply factors and the turning point. These turning points are illustrative only; the turning point itself is not particularly important; if labor productivity is increasing within agriculture, then there is no a priori reason to view an exodus from agriculture as a "turning point", i.e. a good thing. Bearing this in mind, note that it is not a levelling-off or a decline in the number of agricultural workers itself that encourages an increase in labor productivity within agriculture, but a decline in the supply of labor relative to other inputs. The most obvious other input is land. But, as discussed below, transportation, new science-based technology (such as the Green Revolution high-yielding variety seeds), and human capital are also inputs, increases in which can induce a relative scarcity of raw labor.

Labor scarcity and rising labor productivity
Consider the following proposition: large gains in labor productivity within agriculture tend to occur when an exogenous change in conditions affecting agricultural production makes labor scarcer than it
had been relative to land and capital. (This is almost a truism, given the nature of any standard production function.)

Evidence from developing countries today and from the historical experience of Britain, the United States and Japan illustrates this point.

Boserup's well-known suggestion is that population density provides an impetus for a shift to a new "food supply system" and an increase in labor input. Food supply systems range along a spectrum defined in terms of the land-intensity of cultivation: gathering, forest fallow, bush-fallow, short-fallow, annual cropping, multicropping. Her insight (though she did not put it quite this way) was to see that in fact more people, in a fixed land area, create labor scarcity! An increase in density leads to a shift from one food supply system, or type of cultivation, to another; the new type of cultivation is not only more land-intensive, but also more labor-intensive. For example, the movement from forest fallow to annual cultivation using the hoe in West Africa results in an increase in total labor input per hectare from 770 hours (Liberia) to 3,300 hours (Cameroon). "The increase in labor input occurs due to an increase in intensity with which certain tasks have to be performed (for e.g., land preparation and weeding) and due to an increase in the number of operations performed (for e.g., manuring, irrigation, etc.)."

The distinction between population density and the rate of growth of the population is important here. Boserup discusses the positive effects of increases in size due to very gradual increases in population in the preindustrial age (perhaps 1 percent a decade, with fluctuations due to the vulnerability of populations to mortality). She notes that more rapid increases in population can cause difficulty: "The cultivators must be able to adapt themselves quickly to methods that are new to them. . .the community must somehow be able to bear the burden of a high rate of investment and perhaps to undertake sweeping changes in land tenure."

Such labor scarcity also tends to coincide with rising average incomes. Thus much attention has gone to the demand-side explanation for the shift of labor out of agriculture, i.e., that in a stationary population, an equal increase in productivity in agriculture and industry leads to a decline in the agricultural labor force because of Engel's law; the income increase that higher productivity brings reduces the demand for food relative to the demand for other goods. In this discussion, however, I concentrate on the merits of a supply-side explanation for the increase in agricultural labor productivity, an increase that is encouraged by and further permits the shift out of agriculture.

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11/ Pingali and Binswanger, p. 4.

She suggests that the decline of civilization in Mesopotamia and other river areas occurred when societies did not maintain investment in irrigation systems sufficient to support ever-increasing populations.13/

The links among higher density, new cultivation systems, and higher labor inputs have been explored systematically by Pingali andBinswanger, using data on 53 locations in Africa, Asia, and Latin America. They demonstrate for these locations the point noted above, that labor input per hectare increases as the mode of cultivation becomes more land-intensive. More important they show that though yields (product per unit of land) increase dramatically with shifts to more land-intensive modes of cultivation, product per worker-hour does not increase (holding "tools," i.e., hoe, animal plow, tractor) constant.14/ In other words, all other things the same, higher population density leads to an increase in yields, but not necessarily in labor productivity.

Examples of the increases in total product but not product per worker15/ (the latter a better indicator of the welfare of the average person) probably include Mesopotamia, and in the nineteenth century, China and Indonesia.16/ In these preindustrial societies, increases in yields over a given land area increased the total surplus available for priests, artists, and kings, i.e., civilization. Such increases did not, however, necessarily mean any increase in product per capita, or in the welfare of the average person.

Escape from the cycle of higher yield but not higher worker-product does sometimes come. If the labor scarcity imposed by a shift from one mode of cultivation to another cannot easily be met by a growing labor force, a new set of "tools" is likely to be adopted; cultivators will shift from digging stick to hoe, from hoe to animal plow,

13/ Boserup, 1981, p.-

14/ The regression result is log yield/man-hour = -0.01 log farming intensity + 0.71 (0.23) animal traction +1.32 (0.26) tractor + 0.027. (Standard errors are in parentheses. The coefficient on intensity is not significant; the coefficients on the other two variables are significant at the 1 percent level.)

15/ Per worker product may rise without productivity rising if hours per worker increase. More hours of work implies lower welfare, however. Similarly, product per person may rise without productivity rising, if more household members work. The measure of increases in labor productivity (and thus in welfare) is production per worker-hour.

16/ Geertz describes the process for Indonesia. The effect of density of total surplus is especially important in the absence of modern transportation and communication systems. River deltas were the site of flourishing ancient societies because their rich soils allowed for population density and an increase in the total surplus in a limited area.
from animal plow to tractor. The benefits of such a switch will depend on other conditions as well—the switch to the plow is less beneficial for sandy soils and hilly terrain, and will not occur before the grass fallow stage, because of ground stumps and the high cost of maintaining animal under forest and bush fallow.\(^{17}\) The switch, where it does occur, however, is a response to labor scarcity, not land scarcity. Though land appears to be more scarce as the mode of cultivation becomes more land-intensive, it is actually labor that, in relative terms, becomes more scarce—at least if the rate of growth of labor force is not too rapid. In fact, though yields per hectare increase with more intensive land use, yields do not increase with the adoption of new tools. Pingali and Binswanger conclude on the basis of their analysis that tools are adopted for their labor-saving benefits, not land-saving benefits.\(^{18}\)

The agricultural innovations described above are for the most part innovations that individual farmers can introduce, independent of their neighbors' behavior; there are no positive nor negative externalities. A review of the historical experience of Britain, the United States, and Japan illustrates (1) similarly to the above examples, the importance of an increase in labor scarcity in inducing innovations;\(^{19}\) and (2) that innovations that raised labor productivity is the now industrialized countries' agriculture, resulted from or at least were hastened by, socially managed change.

In Great Britain a system of open fields and subsistence farming gave way in the eighteenth century to more intensive cultivation, as the relative price of cereals to livestock rose and increased population raised the demand for food. As in the preindustrial economics described above, the new system required greater labor inputs. But labor supply was increasing, albeit slowly, and labor productivity did not rise; it may even have fallen in the third quarter of the eighteenth century.\(^{20}\)

Increases in labor productivity in agriculture began only in the mid-nineteenth century, when rapid absorption of labor into manufacturing relative to the rate of overall population growth (which was low by modern standards, even with immigration from Ireland—seldom exceeding 1 percent a year) led to a decline in labor supply for agricultural work. That decline encouraged labor-saving innovations, just as a shift from grass fallow to annual cropping does. The "turning point," when the absolute number of workers in agriculture began to fall, came in about 1850. As

\(^{17}\) Pingali and Binswanger, p. 6.

\(^{18}\) Pingali and Binswanger, Table IV, column 1 regression.

\(^{19}\) This section relies heavily on data summarized in Porter.

\(^{20}\) Porter, p. 20, cites Deane and Cole, p. 75.
labor supply fell, British agriculture moved to more livestock specialization, with diversion of arable land to pasture, an increase in the share of area in fodder crops, and increasing mechanization. The repeal of the Corn Laws and the Navigation Acts hastened change by exposing British agriculture to foreign competition. Total agricultural production and yields per hectare increased only slowly (until the 1920s—faster thereafter). But output per worker, i.e., labor productivity, grew rapidly from 1850 as the size of the agricultural work force fell.

Thus British agriculture went through two stages: a first stage in which population increase led to more intensive use of land, more labor inputs, but no increase in labor productivity; and a second stage in which labor scarcity encouraged among other things mechanization and specialization, and labor productivity increased. In the second stage, foreign competition and the increase in market access afforded by rapidly-developing transportation obviously played a role.

In the United States, scarcity of labor was evident from the beginning of European settlement, since land was abundant and cheap. Innovations in farming techniques and mechanization led to substantial increases in labor productivity; labor requirements in wheat production fell from an estimated twenty-three work days per hectare prior to 1830 to four work days per hectare by 1880, all before introduction of the tractor.21/ Though the labor force in agriculture grew rapidly all through the nineteenth century, labor continued to be scarce relative to land—and relative to other inputs, including extensive agricultural extension support services and a rapidly growing network of roads and railways, complemented by a literacy rate close to 100 percent by the close of the 19th century.

In the United States, a fall in the absolute number of workers in agriculture came only in 1910. But from the beginning of European settlements, with settlers adopting a "European" system of cultivation of fixed land, rather than the native American mode of forest and bush fallow, there was labor scarcity. Thus structural transformation within agriculture was occurring all along (long before the turning point when the absolute number of workers in agriculture began to decline). The US experience illustrates that the turning point is not interesting in itself, but only interesting as a crude approximation of the point where specialization is occurring in and outside of agriculture and labor productivity is increasing. In the U.S., specialization was occurring well before the turning point.

The Japanese experience prior to the Meiji period (up to 1868) was comparable to the first stage in Britain. Total agricultural production increased as arable areas expanded with increases in population. But there was little or no increase in labor productivity.22/

21/ Porter, p. 25, cites Johnson and Kilby, p. 201.
By the end of the nineteenth century, however, changes in cultivation techniques introduced in the Meiji era were probably increasing the demand for labor, in just the period when the supply of labor may well have been levelling off. The more intensive rice farming system introduced and actively encouraged by government involved many labor-using activities: installation of drainage (allowing conversion of wet rice fields to dry fields); planting a second crop; seed selection; making and applying compost as well as purchased fertilizers; straight-line replanting, etc. Drainage installation in particular required active organization and cooperation among individual producers. As Table 5 shows, between 1880 and 1920, though total population was growing at about 1 percent a year, the agricultural labor force declined slightly, and agricultural work hours increased, implying some labor scarcity. In the same period, labor-saving "tools" were also introduced, most notably use of draft animals for plowing. Labor productivity increased throughout the entire period (see last two columns of Table 5).

The historical evidence implies that for developing countries where over the next five decades or so the agricultural work force will continue to increase, large and management-intensive investments (i.e., investments that require administrative and organizational skills, in part because they have large positive externalities) will be critical if labor

<table>
<thead>
<tr>
<th>TABLE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan: Population, agricultural labor force, and agricultural work hours, 1880-1920</td>
</tr>
<tr>
<td>Total population</td>
</tr>
<tr>
<td>(thousands)</td>
</tr>
<tr>
<td>1880</td>
</tr>
<tr>
<td>1885</td>
</tr>
<tr>
<td>1890</td>
</tr>
<tr>
<td>1895</td>
</tr>
<tr>
<td>1900</td>
</tr>
<tr>
<td>1905</td>
</tr>
<tr>
<td>1910</td>
</tr>
<tr>
<td>1915</td>
</tr>
<tr>
<td>1920</td>
</tr>
</tbody>
</table>

Source: Porter, Annex 1, Table 3.
productivity (and income) is to increase in the agricultural sector. Land-poor countries have fewer options; the more densely populated a country is already, the less leeway there is for intensification of land use to bring on labor. Countries such as Bangladesh, China, Indonesia, Egypt, and Kenya, with populations still largely dependent on agriculture, are already well beyond the density level of Great Britain in 1880 (Table 6), though still short of Japan's density in 1880. Given expected increases in population size, many will be approaching Japan's density in the next three or four decades (a period in which in many countries, population will double). In most of these, annual or multicropping are already predominant modes of cultivation. For these densely populated countries some other stimulus for a structural transformation within agriculture will obviously be required.

In Japan in the Meiji era government services that speeded labor-using technical changes within agriculture were critical. Japan had the advantage of a lower rate of increase of agricultural labor supply; countries today have the advantage of modern communication, transportation and education systems available for adaptation.

For land-rich countries, including many in Africa, the options are greater. An improvement in transportation can have the effect of increasing the effective amount of land available by broadening markets, thus raising labor demand and stimulating labor-saving innovations. Table 7 compares rail in the U.S. in the late nineteenth century to rail and road in Brazil, Kenya, and India today. The comparison suggests these countries are doing reasonably well in providing transport systems, though the extent to which such systems serve agricultural areas is not clear, and the transport system in African countries with extensive land frontiers, such as Zaire, Uganda, and Ivory Coast, is probably much poorer.

Importation of a new technology, such as the high-yielding seeds of the Green Revolution, can also increase the effective amount of land and increase labor demand, leading to labor-saving innovations and higher labor productivity if labor is not plentiful. But it is successful only when accompanied, as in northern India, by extensive government support services in irrigation management and transport development, and by technical support to farmers in adapting new varieties to local conditions.

Similarly, human capital is associated directly with adoption of new techniques which increase yields (again increasing the effective amount of "land"), increasing labor productivity. Figure 1 compares literacy rates for selected countries and years, indicating the relatively low endowment of the poorer low-income countries today compared with northern Europe in 1900.
## TABLE 6

**Ratio of agricultural labor force to agricultural land**

(persons/km x 1,000)

<table>
<thead>
<tr>
<th></th>
<th>1880</th>
<th>1960</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developed countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Britain</td>
<td>9.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan(a/)</td>
<td>309.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Developing countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td></td>
<td>192.9b/</td>
<td>238.9</td>
</tr>
<tr>
<td>India</td>
<td>78.1</td>
<td>101.4</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>169.7</td>
<td>206.0</td>
<td></td>
</tr>
<tr>
<td>Rwanda</td>
<td>102.0</td>
<td>173.3</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>8.6</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>81.7</td>
<td>86.9</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>115.5</td>
<td>93.2</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>33.0</td>
<td>55.9</td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td>50.5</td>
<td>76.7</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Agricultural land includes arable plus permanent cropland and permanent pastures; it excludes forest and woodland.

\(a/\) Arable land.

\(b/\) 1966.

**Source:** Porter, 1983; World Bank and FAO estimates.
TABLE 7

Infrastructure in selected developed and developing countries
(hectares of arable land per km of rail and road)

<table>
<thead>
<tr>
<th></th>
<th>Road</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>408</td>
<td></td>
</tr>
<tr>
<td>Great Britain</td>
<td>242</td>
<td></td>
</tr>
<tr>
<td>Brazil (1978)</td>
<td>36</td>
<td>1,783</td>
</tr>
<tr>
<td>Kenya (1983)</td>
<td>33</td>
<td>431</td>
</tr>
<tr>
<td>India (1980)</td>
<td>135</td>
<td>2,753</td>
</tr>
</tbody>
</table>

Sources: Porter, 1984; World Bank.

Figure 1: Literacy rates, selected countries and years

Section 3: Summary and Conclusions

The discussion in Sections 1 and 2 suggests the following:

1. A population perspective on the agricultural sector implies a focus on raising labor productivity. Insofar as it is the rapid rate of population growth that slows development and not a global scarcity of natural resources, the population problem within agriculture is relevant in land-rich as well as land-poor countries. As in other sectors, the problem is that of pressure on investment resources and on the efficiency or management of such resources, under conditions of rapidly increasing labor supply.

2. Raising labor productivity in agriculture will be relatively difficult in those countries -- mostly in Africa and South Asia -- facing continuing large increases in the absolute size of their agricultural workforces. A country such as Kenya could have as much as a ninefold increase in the size of its agricultural workforce by the year 2050. The absolute size of Japan's agriculture workforce was already falling by about 1900; Korea's began to fall in 1955.

3. Though increases in labor induce certain farmer-managed innovations in agriculture that raise land yields and have generally prevented declines per worker output, (including intensification of land use and use of organic fertilizers), the farmer-managed innovations that raise labor productivity (e.g. mechanization) are less likely until labor scarcity and rising wages make them economically viable for the individual farmer.

4. The more rapid the growth rate of population, the more delayed the onset of labor scarcity in the agricultural sector, all other things equal, and thus the more delayed the farmer-based innovations that would raise labor productivity.

5. Labor scarcity can be created even with continuing increases in the number of agricultural workers, via "management-intensive" innovations and associated increases in non-labor inputs: land (through irrigation, for example); transportation, which increases market size; chemical fertilizers and other science-based changes such as better seeds, which allow intensification and in effect increase land use; and extension services and education of farmers, which increase efficiency in use of non-labor compared with labor inputs. These management-intensive innovations and associated inputs are necessary, indeed critical in countries where population growth is still rapid. But unlike farmer-managed change, they often have high positive externalities, requiring a set of society-wide decisions and institutional incentives. Research into and adaptation of new technologies is one example: the money and research skills are overwhelmingly in the rich countries and produce, if anything, labor-saving not labor-using innovations.
6. Rapid population growth in the developing countries if anything makes more difficult the choices among and management of investment opportunities. Thus even in land-rich countries, policy efforts to increase labor demand in agriculture should be accompanied by policy efforts to reduce supply over the long run by reducing fertility. That such efforts are appropriate and feasible is discussed at length in the World Development Report 1984.
BIBLIOGRAPHY


CHAIRMAN'S COMMENTS

by

Donald C. Pickering*

In opening the Symposium, attention was drawn to the fact that it was co-sponsored by the Agriculture and Rural Development Department, the Population, Health and Nutrition Department, and the Personnel Management Department. This was the first time the Symposium had been co-sponsored with another OPS Sector Department, for reasons made obvious by study of the program viz:

Session I deals with:
Population and Food
and
Population Change and Development.

Session II deals with:
Population Impact on Agricultural Development.

Session III with:
Food Security and Nutrition, and,

Session IV with:
Operational Implications of Food and Population Policy.

These are all topics of the utmost importance that will provide food for thought and plenty of material for discussion.

The paper entitled "Land, Food and Population in the Developing World" presented by Dr. Rudolph Dudal, former Director, Land and Water Development Division in FAO and now a distinguished member of the faculty of Agricultural Sciences at Leuven University in Belgium, and Graham Higgins, Chief of the Soil Resources, Management and Conservation Service, Land and Water Development Division in FAO, Rome, managed in the space of a very short time, to highlight the need to focus on ways and means of tackling such land, food and population issues as:

- The location and extent of cultivable areas, and their potential use capability under different management systems.
- The inputs necessary to meet future food demands, and the location of surplus and deficit areas under different management systems and food movement assumptions.
- Likely risks of land degradation and the measures needed to ensure sustainable production.

* Assistant Director, Agriculture and Rural Development Department, World Bank
Where and on which crops, purchased inputs are likely to be most cost effective. The authors argue that FAO's "Agro-Ecological Zone Study", and particularly the "Potential Population Supporting Capacity Study" make a first approximation of the potential population supporting capacities of lands of developing countries in comparison with their 1975 and projected 2000 populations, and that these recent FAO activities point the way for more detailed studies in this subject area at the national level.

They conclude that, despite the very broad nature of their studies, they highlight some key considerations in the land, food and population equation, namely:

- That land resources and their production potentials are very unevenly distributed within and between countries.
- That increasing input levels and improving land management in developing countries are vital if present and future populations are to be adequately fed.
- That there are substantial areas where land resources are insufficient to meet the food needs of present populations leave alone those projected to be dependent on them by the end of the century.

They recognize that assessed food deficits can be met from the resources of other areas but that such actions involve a wide range of considerations outside the scope for the paper, which therefore centers on means for attainment of the objective of food self-sufficiency and self-reliance to the extent that they are feasible. The authors conclude that these objectives cannot begin to be achieved without long-range and sound land use planning and without clear indications of equally long-range food requirements through to the year 2100, when populations are estimated to have stabilized.

Finally, they assert, that to achieve appropriate long-range plans and the most efficient use of available resources, it is essential to establish a clear inventory of the physical resource base and its potential. While some may disagree with particular aspects of the paper, few could argue with the authors that agricultural policy makers in developing countries must know with greater precision now than ever before, the extent and potential of available physical resources and the dimensions of the food needs in their countries. And if the Bank is to be successful as a development agency, so must we.
POPULATION CHANGE AND DEVELOPMENT was the title of the second part of the first session. The key note paper was presented by Nancy Birdsall who led the team that prepared the 1984 World Development Report which focused on the impact of population on development.

Ms. Birdsall's paper suggests that a population perspective on agriculture implies a focus on raising labor productivity, and since it is rapid population growth that slows development, rather than a global scarcity of natural resources, the population problem within agriculture occurs in both land rich and land poor countries and manifests itself as pressure on investment resources and the efficient management of such resources under conditions of rapidly increasing labor supply. She claims that raising labor productivity in agriculture will be relatively difficult in Africa and South Asia where many countries continue to face large increases in the size of their agricultural work forces. Farmer managed innovations that raise labor productivity such as mechanization, are not likely to be attractive to farmers until labor scarcity and rising wages render them economically viable.

Labor scarcity can be created via management intensive innovations and associated non-labor inputs: in land via irrigation; by improved transportation which increases market size; by use of fertilizers and improved seed that increase production and hence intensity of land use; and the provision of extension and farmer education services which disseminate information on increased efficiency in the use of non labor, compared with labor inputs. The paper argues that, unlike farmer managed change these management intensive innovations require national decisions and institutional incentives. Agricultural research is one example, with resources for such activities centered overwhelmingly in the developed rather than the developing countries and tending to produce labor saving rather than labor using innovations.

The paper concludes that rapid population growth in the developing countries makes for great difficulty of choice among, and the management of, investment opportunities. Thus, even in land rich countries, policy efforts to increase labor demand in agriculture should be accompanied by efforts to reduce labor supply over the long run by reducing fertility.
LAND, FOOD, AND POPULATION IN THE DEVELOPING WORLD

The Chairman thanked the two speakers for a most stimulating and interesting presentation and noted that in the space of a very short time they had managed to highlight the need for focusing on ways and means to tackle land, food and population issues such as:

- The location and the extent of cultivable areas and their potential use capability under different management systems.
- The inputs necessary to meet future food demands and the location of surplus and deficit areas under different management systems and food movement assumptions.
- Likely risks of land degradation and the measures needed to ensure sustainable production.
- Where and on which crops purchased inputs are likely to be most cost effective.

He drew attention to the authors' argument that FAO's "Agroecological Zones Study" and particularly the "Potential Population Supporting Capacities Study" make a first approximation of the potential population supporting capacities of lands in developing countries in comparison with their 1975 and projected year 2000 populations and that these recent FAO activities point the way for more details studies in the subject area at the national level.

The authors conclude that despite the very broad nature of the studies they highlights some key considerations in the land, food and population equation, namely:

- That land resources and their production potential are very unevenly distributed within and between countries.
- That increasing input levels and improving land management in developing countries are vital in present in future populations are to be adequately fed.

There are substantial areas where land resources are insufficient to meet the food needs of present populations with more adverse ratios projected by the end of the century.

The Chairman further drew attention to the authors' recognition that assessed food deficits can be met from the resources from other areas, but that such actions involve a wide range of considerations outside the scope of paper, which therefore centers on means for attainment of the objectives of food self-sufficiency and self-reliance to the extent that they are feasible. He further noted the author's conclusion that these objectives require long range and sound land use planning and clear indications of equally long range food requirements through the year 2100 by which time populations are expected to stabilized. To achieve appropriate long range plans and the most efficient use of the available resources it is essential to establish a clear inventory of the physical resource base and its potential. He suggested that someone may disagree with particular aspects of the paper, few could argue with authors that agricultural policy makers in developing countries must know with greater precision now than ever before, the extent and potential of available physical resources and the dimensions of the food needs in their countries and, if the Bank is to be successful as a development agency, so must those involved in the development financing of agriculture.

Summary of Discussion

A speaker from East Africa Projects open the discussion, noting that the comparatively high cost conservation practices, shown in slides during the presentation, often had unattractive economic and financial returns and asked whether lower cost practices, such as the maintenance of ground cover, contour planting and provision of drainage did not have an important role.

Dr. Dudal replied that such low cost measures were strongly advocated but that their introduction may at times conflict with the farmers cropping patterns. He further commented that such activities as terracing were usually undertaken in order to create additional land for cultivation rather than to conserve the soil on lands already been cultivated. This reflected farmers' apparent unwillingness to adopt conservations measures in many instances. In undertaking economic analysis the costs of land-loss and downstream effects of erosion need to be taken account of in much more precise detail than has been the case in the past. In reply to a question from a member of OPS Agriculture, Mr. Higgins said that countries where studies were presently being undertaken, using the methodology developed by FAO, comprise in the first instance; Thailand, Malaysia and Philippines in the far East where the countries themselves had adopted the methodology and FAO was merely providing some support expertise. There was also interest being expressed by people in Indonesia concern with population projections. Secondly, Mozambique, Ethiopia and Bangladesh were undertaking county studies with funding by UNDP and in addition Kenya was going ahead with FAO regular program funds and FAO support to further develop the methodologies. Thirdly, the Southern
African Development Coordinating Conference (SADCC) countries\(^1\) have expressed interest and studies are beginning to get on the way. In addition to these, China wants to start and Gabon has ask for assistance.

On a further point raised by the same staff member Mr. Higgins commented that the climatic data used for regional studies could only comprise long term averages but at the country level it was intended to superimpose climatic variability by adjusting the potential productivity to reflect risk of drought. However, the additional work involved by using greater detail was substantial. If the scale is double the amount of data used will increase fourfold.

A staff member from West Africa Projects questioned the increases in productivity assumed when inputs are used. Even with a high level of inputs the Bank's experience indicated that a doubling of yields above those achieved by traditional methods was as much as could be expected. This compared with the ten-fold increase the FAO study has adopted. He was also concern that even in the USA, where sophisticated land use systems were used, these could still lead to unsustainable production and he wondered how one could bring about sound and sustainable agriculture in Africa.

In reply Mr. Higgins agreed that high levels of input use may proved unachievable in many countries over the time span used for the FAO study, however, in the model, the traditional systems were seen to require long periods of fallow and still resulted in long term productivity declines which effectively downgraded the low-input systems in relation to high-input systems where fallow was minimized, full conservation measures were adopted and where yield response to inputs might result in a doubling as suggested. If each of the three factors give a doubling response then the overall increase was by a factor of eight and this order of magnitude was considered reasonable although omittedly we presently haven't got all the answers. Dr. Dudal stressed the need to avoid the sort of planning mistakes which have been made in the past through inadequate study and research back-up before going ahead with development. He cited examples of a sugar factory located in an area where frost seriously affected productivity and another project where a paper plant was erected with the intention of using straw as a feed stock without realizing that the straw was required as an animal feed.

In reply to questions from staff members in PHN and OED, Mr. Higgins said firstly that FAO population experts believe that it would be inadvisable to project populations beyond the year 2000 on the basis of environmental regions and secondly that the methodology had not taken account of increasing difficulty in providing adequate credit for small-holders.

\(^1\) Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, and Zambia.
A participant from OPS Agriculture commented that when investment needs for food self-sufficiency are fully quantified they may give rise to low economic rates of return and that, in view of the need for high economic growth in developing countries, this may result in investments being focused in other areas than food self-sufficiency. He also commented that results of the FAO work will enable planners to plan better for migration between countries and regions, which might proved a better policy than food self-sufficiency in some instances from economic stand point.

Another participant from OPS Agriculture inquired whether the 2 billion hectares of potentially cultivable land shown in Table VI, included Tropical Rain Forest, as in his experience these infertile Latosols have proved difficult to develop for sustainable cropping. In reply Mr. Higgins indicated that they were included, on the assumption that a suitable crop mix, consisting of perennials and food crops tolerant of low pH, was employed, which would make them cultivable on sustained basis though the economic and financial returns might well be marginal.

A consultant employed by OPS Environment Science and Technology Unit expressed concern that high inputs dependent on fossil fuel energy were not sustainable in long term and enquired whether a separation of inputs into fuel dependent and others might be considered. Mr. Higgins replied to all inputs proposed in the models would be dependent to some extent on fossil fuels. Dr. Dudal observed that only 4% of World energy consumption was used for crop production compared with, for example 24% for transportation. Fertilizer represented only 1% of World energy use. He thought therefore that significant cut backs in energy consumption should not be looked for from agriculture inputs.

A staff member from East Africa Projects commented that for many small countries in Africa it was essential to expand export production in order to earn foreign exchange to finance inputs. As a result a substantial area of land capable of production was not available for food production if the correct balance between food, industrial and export crops is to be achieved. It would be necessary to take account of the economic costs and returns of the major alternatives in deciding on investment priorities.

In reply to another participant from South Asia Region Mr. Higgins said while results of the study had not been systematically cross checked with results of previous studies in comparable areas, it was noteworthy that an independent study conducted by East West Center and Canada came up with comparable results for South America when low inputs were assumed although the study was undertaken in much more detail than that of the FAO.

Mr. Higgins went on to quote a senior Government official in Kenya as saying that the country can no longer afford to meet the costs of transporting food from surplus areas in the south to deficit areas in the north and that the FAO supported study was needed to determine which districts could be expected to achieve food self-sufficiency in the medium term and in those where this cannot be achieved, and what other development
options should be considered. In reply to a question from the Chairman Mr. Higgins said that the study for Kenya would be completed in 1985.

A participant from PHN considered the FAO study was oriented almost entirely towards those factors affecting food supply but ignored those which would impact on demand. He took as an example the World development report projection of a nine-fold increase in the agricultural population of Kenya with even the most optimistic assumptions regarding the expansion of work opportunities outside agriculture. This would have serious effects on the demand for agricultural produce and would lead one to much less optimistic expectations for the future. Mr. Higgins agreed that the enormous increases in agriculture population would affect the demand for agricultural produce but felt that on the whole the FAO projections had not been over optimistic. Dr. Dudal drew attention to the fact that FAO's methodology starts from an assessment of the physical resource base. Planning of such a broad scale could not take account of factors such as prices but that decision makers within the country concerned could feed these factors in at a particular point in time when making their own development plans.

A participant from OPS Agriculture expressed concern at the suggestion to use the national study as a tool for detailed food security planning in Kenya in view of the need to take account of all the other economic issues which the methodology of FAO does not address. Mr. Higgins accepted the criticism and thought that he would be in better position to respond after another twelve months of experience. Another OPS Agriculture participant said that he shared the same concern if too much emphasis is placed on such a relatively superficial methodology as a planning tool. The separate focus in the methodology on low, intermediate and high technology tends to promote high technology and fails to look at the appropriate combination of technologies taken from each level which would be economically sound. He also questioned how the model relates yields to inputs because he found that, in attempting to use technical frameworks as the basis for economic analysis, such relationships often prove weak. Mr. Higgins responded by agreeing that interactions between different levels of technology are important but, because of the need in the study to generalize for areas covering all the developing world, this level of detail which is not possible. Regarding methods of calculating potential production, he felt that the basic methodologies of the model were adequate, going from the calculation of bio-mass potential through climatic constraints and agricultural constraints to derive yield potentials under particular environmental conditions.

However, he hoped that further improvements in the model would be developed in the future.

A participant from the Inter-American Development Bank noted that the FAO definition for Central American countries was not consistent with that of IADB and Mr. Higgins agreed and offered to provide a list of the countries so catagorized by FAO.
A POPULATION PERSPECTIVE ON AGRICULTURAL DEVELOPMENT

The Chairman thanked the speaker for her succinct and interesting presentation in which she had raised a number of important issues and drawn conclusions significant to all concerned with the development. He drew attention to the suggestion in the paper that a population perspective on agriculture implied a focus on raising labor productivity and that, since it is rapid population growth that slows development rather than a global scarcity of natural resources, that the population problem within agriculture occurs in both land-rich and land-poor countries and manifests itself as pressure on investment resources and the efficient management of those resources under the conditions of rapidly increasing labor supply. He also drew attention to the difficulties of raising labor productivity in agriculture which may prove relatively more difficult in Africa and South Asia where many countries continue to face large increases in their agricultural work force. Farmer managed innovations that raise labor productivity, such as mechanization, are unlikely to be attractive to farmers until labor scarcity and raising wages render them economically viable.

The Chairman drew attention to the point that labor scarcity can be created by management intensive innovations and associated non-labor inputs, in land via irrigation, by improve transportation which increases market size, by the use of fertilizer and improved seed to increase production and hence intensity of land use and by the provision of extension and farmer education services which disseminate information and increased efficiency in the use of non-labor compared with labor inputs. The speaker had argued that unlike farmer managed change, these management intensive innovations required national decisions and institutional incentives. Agricultural research is one example. The resources for such activities centered overwhelmingly in the developed rather than the developing countries and tend to produce labor saving rather than using innovations.

In conclusion the Chairman noted that rapid population growth in developing countries makes for great difficulty of choice among and the management of, investment opportunities. That even in land-rich countries policy efforts to increase labor demand in agriculture should be accompanied by efforts to reduce labor supply over the long run by reducing fertility.

Summary of Discussion

A participant from West Africa Projects observed that the presentation assumed an easy transition between "Rural" and "Agricultural". He enquired whether an increasing rural population in Kenya really implied increasing absorptivity of that population as farm labor. Wouldn't rural industries make a significant contribution to rural employment? The speaker replied that even under an optimistic scenario for off-farm growth, the national growth of off-farm jobs would hardly exceed 4%. However, rural off-farm employment is only generated when income in rural areas (i.e. in agriculture) is increasing. With an enormous growth in rural labor, for which the only means of generating a livelihood was agriculture production, the market share of the individual producer would in fact decline and income would decline in parallel.
A participant from OPS Agriculture observed that the increase in productivity in Japan in the nineteenth century has been attributed to agricultural extension and he questioned the justification for this. The speaker replied that the Japanese Government instituted a number of labor intensive agriculture innovations (for example, drainage and terracing) and this enabled labor utilization to be maintained until about end of the century when, with a decline in labor availability, labor saving activities were introduced.

Mr. Schuh observed that one omission in the paper was the complementarity between agricultural technology and education to which the speaker replied that this point had been made in the World Development Report and that there must be incentives to educate children to parallel incentives for reduction in fertility.

Another participant from OPS Agriculture commented that some EMENA countries had recently experienced a labor scarcity situation due to migration in search of more remunerative work. As an example, the Jordanian agriculture labor force is largely comprised Egyptian migrants. He questioned how a country might adjust to this. The speaker in return questioned why farmers in such labor scarce countries were not introducing labor saving methods. Was there a lack of management input?

Another staff member from West Africa Projects noted that the paper seemed to focus on the supply side, increasing outputs as a means of increasing incomes. However, on a global scale there was a market problem and on the national scale, domestic markets depend on urban growth. As a result migration to the cities may be valuable in order to create the market growth needed to sustain agriculture in the rural areas. Perhaps efforts to retain the rural population on the farm were misguided? The speaker agreed there was a complementarity between the urban and rural population dynamics. Another participant from West Africa Projects thought that there was a need to look again at promoting more off-farm employment whether rural or urban.

Dr. Dudal from FAO noted that the experience of the nineteenth century in the USA where an enormous expansion of the land base occurred was not paralleled in this century in Africa. A number of factors were responsible for this difference but disease problems, both for humans and for draft animals, were serious constraints in many parts of Africa. Furthermore, Africans, unlike USA farmers, seldom irrigate under low rainfall conditions, probably due to the prevalence of water born diseases as well as the limitations of topography and soils.

In reply to further questions from PHN and AGR participants the speaker drew attention to the suggestion that population growth, such as occurred in Hong Kong and Singapore, can be a good thing in that it results in incentives to develop new technology. The problem is not with numbers but with rates of growth. While traditional agriculturists may adopt improved technologies they would not necessarily adopt more labor efficient technologies when increasing population pressures exist.

The Chairman then closed the discussion.
INTRODUCTION

Rapid population growth since the turn of the century has led to an exhaustion of the land frontier in most countries across the world causing a decline in arable land per capita and an associated decline in labor productivity. Traditional societies across the world have devised remarkably similar means of coping with reductions in per capita land availability. This paper highlights the farmer based and modern technological options available to societies for achieving growth in agricultural output through increases in land and labor productivity.

The farmer's means of coping with increasing population densities and/or increased demand for agricultural output has been an expansion in the area under cultivation. Additional land was brought under cultivation either through a reduction in fallow periods or through the cultivation of virgin land. With the exhaustion of the land frontier intensive cultivation of permanent fields became the norm. Permanent cultivation systems are characterized by land investments for terracing, drainage and irrigation, intensive manuring systems and a change from hand cultivation to the use of animal draft power. All of Europe and East and most of South Asia had made this transition to permanent cultivation of land before this century, while most of Sub-Saharan Africa is still under fallow systems today. By comparing Sub-Saharan Africa with Asia we are able to illustrate the process of agricultural intensification and the associated changes in agricultural technology.

Farmer generated technical change is capable of sustaining slow and steadily growing populations with modest increases in agricultural output. It appears, however, to be incapable of supporting rapidly rising agricultural populations and/or rapidly rising non-agricultural demand for food. It is at this stage that large scale irrigation systems and science and industry based technical changes must become major sources of the rate of

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growth in agricultural output. State supported large scale irrigation systems have been in existence for centuries in China and Egypt, and have become prominent in India in the late 19th and early 20th century. Inputs such as high yielding seed varieties and chemical fertilizers not only increase the productivity of land but also increase the productivity of labor thus leading to increases in per capita output and therefore generating surpluses that can be transferred to the non-agricultural populations. However, the transition to science and industry based inputs is costly especially in terms of establishing an institutional structure and an industrial base that is capable of generating and supplying these technologies. The ability of a country to achieve rapid growth in agricultural output is therefore constrained by the size of its physical and human capital base.

Section 1 of this paper discusses the determinants of the intensity of land-use emphasizing the consequences of population concentration and improvements in transport infrastructure. Section 2 discusses the farmer based innovations in response to agricultural intensification and Section 3 analysis the role of science and industry based innovations in achieving rapid increases in agricultural output.

A. DETERMINANTS OF THE INTENSITY OF LAND-USE

1. Population Density

The existence of a positive correlation between the intensity of land-use and population density has been shown by Boserup (1965, 1980). She argues from the premise that during the neolithic period forests covered a much larger part of the land surface than today. The replacement of forests by bush and grassland was caused by (among other things) a reduction in fallow periods due to increasing population densities.

"The invasion of forest and bush by grass is more likely to happen when an increasing population of long fallow cultivators cultivate the land with more and more frequent intervals."

(Boserup, 1965, p. 20)

Table 1 presents the relationship between population density and the intensity of the agricultural system. At very sparse population densities, up to four persons/square kilometer, the prevailing form of farming is the forest fallow system. A plot of forest land is cleared and cultivated for one or two years and then allowed to lie fallow for 20-25 years. This period of fallow is sufficient to allow forest regrowth. An increase in population density will result in a reduction in the period of fallow and eventually the forest land degenerates to bush savannah. Bush fallow is characterized by cultivation of a plot of land for two-six years followed by six-ten years of fallow. The period of fallow is too short to allow forest regrowth. Increasing population densities are associated with longer periods of continuous cultivation and shorter fallow periods. Eventually the fallow period becomes too short for anything but grass
### Table 1: Food Supply Systems in Tropics

<table>
<thead>
<tr>
<th>Food Supply System</th>
<th>Farming Intensity(^1)/ (R-Value)(^2)</th>
<th>Population Density Group(^2)/ Persons/km(^2)</th>
<th>Climatic Zone(^3)/</th>
<th>Tools Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>G. Gathering</td>
<td>0</td>
<td>0 - 4</td>
<td>Humid</td>
<td>axe, matchet &amp; digging stick</td>
</tr>
<tr>
<td>FF. Forest fallow</td>
<td>0 - 10</td>
<td>0 - 4</td>
<td>Humid</td>
<td>axe, matchet, digging stick</td>
</tr>
<tr>
<td>BF. Bush fallow</td>
<td>10 - 40</td>
<td>4 - 64</td>
<td>Semi-humid, semi-arid &amp; high altitude</td>
<td>hoes, animal traction</td>
</tr>
<tr>
<td>SF. Short Fallow</td>
<td>40 - 80</td>
<td>16 - 64</td>
<td>Semi-humid, semi-arid &amp; high altitude</td>
<td>animal traction</td>
</tr>
<tr>
<td>AC. Annual Cropping</td>
<td>80 - 120</td>
<td>64 - 256</td>
<td>Semi-humid, semi-arid &amp; high altitude</td>
<td>animal traction &amp; tractors</td>
</tr>
</tbody>
</table>

1/ \(R = \theta\) of years of cultivation *100/\# of years of cultivation + \# of years of fallow. Source, Ruthenberg, 1980, p. 16.


5/ Description of food supply systems:
- Gathering: wild plants, roots, fruits, nuts
- Forest-fallow: one or two crops followed by 15-25 years of fallow
- Bush-fallow: two or more crops followed by 8-10 years of fallow
- Short-fallow: one or two crops followed by one or two years of fallow: also known as grass fallow
- Annual cropping: one crop each year
- Multi-cropping: two or more crops in the same field each year

Note 1: The above food supply systems are not mutually exclusive. It is quite possible for two or more of the systems to exist concurrently (e.g., cultivation in concentric rings of various lengths of fallow, as in Senegal).

Note 2: The above population density figures are only approximations, the exact numbers depend on location specific soil fertility and agroclimatic conditions.
growth. The transition to grass fallow occurs at population densities of around 16-64 persons per square kilometer. Further increases in population result in the movement to annual and multi-cropping, the most intensive systems of cultivation.

The above discussion leads to the broad generalization that for given agroclimatic conditions, increases in population density will gradually move the agricultural system from forest fallow to annual cultivation and even multi-cropping. The reasons for population concentration and/or growth and the consequent decline in arable land per capita are discussed below.

Since the turn of this century we have observed a substantial increase in the natural rate of population growth across the world, mainly due to a sharp decline in the death rates caused by rapid advances in public health services. At the world-wide level, and at the level of a specific country, the decline in arable land per capita must be attributed primarily to this general increase in population. Within a country and within regions, however, population concentrations vary by soil fertility, altitude and market accessibility. These intra-country variations are briefly discussed below using examples primarily from Sub-Saharan Africa. Table 2 provides the major causes and consequences of population concentration.

2. **Soil Fertility**

The marginal productivity of labor is relatively higher on more fertile soils and hence one would expect immigration from less endowed areas leading to reductions in cultivable areas per capita. Ada district, Ethiopia; Nyanza Province, Kenya and the southern province of Zambia are a few examples of fertile areas that are relatively densely populated and intensively cultivated. High altitude areas are similarly densely populated due to immigration from the lowlands because of lower disease incidence (notably malaria and sleeping sickness). Population concentrations on the Ethiopian and Kenyan Highlands are popular examples of this phenomenon.

3. **Transport Infrastructure and Market Access**

Given suitable soil conditions, areas with better access to markets either through transport networks or those in the proximity of urban centers will be more intensively cultivated. Intensification occurs due to two reasons:

a) higher prices and elastic demand for exportables implies that marginal utility of effort increases, hence farmers in the region will begin cultivating larger areas; and

b) higher returns to labor encourage immigration into the area from neighboring regions with higher transport costs.
### Causes and Consequences of Population Concentration

<table>
<thead>
<tr>
<th>Causes</th>
<th>Direct Consequence</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural improved public health and lack of emigration</td>
<td></td>
<td>Reduction in fallow periods: Movement from shifting to permanent cultivation</td>
</tr>
<tr>
<td>Soil fertility: immigration to capture the benefits of higher returns to labor input</td>
<td>Reduction in available area per capita</td>
<td>Mechanization: Flowing: where agro-climatic and soil conditions make it profitable</td>
</tr>
<tr>
<td>Transport facilities:* immigration to capture the benefits of reduced transport costs</td>
<td></td>
<td>Transport: where markets exist for food and other crops</td>
</tr>
<tr>
<td>Urban demand:* immigration to capture the benefits of market proximity</td>
<td></td>
<td>Milling: in response to higher opportunity cost of time for female household members</td>
</tr>
<tr>
<td>Health: avoidance of malaria and tsetse fly immigration to cooler highlands</td>
<td></td>
<td>Land investments: for soil fertility, drainage, terracing, etc. Increase in the marginal lands brought under cultivation</td>
</tr>
<tr>
<td>Historic: tribal war/slave trade immigration to inaccessible highlands</td>
<td></td>
<td>Land rights: from general use rights to specific land rights</td>
</tr>
<tr>
<td>Land laws, rights restrictions on the right to open new land</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In the case of improved transport facilities and urban demand one may observe an expansion in the area under cultivation in the absence of immigration.

---

*Table 2*
Intensive groundnut production in Senegal, maize production in Kenya and Zambia and cotton production in Uganda have all followed the installation of the railway and have been mainly concentrated in areas close to the railway line. Similarly, agricultural production around Kano, Lagos, Nairobi, Kampala and other urban centers is extremely intensive compared to other parts of these countries. It should be noted that agricultural intensification in response to improved market access could occur even under low population densities due to individual farmers expanding their area under marketed crops. The consequences of intensification in these circumstances do not differ from those in areas with high population densities.

4. Other Causes

Finally, it should be noted that inter and intra-country variations in population densities, especially in Sub-Saharan Africa, have historically been caused by tribal warfare and slave trade resulting in population concentrations in relatively inaccessible highlands. Population concentration on the high plateau of Rwanda and Burundi was in response to the incursions of slave traders and for health reasons. Similar migrations from the lowlands to the Mandara Mountains in Cameroon, the Jos Plateau in Nigeria and the Rift Valley in Kenya and Tanzania have been based on the desire for personal security. Subsequent natural population growth has made many of these areas the most densely populated parts of Africa.

5. Implications of Agricultural Intensification

Traditional societies across the world have devised remarkably similar means of coping with reductions in agricultural land per capita caused by population concentration and/or market access. Farmer initiated adjustments to growing land scarcity are: (i) a reduction in fallow periods and the concentration of cultivation on soils most responsive to intensification, such as deep clayey soils; (ii) an increase in land investments, such as destumping, terracing, drainage and irrigation; (iii) an increase in labor input for more intensive manuring techniques; and (iv) a switch from hand hoes to animal drawn plows and then to tractors. These farmer based innovations are discussed in detail in Section 2 of this paper. It should be borne in mind, however, that innovativeness on the part of the farmer can only accommodate slowly growing populations. Rapid growth in food output can be achieved, however, only when farmer initiated innovations are complimented by science and industry based inputs, such as high yielding varieties, fertilizers, pesticides, etc. Section 3 discusses the rate and direction of science based technical change and the growth of agricultural machinery and chemical industry in response to rising population densities.
B. FARMER BASED INNOVATIONS IN RESPONSE TO INTENSIFICATION

1. Changes in Land-Use

The intensification of agricultural systems is constrained by climatic and soil factors. Table 1 illustrates the impact of climatic factors on the intensification of the agricultural system. For given agroclimatic conditions the extent of intensification is conditional on the relative responsiveness of the soils to inputs associated with intensive production such as land improvements, manure and fertilizers. The responsiveness of intensification is generally higher on soils with higher water and nutrient holding capacity. This is primarily because higher water holding capacity reduces drought risk. Water holding capacity is higher the deeper the soils and the higher their clay content. It is low on shallow sandy soils.

Graph 1 presents a stylized picture of the differences in soil types across a toposequence for given agroclimatic conditions. Soils on the upper slopes are relatively light and easy to work by hand, tillage requirements are minimal on these soils. The clay content and hence the heaviness of the soils increase as one goes down the toposequence, consequently power requirements for land preparation increase. Movement down the slope also reduces yield risks due to increased water retention capacity of the soils. The soils are heaviest in the depressions and marshes at the bottom of the toposequence. These bottom lands or bas fonds are often extremely hard to prepare by hand and are often impossible to cultivate in the absence of investments in water control and drainage. The extremely high labor requirements for capital investments and land preparation make the bottom lands the least preferred for cultivation under low population densities, and they are often found to be under fallow. As population densities increase, however, the bottom lands become intensively cultivated due to the relatively higher returns offered to labor and land investments, especially in rice cultivation. Also, as population densities increase labor supply increases making it possible to undertake the labor intensive investments in irrigation, drainage, etc.

For instance, Grove (1961) cites the case of fadama (flood land) use in Northern Zaria, Nigeria. This land was not cultivated by the local farmers who preferred the lighter soils of the mid-slopes. Seasonal migrants from the densely populated areas near Kano, however, chose to cultivate this land as they had long been accustomed to bottom land cultivation. The "stranger farmers" from Kano cultivated the fadamas in the dry season until the population densities in Zaria became high enough to induce local group to undertake this type of cultivation as well. Fadamas in Zaria are now fully utilized and are scarce (being bought, sold and rented.

Soil type differences across a toposequence that are characterized here could be micro-variations limited to a few hundred meters or a few kilometers, or they could be macro-variations where entire regions are part of one level of the toposequence. For example, the northeastern part of Thailand can be characterized as being the upper slopes while the central plains of Thailand are the lower slopes and valley bottoms.
Graph 1

TOPOSEQUENCE AND SOIL TYPE

Upper Slopes
Mid-Slopes
Lower Slopes
Depressions and/or Marshes

Relatively Light Stream
Relatively Risky River

Intermediate
In Case of Heavy
Cultivation Low
and Risk Risk

Power requirements Low
for land preparation High

Response to Low
Intensification High
Preferences for cultivating different points of the toposequence are also dependent on the agroclimatic conditions. Table 3 presents soil preferences by farming intensity and agroclimatic zones. Under arid conditions lower slopes and depressions are the only lands which can be cultivated because it is only here that water retention capacity is sufficient to sustain a crop at very low rainfall levels. This is the reason for the intensive cultivation systems of an oasis type one observes in arid areas even under low population densities. Pockets of arid farming in primarily pastoral areas of Botswana are a good example of this phenomenon.

Under semi-arid conditions the mid-slopes are the first to be cultivated. As population densities increase, cultivation replaces grazing in the lower slopes and eventually in the depressions. Power sources for tillage are first used in the bottom lands generally around the time when population pressure makes these lands valuable for cultivation. The reversal of land preferences is quite dramatic. In the semi-arid zones of Africa where population density is low the lower slopes and depressions are left for grazing and contribute only minimally to food supply. In the semi-arid zones of India, on the other hand, the depressions are intensively cultivated usually with rice using elaborate irrigation systems and animal traction.

Yield risks due to low water availability are not a major problem in the sub-humid and humid tropics, hence one finds cultivation starting at the upper slopes and gradually moving downwards as population pressure increases. At high population densities the swamp and depressions become the most important land sources for food production, often associated with extremely intensive rice production. One observes such labor intensive rice production in South and Southeast Asia and could expect the same for Africa as population densities increase.

Population pressure leads to a sharp reversal in preference (price) of different types of land in all but the arid zones. As population densities increase one observes the cultivation of land which requires substantially higher labor input but which at the same time also is more responsive to the extra inputs. Table 4 provides examples of population density, agroclimates and patterns of land-use in selected African countries.

2. Land Investments

In the early stages of agricultural intensification, forest and early bush fallow, there are almost no investments made in land. Tree cover is cleared by felling and fire and the stumps are left in the ground to allow quick regeneration of vegetation when the plots are returned to fallow. As a plot of land is used more permanently the first major investment that takes place is to remove all the tree stumps from the fields and to have well defined plots of land on which cultivation takes place. This generally happens around the late bush fallow and early grass fallow stage of cultivation.
Table 3
FARMING INTENSITY, AGRO-CLIMATES AND SOIL PREFERENCES

<table>
<thead>
<tr>
<th>Agro-climates</th>
<th>Farming Intensity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forest &amp; Bush Fallow</td>
<td>Grass Fallow</td>
<td>Permanent Cultivation</td>
</tr>
<tr>
<td>Arid</td>
<td>Lower slopes &amp; depressions only</td>
<td>Lower slopes &amp; depressions only</td>
<td>Lower slopes &amp; depressions only</td>
</tr>
<tr>
<td>Semi-arid</td>
<td>Mid-slopes</td>
<td>+ Lower slopes</td>
<td>+ Depressions</td>
</tr>
<tr>
<td>Sub-humid</td>
<td>Upper slopes</td>
<td>+ Mid &amp; lower slopes</td>
<td>+ Depressions</td>
</tr>
<tr>
<td>Humid</td>
<td>Upper slopes</td>
<td>+ Mid &amp; lower slopes</td>
<td>+ Depressions</td>
</tr>
<tr>
<td>Location:</td>
<td>Gambia</td>
<td>Ukara Island</td>
<td>Sukumaland</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------</td>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>Agro-climatic zone:</td>
<td>Sub-humid</td>
<td>Sub-humid</td>
<td>Sub-humid</td>
</tr>
<tr>
<td>Population density:</td>
<td>Low</td>
<td>Very high</td>
<td>High</td>
</tr>
</tbody>
</table>

**Patterns of Land Use**

- **Upper slopes**
  - forest
  - grazing
  - grazing in wet season

- **Mid-slopes**
  - rainfed groundnut, millet, cotton
  - rainfed millet, manioc
  - cassava, cotton, legumes
  - maize, plow use
  - maize and root crops
  - millet and sorghum

- **Lower slopes**
  - palm forest
  - legumes
  - sorghum, maize
  - maize plow use
  - maize and taro

- **Depressions**
  - flooded rice
  - irrigated rice, sorghum, sweet potatoes and vegetables
  - irrigated rice, sweet potatoes, plow use
  - uncultivated
  - sorghum and maize

**References**

- Ruthenberg (1980)
- Ludwig (1968)
- von Rotenham (1968)
- Trapnell and Clothier (1937)
- Trapnell and Clothier (1937)
- Schapera (1943)
As discussed in the previous section, cultivation generally starts on the easy to work soils of the mid-slopes. These soils are also the most susceptible to erosion as the farming system intensifies. Accordingly, systems of land-use in Africa developed protective devices against erosion as population densities increased, such as: ridging and tie-ridging, silt traps and elaborate systems of stone-walled terraces. These protective land investments were in use in the more densely populated parts of Sub-Saharan Africa prior to the colonial period (Allan, 1965, p. 386). The hilltop refuges provided several historic examples of terrace cultivation in Africa, for instance: Jos Plateau, Nigeria; Mandara Mountains, Cameroon; Kikuyu Highlands, Kenya; Mt. Kilimanjaro, Tanzania; Kigezi District, Uganda; and Rwanda-Burundi (Okigbo (1979), Morgan (1969), and Gleave and White (1969)).

Anti-erosion investments in land are becoming increasingly common in the more recently intensified areas of Africa. Machakos District of Kenya, for example, was a cite of increased migration from the highlands and between 1955 and 1965 the farmers in the district almost universally accepted the practice of bench terracing the mid-slopes that are very intensively cultivated (Ahn, 1979).

As population densities increase one observes a movement from the mid-slopes to the hard to work soils of the lower slopes and depressions. This movement to the valley bottoms creates a need for drainage without which the heavy, waterlogged soils cannot be brought under cultivation. The draining operation is extremely labor intensive and is generally avoided until population pressure makes the cultivation of this land renumerative. The use of the valley bottoms for rice cultivation which is very common and a very important source of food supply in South and Southeast Asia is rare in tropical Africa. Floodland cultivation of rice in Guinea, Sierra Leone, the Senegal and Niger valleys and the basin of Lake Victoria has been increasing and one would expect this trend to continue throughout Africa. In Sukumaland, Tanzania for instance, the flood plain land which 40 years ago was left for grazing is now completely cultivated with rice and the demand for this land is extremely high (Rounce, 1949).

In Asia, small scale irrigation and water control techniques that reduce water stress or allow dry season cultivation are very common. In semi-arid India, the gently rolling hills are intensively used for rainfed crops, the run-off being stored in tanks and used for irrigated wet rice cultivation in the valley bottoms. While some of these tank systems have been in operation for hundreds of years the majority of the investment in these systems was made in the late 19th and early 20th century. Since the 1950s tank irrigation has been surpassed by investment in wells for cultivating a second crop on the mid-slopes, water is drawn from the wells with the help of electric or diesel pumps (Engelhardt, 1984). The ultimate in water control structures is seen in the meticulously terraced hillsides of Java and the Philippines where in each rice field the required depth of water is stored and the excess drained into the field immediately below (Ruthenberg, 1980).
As the land frontier becomes exhausted farmer initiated irrigation systems have to be complimented by state supported large scale irrigation systems for expanding cultivation onto marginal lands and increasing the intensity of cultivation on currently cultivated land. Large scale irrigation systems are of great antiquity in Egypt, China and Japan, they have become very important in India, Korea and Taiwan in recent decades. It is important to note that the building of such large scale systems is induced by high population density when adequate labor supply is available and when the demand for expanding cultivated area through irrigation is high. The failure of large scale irrigation systems in Sub-Saharan Africa can be attributed to extreme labor scarcity and the lack of demand for expanding cultivated area. The Office du Niger scheme in Mali is a case in point. The 50,000 hectares that were actually developed by 1964 fall far short of the initial target of several hundred thousand hectares; and even in this area the density of settlement is insufficient to yield an output that would meet all costs of both the settlers and the management of the scheme, provide the settlers with good livelihood and earn some return on the large amount of capital invested (de Wilde, 1967, p. 288).

3. Development of Organic Fertilizer Use

Under forest and bush fallow cultivation long-term soil fertility is maintained by periodic fallowing of land. Renewed vegetative growth on fallowed land helps to return fresh organic matter to the top soil and therefore re-charges it with nutrient supplies. Also, when fire is used for clearing vegetation prior to cultivation the burnt ashes return to the soil the nutrients taken up by trees and bush cover. This closed cycle of nutrient supply is disrupted when long fallow periods are replaced by grass fallows.

The nutrient supply to the soil under grass fallow declines since grass cover cannot return the same amount of nutrients to the soil as tree and bush cover. Accordingly, at this stage the farmer starts complimenting fallow periods with additional organic wastes from the household, mainly in the form of vegetative waste and dung from cattle and livestock. At first these fertilization techniques are fairly rudimentary, often involving no more than a periodic transport of household refuse to the plots to be cultivated. Sometimes, as in the case of the farmers on the Mandara mountains and the Ethiopian Highlands, the dwellings are situated at a high point so that the refuse washes down to the fields below. In the lower rainfall zones, where vegetative cover is lower, more labor input may be required to augment the supplies from the household. The Bemba, in Zambia for instance used to cut branches from surrounding trees and carry them onto the plot of land to be cultivated and burn the pile of branches to provide nutrients for the plot (Chitemene techniques). Richards (1939), reported that branches were cut from an area up to six times as large as that to be planted.

As farming intensities increase more labor intensive fertilizing techniques such as composting and then manuring evolve. The Fipa of Tanzania collect fallen and cut vegetation and bury it in mounds. Beans,
manioc, cowpeas, etc. are planted on these mounds which are rich in nutrients due to rotting vegetation. This system of composting is common in Tanzania, Zambia and Zaire (Miracle, 1967).

The use of animal manure is common in most of the densely settled intensively cultivated pockets of Sub-Saharan Africa. Farmers in the hill refuges, mentioned earlier, have for generations used manure on their terraced fields. The inhabitants of the very densely populated Ukara Island in Lake Victoria laboriously collected three tons of manure per year from each adult cattle and transported it to the fields by headloads. In addition to this they practised green manuring with legumes (Allan, 1965, p. 201). The use of manure is also characteristic of the densely populated parts of Northern Nigeria. In the villages of Katsina Province, livestock are kept tethered in the compound and the manure is collected in heaps. Household refuse and ashes are added to the heaps. Those farmers with large holdings usually supplement their supplies through an active manure market. In the villages near Kano city, farm manure was complemented by night soil transported from the city (Gleave and White, p. 284). In areas where livestock herding has traditionally been separate from farming, one tends to observe contracts between herdsmen and farmers as farming intensities increase. The typical case being a farmer inviting a herder to graze his stock on the fallow land and thus benefit from the cattle droppings. Toulin (1983) describes such contracts in central Mali. Farmer-herder contracts are also common in India.

Finally, one observes the incorporation of legumes in a crop rotation cycle as green manure. Green manuring along with other fertility restoring measures is a common practice in several parts of India and China. The use of cowpeas in the rotation cycle is becoming increasingly common among the permanently cultivated areas of Africa. All of the manuring techniques discussed above were and continue to be very important in China, Japan and most of Europe.

As agriculture intensifies, one observes a sharp decline in yields due to a drop in soil fertility which can only be reversed by more labor intensive fertility restoring techniques. Pingali and Binswanger (1984) using data from 52 specific locations in Africa, Asia and Latin America show a significant positive association between manure use and farming intensity. It is important to note that farmers at lower agricultural intensities are already familiar with the more evolved manuring techniques since many of them use these techniques on their garden plots. The reason they do not use these techniques on all their fields is that there are other alternatives, such as fallowing, which require much lower labor input than intensive manure production. It is only when land pressure makes it inevitable that general use of these techniques is resorted to.

4. The Evolution of Tool Systems

The transition from digging sticks and hand hoes to the plow is closely correlated with the intensity of farming. The simplest form of agricultural tool, the digging stick, is most useful in the very extensive forest
and bush fallow systems where no land preparation is required. As the bush cover begins to recede the ground needs to be loosened before sowing and at this stage hand hoes replace digging sticks. Hand hoes are used for land preparation and weeding in the latter stages of bush fallow, grass fallow and even some instances of annual cultivation. Land preparation using the hoe becomes extremely labor intensive and tedious by the grass fallow stage. This is especially true because of the persistence of grass weeds. "The use of a plow for land preparation becomes indispensable at this stage," (Boserup, 1965, p. 24). A switch to the plow during grass fallow results in a substantial reduction in the amount of labor input required for land preparation. The net benefits of switching from the hoe to the plow are conditional on soil types and topography. The benefits are lower for sandy soils and for hilly terrain.

The above discussion on the evolution from hand hoes to animal drawn plows is formalized in Graph 2. This graph compares the labor costs under hand and animal powered cultivation systems and shows the point where animal traction is the dominant technology.

The overhead labor costs in the transition from hand to animal power are: the cost of training animals, the cost of destumping and leveling the fields, and the cost of feeding and maintaining the animals on a year-round basis. The cost of training the animals is independent of the intensity of farming. The cost of destumping is extremely high under forest and early bush fallow system due to the high density of stumps per unit area and due to a highly developed root network that is difficult to remove. As the length of fallow decreases the costs of destumping decline because of reduced tree and root density. Destumping requirements are minimal by the grass fallow stage. The costs of feeding and caretaking of draft animals is also very high during forest and early bush fallow, primarily due to the lack of grazing land and due to the prevalence of diseases such as trypanosomiasis. As the fallow becomes grassy, grazing land becomes prevalent and so does animal ownership; hence the costs of maintaining draft animals decline. By the annual cultivation stage, however, grazing land becomes a limiting factor necessitating the production of fodder crops which in turn lead to an increase in the cost of feeding and maintaining draft animals. The total cost of using draft animals for land preparation, early season weeding and manuring is given by the curve, \( T_p \).

The labor costs for cultivation using hand tools rise rapidly as farming intensity increases. This is mainly due to the increased effort required for land preparation, weeding and for maintaining soil fertility. \( T_h \) shows total labor costs using hand hoes for land preparation and weeding, while \( T_h' \) adds in the cost of maintaining soil fertility. The shape of the \( T_h' \) curve depends on: (i) the ease of producing compost; (ii) the rate of decay of organic matter; and (iii) the cost of chemical fertilizer. In humid and sub-humid areas it is easier to produce compost and manure relative to semi-arid and arid areas due to an abundance of natural vegetation, hence the labor costs involved in the production of manure are lower and the \( T_h' \) curve is flatter. In hot tropical areas the very high temperatures cause the organic matter to decay at a faster rate relative to the more temperate highlands, and hence require additional compost and manure inputs.
Graph 2

A COMPARISON OF LABOR COSTS UNDER HAND AND ANIMAL POWERED CULTIVATION

\[ \text{T}_p = \text{Labor costs for land preparation, early season weeding and manuring using animal traction} \]

\[ \text{T}_h = \text{Labor costs for land preparation and early season weeding using land hoes} \]

\[ \text{T}_h' = \text{T}_h \text{ plus labor costs for maintaining soil fertility without manure from draft animals} \]

Switch Point = Farming intensity at which animal traction is the dominant technology.
making the $T_h$ curve steeper. The $T_h$ curve becomes flatter the cheaper chemical fertilizers are due to the substitution of fertilizers for labor intensive manure production.

Animal drawn plows are the dominant technology at the point where the costs of hand cultivation exceed the costs of transition to animal power. This switch point is shown in the graph. This discussion illustrates the following conclusions:

a) The transition to animal-drawn plows would not be cost effective in forest and bush fallow systems due to the very high overhead labor costs required for destumping and animal maintenance.

b) There is a distinct point in the evolution of agricultural systems where animal draft power becomes economically feasible.

c) This dominance point is conditional on soil types and soil fertility: the transition would occur sooner for hard to work soils (clays) and for soils which require high labor input for maintaining soil fertility.

The complimentarity between animal traction and manure use implied in (c) above is explained by the inverse relationship between farming intensity and soil fertility and by the increased availability of manure when draft animals are introduced into the farming system. Fertilizers tend to substitute for manure around the annual and multi-cropping stage.

The transition from animal plows to tractors is explained better in the context of choice of techniques rather than in terms of the evolution of farming systems. Factors that determine this transition are capital availability, economic efficiency of tractor use, labor cost and peak season labor scarcity. Tractors generally emerge as feasible alternatives to animal drawn plows at the stage of permanent cultivation of land. Land preparation and transport are usually the first operations for which tractors are used.

A very detailed analysis on the evolution of tool systems using information from field visits to approximately 50 locations in Sub-Saharan Africa is provided in Pingali, Bigot and Binswanger (1985). In this study we provide empirical evidence on the positive relationship between farming systems and tools use and show that the evolution from hand hoes to animal drawn plows occurs at the grass fallow stage and not before. Empirical evidence on the labor saving benefits and the consequent increases in yields per manhour through a change to animal drawn plows and tractors is provided in Pingali and Binswanger (1984).
C. SCIENCE AND INDUSTRY BASED INNOVATIONS

In the last section we showed how societies have coped with increasing population densities and/or increased market demand for food output through more intensive use of farmer generated inputs, mainly land and labor. Such intensification can and often does increase agricultural output but it is important to remember that the rate of growth in output is low in the absence of science and industry based inputs. Under these conditions, agricultural output may not keep up with or only barely keep up with the growth in population and little surplus is available for transfer to the rest of the economy. This point becomes extremely clear when we consider that agricultural output in much of the developing world is growing at 1-1.5% p.a. while population is growing at 2-3% p.a. Therefore, in order to sustain growing rural populations and to feed the urban population, agricultural output in the developing world would have to grow at an unprecedented 3-4% per year. This is an improbable outcome since in the 40-year period (1930-1970) the developed world has averaged a growth in agricultural output of only 1.5-2% per year (Binswanger and Ruttan, 1978). The development of more productive mechanical, biological and chemical technologies could help in narrowing the gap between the demand for and the supply of food in the developing countries. The remainder of this paper concentrates on the potential role of science and industry generated innovations and inputs in increasing agricultural output.

1. Population Density and The Rate and Direction of Science Based Technical Change - The Induced Innovation Hypothesis

The history of agricultural growth of the developed world illustrates that the rate and direction of technical change are influenced by an economy's land and labor endowments, by the non-agricultural demand for labor and by conditions of demand for final agricultural products. In agriculture the constraints imposed on development by an inelastic supply of labor may be offset by advances in mechanical technologies while the constraints imposed by an inelastic supply of land may be offset by biological technology. This responsiveness of science-based invention and innovation to economy wide factors has come to be known as the process of induced innovation (Hayami and Ruttan, 1973, Binswanger and Ruttan, 1978).

A comparison of agricultural development in the United States and Japan illustrates clearly the influence of land and labor endowments on the direction of technical change. This comparison highlights the extremes in land and labor endowments. In 1880 Japan had only 0.65 ha of land per male worker, while the U.S. had 25.4 ha, i.e., about 40 times as much. By 1970 this difference in land/labor ratio increased: Japan had 1.57 ha per worker while the U.S. had 160.5 ha per worker, 100 times as much. These differences in land/labor endowments are reflected in massive differences in factor prices. For instance, in 1880 a worker in Japan had time period to work nearly 2,000 days to buy a hectare of land, while his U.S. counterpart could buy land after working roughly one-tenth that time.
However, the rate of growth in agricultural output has been remarkably equal for these two countries in the 90-year period (1880-1970), roughly 1.6% per annum. Japan and the U.S. have relied on entirely different technological paths to achieve growth in output. Japan emphasized biological, yield raising technology supported by heavy irrigation investments, along with intensive manuring techniques while the U.S. emphasized mechanical technology. Careful historical and econometric enquiries by Hayami and Ruttan (1975) andBinswanger and Ruttan (1978) substantiate this conclusion.

The induced innovation literature has several implications for the rate and direction of technical change in agriculture of the developing countries. The obvious case is countries where population pressure increases against land resources making land increasingly scarce and expensive relative to labor. Here the development of biological and chemical technologies is the most efficient way to promote agricultural growth. Recent technical change in India and Philippine agriculture are cases in point (Hayami and Ruttan, 1984). Up until the end of the 1950s growth in agricultural output was brought about primarily by expansion of the cultivated area in response to increased world demand for export crops and domestic demand for food crops. With the rapid growth of population after World War II, the supply of unexploited land became progressively exhausted. Towards the end of the 1950s expansion of cultivated land stagnated but the number of workers in agriculture continued to grow leading to a decline in cultivated area per worker. In the 1960s, in response to increasing land prices and falling wages the Philippine agriculture made a transition from the traditional growth pattern, based on an expansion of the cultivated area, to a modern pattern based on an increase in land productivity. Increases in land productivity were achieved through expansion of the irrigation system, modern varieties of rice fertilizers and other chemical inputs. Taiwan (China) went through a similar transition from area expansion to improvements in land productivity in the 1930s (Hayami and Ruttan, 1978). Innovations in biological technology that led to the rapid diffusion of the green revolution, or seed-fertilizer technology, in South Asia after the mid-1960s were induced by changes in relative resource endowments and factor prices similar to changes that occurred in Japan and Taiwan (Binswanger and Ruttan, 1978, p. 360). One could expect similar development in the more densely populated parts of Sub-Saharan Africa in the future for example as is happening in the Kenyan Highlands today.

U.S. agriculture, in contrast, emphasized mainly mechanical technology in the period 1880-1970. Innovations in biological technology did not become important in U.S. agriculture until the 1940s, well after the land frontier had been exhausted. Developing country examples of technical change emphasizing mechanical technology are not common. Presumably such change is possible where labor rather than land is a constraint on agricultural growth and where export markets make the cultivation of larger areas profitable. Expansion in the area under sugar cane production in the South and Central West Regions of Brazil were closely associated with the substitution of labor with tractor power. The rapid adoption of tractor power in these regions during the 1960s was induced by rising wages under conditions of land abundance (Sanders and Ruttan, 1978). Mechanization of European farms in Sub-Saharan Africa during the Colonial period was similarly induced by severe labor constraints. Europe and Japan made the transition
to mechanical inputs after the wage explosion of the 1950s caused by a rapid increase in the non-agricultural demand for labor. In the late 1960s and 1970s one has come to observe partial mechanization of agriculture under low wage conditions — for instance in the Indian Punjab, Thailand and Philippines. Mechanization under low wage conditions is selective, concentrating only on the power intensive operations such as tillage, transport and processing. In all these cases mechanical inputs for power intensive operations co-exist with human and animal power for control intensive operations such as weeding and interculture.Binswanger (1982) shows that it pays to mechanize the power intensive operations even under low wages while control intensive operations are mechanized when wages are high and/or rapidly rising.

The above discussion indicates that the land and labor endowments of an economy are important determinants of the direction of technical change. The rate of technical change, however, is conditional on the economy's ability to generate and/or adapt innovations to match its specific environmental and economic conditions. In other words, the rate of technical change is determined by an economy's capital base (both industrial and human capital) and on its ability to provide institutional support for rapid technical change. To be complete therefore, any discussion of induced technical change has to consider the environmental and institutional framework in which innovation, development and adoption of new technology takes place.

2. The Generation of Innovations and the Development of an Industry

a) The Agricultural Machinery Industry

Mechanical technology is sensitive to (i) agroclimatic factors such as: soils, terrain, rainfall regimes and (ii) to economic factors such as: capital availability, farm size and materials available. Where there is a divergence in either environmental or in economic conditions direct transfer of mechanical technology is limited. Accordingly, where factor endowments warrants it, one observes a great deal of invention and/or adaptation of mechanical technology to meet local conditions. In the early phases of mechanization such work is usually done by small manufacturers or workshops in close association with farmers. This process provides direct solutions by mechanically minded individuals to problems perceived by farmers. For instance, in 1880 there were 800 distinct models of plows advertised for sale in the U.S. Early machinery innovation in the developing world reveal similar reliance on small workshops and direct farmer contact. The emergence of a diversified machinery industry out of small shops in the Indian Punjab, the power tiller industry in Thailand and the Philippines all followed similar patterns. In the early phases small workshops have a distinct advantage over large corporation because of: (i) the location specificity of the innovations, and (ii) the producer's ability to capture the gains of their innovative effort through sales.

The contribution of large corporations increases overtime but continues to be most important in the area of engineering optimization. It is at this stage that engineering staff of corporations are most effective.
For instance, it was only around the start of the 20th century that the plow industry in the U.S. consolidated with the large firms, such as John Deere, purchasing the patents and assets of small firms as they expanded.

Given this dominant role of individual initiative in the development of agricultural machinery, what are the appropriate government policy interventions towards mechanization? The government should encourage small scale innovation and adoption through: (i) patent laws for the enforcement of innovator's rights; (ii) testing, standardization and information dissemination, and (iii) support of agricultural engineering education and some university-based research. Finally, it should be noted that efforts to protect the domestic agricultural machinery industry through import controls have not generally been successful. This is because the small innovators no longer have access to models or a wide range of engines to design locally adapted machines. For a more complete account of the historical patterns in development of the agricultural machinery industry, see Binswanger, 1982.

b) The Agricultural Chemical Industry

Agricultural chemical innovations are generally in the form of fertilizers, pesticides and herbicides. The demand for agricultural chemicals (with the exception of pesticides) is induced by factor prices in the same way as the demand for biological and mechanical technology. A substitution of chemical fertilizers for farm-produced animal and green manure would occur only when the price of fertilizers declines relative to the price of labor. Similarly, a decline in the price of herbicides relative to the price of labor leads to a substitution of herbicides for hand weeding. For instance, given the low wage rates in Semi-Arid India, the use of herbicides is uneconomical compared to hand weeding (Binswanger and Shetty, 1977). No particular labor-saving bias is associated with the use of pesticides since pest damage to outstanding crops cannot usually be prevented by hand labor. Pesticides, of course, protect the higher output obtained through the use of fertilizers and high yielding seeds against insects and disease and can therefore be considered a complimentary (insurance) input. Unlike in the case of mechanical technology, small entrepreneurs do not play a major role in the generation of chemical innovations. This is because the innovators require special skills acquired through university training and specialized facilities which are too expensive to provide for an individual researcher. Accordingly, most research and development of agricultural chemicals is conducted by large corporations. These corporations can accrue the returns to their investment in research through the sale of the final product which is protected by patents. Chemical innovations have to be adapted to agroclimatic differences such as soils and rainfall regimes but here again adaptive research is more easily done by the parent corporation. The parent company may set up experimental fields in different environments as part of its sales effort.
As in the case of mechanical technology, private corporations have a comparative advantage in the research, development and production of chemical technology. Here again the role of government should be restricted to enforcing patent laws, testing and supporting university education and basic scientific research.

3. **Agriculture Research Institutes**

Not all agricultural research can be left to individual or private sector initiative and innovativeness. There are several areas of research where incentives for private sector research have not been adequate to induce an optimum level of investment. In these areas the social rate of return exceeds the private rate of return because a large share of the gains from research are captured by other firms and by consumers rather than by the innovating firm (Ruttan, 1982). The most obvious case is basic or supporting research in genetics, plant pathology and physiology, soil science, etc., which has implications for the development of chemical and biological innovations. Applied research by private corporations uses the results of basic scientific enquiry without having to fully compensate the basic researcher who produced the results.

The second case is where the search for solutions is very expensive and very risky but once the solutions are obtained they can be easily reproduced by the users or other firms. For instance, research and development of new crop varieties is extremely complex having to consider a wide variety of parameters ranging from agroclimates and soil types to consumer tastes. Yet once a suitable variety is developed it can be reproduced by individual farmers. Seed companies, therefore, have not been able to capture more than a small share of the gains from the development of new crop varieties. Hybrid varieties are an exception to this generalization.

Public sector agriculture research institutes are therefore an essential part of a strategy for rapid growth in agricultural output through science and industry based inputs. Public research effort in agriculture should concentrate mainly on the provision basic research and on research leading to advances in biological technology. Public research on mechanical and chemical technology should be minimal and mainly university based since the private sector has greater initiative to conduct research in this area.

It is important to remember that the role of the public sector in the production of agricultural technology is enhanced only when agriculture intensifies and technologies (such as high yielding varieties) that increase the productivity of land are demanded. Agricultural Experiment Stations became important sources of growth in the U.S. only after the land frontier was exhausted. Japan's National Agricultural Station became prominent earlier in 1904 when it began initiating a crop breeding project in the face of stagnation in agricultural output. Much of the post-independence consolidation and re-alignment of the Indian agricultural research system took place in the 1960s coinciding with the initiation of major crop improvement programs. And finally, agricultural research
capacity in Brazil began to develop in the 1960s and 1970s as the pressure on land and the demand for land productivity in the Northeast Region began to increase. (All the above examples were obtained from Ruttan, 1982.)

CONCLUDING REMARKS

Over the past century agricultural output in the developed world has grown at a rate of around 2%, no matter what the initial factor endowments or technologies used. In addition to accommodating its population growth, this growth rate has been able to accommodate the increases in final demand for food associated with rapidly rising per capita incomes. And it has been associated, by and large, with falling real food prices.

Developing countries are experiencing rates of population growth of between one to four percent. If, as we all desire, their per capita incomes were to grow, at rates comparable to those experienced by the developed world, food demand would grow at rates of between 2 to 5%. Sustained rates of growth of food supply which exceed 2 or 2 1/2% per year are, however, unprecedented in the history of the developed world. Of course, there exist the possibility of expanding supply via trade. But for countries where still a large proportion of the economy is in agriculture, such a strategy implies truly staggering rates of non-agricultural growth. The non-agricultural growth rates must be high enough to satisfy both increased domestic non-agricultural demand as well as increased exports to trade for food. Since such high non-agricultural growth rates are hard to achieve a combination of agricultural policies and programs must therefore be found which will raise growth rates of agricultural supply to substantially higher levels than what we are accustomed to. Such a strategy needs to encourage investment and innovation on the part of all the actors involved in the technology generation, investment and production process.

We have seen the truly impressive role which farmer innovation and investment has played historically even in continents which are not normally associated with a dynamic agriculture. The research on the recent experience of developed countries has perhaps not sufficiently emphasized that farmer innovation and investment continue to be of major importance in interaction with science- and industry-based innovations. Indeed, the increasing complexity of science- and industry-based innovation places an ever higher burden of technology screening and adaptation on farmers, and it is not, therefore, surprising to find that human capital is becoming an ever more important input into the agricultural production process. While farmer innovation and farmer investment can be driven by the necessity of increasing subsistence food production, favorable price policies are a necessary condition to provide greater incentives to accelerate the farmer-based investment and innovation processes. But the discussion of this paper also shows that favorable prices are only one necessary condition for rapid agricultural growth. They are simply not sufficient. In the current climate of tight or shrinking development budgets, there is a danger that budgets for the core agricultural activities of the government may be cut too much.
First of all we have seen the important role of infrastructure investments in speeding up the process of intensification. High border prices in Zaire, for example, could not be transmitted to the interior of the country via the deteriorating interregional road network. And local rural roads have as much to do with the level of farmgate prices as border price.\footnote{For a discussion of the role of railroad and road investments in the very successful agricultural development of Thailand, see IBRD, 1982.}

Direct government investment is also required into medium and large scale irrigation and drainage systems. History shows that such investments become necessary long before area growth comes to a halt. In India, for example, the late 19th century and early 20th century was a major period of investment into small, medium and large scale irrigation but area growth continued to contribute substantially to output growth until 1965. Nevertheless, as the experience with large scale irrigation in much of Africa shows, one can also invest in irrigation too early, when land resources are too large to make labor intensive irrigated agriculture attractive.

In land abundant countries strategies based on area expansion are the lowest cost sources of growth to even a poor agricultural population. At the opposite extreme are countries like Bangladesh where the required resources for large scale irrigation and drainage schemes are truly daunting. And the scale of projects required simply exceeds what farmers, or even local governments, can undertake on their own.

Improved incentives for private research and development are also required: patent systems, other forms of protecting innovators' rights, and absence of arbitrary government interference are a must. Too many countries are excessively fearful of private seed companies, for example, or of international competition in the agricultural machinery area.

But again historical experience and research such as Evenson's or Ruttan's shows that no country has been able to benefit from science-based technical change in the absence of an agricultural research system capable of doing both basic and applied scientific research. Even borrowing of technology has been shown to be difficult without a public sector capacity of adaptive research. In passing it is well worth noting that most external donors have, until recently, not provided support for research systems on a sufficiently long-term basis but distracted from strengthening national systems by building research components into short-term projects. Project trends are fortunately changing, but perhaps not sufficiently fast.

Apart from these core government activities there are areas where the role of government is less well documented. Available evidence on extension suggests that rates of return to extension activities justify the cost, and rates of return to well managed extension system may be very high (Lau, Feder and Slade, 1984). On the other hand, governments and donors have, by and large, overemphasized public distribution of credit over the
past two decades, probably at the expense of more important long-term investment in sources of growth. And while governments certainly have regulatory functions in areas of marketing and trade such as the establishment of auction markets, the fostering of competition or the stabilization of highly volatile prices many governments have excessively intervened in the marketing and storage processes themselves by attempting to perform functions which are better performed by traders and transport entrepreneurs.

Given the amount of knowledge and research about the agricultural development process, two current debates seem rather pointless. The first is about whether it is sufficient to "set prices right" to get agricultural development going. Of course, it is not. It is only a necessary condition. The second debate is the one about private versus public sector activities. Both are required and the knowledge base is sufficient in most circumstances to be quite clear about where private enterprise is sufficient and where it is not. Only by harnessing private initiative wherever possible and by actively pursuing the core government activities can the extraordinary rates of growth of agricultural output be achieved which are required of developing countries over the next 30 to 50 years. While these countries probably do not face starvation even under low agricultural growth scenarios, the goal is not avoiding starvation but rising per capita incomes and drastically improved nutrition levels.
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1. Is Population Growth a Factor in Sub-Saharan African Agriculture?

The relationship between population growth and agricultural growth is well recognized. In countries where population is growing at high rates, there is pressure on agriculture to expand more quickly in order to feed the growing population or to generate the income from agriculture that would feed the growing population. This is especially true for many countries of sub-Saharan Africa (SSA) where population is growing at unprecedented rates and where large proportions of the population are dependent on agriculture for their income. Unfortunately, agricultural growth in SSA has been exceptionally slow, causing increasing numbers of Africans to remain in poverty and in fact suffer deteriorating living conditions.

There is another link between population growth and agriculture that extends beyond this pressure to produce more food for a growing dependent population. Population growth can have a more direct influence on agriculture through its effect on the productivity of labor in agriculture, the result either of economies of scale, at the earlier stages of population growth, or diminishing marginal returns to labor at the later stages as the population's size starts to exert undue pressure on fixed land resources. Because of the low population densities in SSA, the common belief is that only economies of scale are operating there at present and that diseconomies are not anticipated until much later. This seems especially true because only a very small proportion of potentially arable land is under cultivation in the region and there is at present little pressure in agriculture to move to marginally productive lands except in extreme cases like Rwanda, Burundi, and the Kenyan highlands.

This paper aims to explore the hypothesis that population growth is causing declines in agricultural productivity in SSA at present, despite the presence of large untapped land resources in the region. Two explanations are proposed for this early onset of declining productivity. First, the distribution of population in SSA is not congruent with the distribution of natural resources; hence, there are large differences in population-resource balance across the region with a few countries already at critical stages. Second, in a situation where agriculture is unable to progress to higher levels of technology, as is true in SSA, the onset of diminishing returns may occur earlier than otherwise; much of SSA agriculture may already have reached this point.

The paper begins with a discussion of SSA's poor performance in agriculture over the last decade and contrasts that with the region's vast potential population supporting capacity. It shows wide inter-country variations in carrying capacity as well as in the extent to which different countries have approached or exceeded capacity. It then examines the relationship between a country's population-resource balance and its agricultural performance. The discussion highlights the fact that population size may already be a problem for many SSA countries as they approach the limits of their agricultural carrying capacities.

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The effects of population growth on prospects for agricultural growth and technological change will then be discussed. The argument will center around the relationship between population growth, the length of fallow periods in the forest and bush fallow systems of SSA, and the effects of shortening fallows on soil fertility. The critical role played by technological change in this agricultural system will be emphasized and related to the unprecedented juxtaposition of early-stage agricultural transition with later-stage demographic transition. Finally, conditions under which population growth would generate, and those under which it would constrain, agricultural growth will be identified. The ultimate objective is to suggest ways in which agricultural sector development considerations can be integrated into population policy decisions and, conversely, to suggest ways in which population density and growth variables can be integrated into agricultural planning.

2. Population Growth, Carrying Capacity, and Agricultural Growth in Sub-Saharan Africa

During the twelve years from 1970 to 1982, agricultural production in SSA grew at an average of 1.5 percent per year, much lower than the average of 2.5 percent for all low income countries combined and lower than that for Bangladesh (2.3 percent) or India (1.8 percent). During the same period, SSA's population grew at 2.9 percent per year, almost twice as fast as agricultural production. As a consequence, per capita food production for 1980-82 was only 92 percent of the 1969-71 level, reflecting a deterioration in agricultural performance over the decade of the seventies. The low income countries in SSA fared especially badly, with food production per capita in 1980-82 only 87 percent of the 1969-71 level; even Bangladesh, the lowest income non-African country, performed better with a corresponding per capita production index of 94 percent. (See Table 1 for comparative statistics.)

How can such poor performance be explained? Much of the failure of SSA agriculture has been blamed on a public policy structure that fails to provide the right incentives for growth. In particular, tariff and exchange rate policies that discourage agricultural exports and encourage food imports have been cited (World Bank 1981). But beyond the effects of price and incentives policies, there could be factors at play in SSA that would make growth in agriculture difficult even if countries "got the prices right". This paper argues that one such factor could be the effect of population pressure on limited land resources, and hence on agricultural productivity.

The figures in Table 1 show that SSA is different from other developing regions of the world in both population and agriculture sectors. Demographically, it has lower density and higher growth than all other regions; agriculturally, it is growing more slowly than other regions. As will be discussed later in this paper, its agriculture is presently at a level of technology far more primitive than in most other regions. All these suggest that SSA may not necessarily follow a development path
similar to that experienced by other regions that are now further along in the agricultural transition.

SSA's grim performance over the last decade stands in stark contrast with the picture of a region with large tracts of unused land and promise of much potential. Recent estimates by the FAO (Higgins et al. 1982) of agricultural potential in different regions of the world give the best estimates to date of the magnitude of that potential. Estimates are made for three different levels of technology - low, intermediate and high - and are computed on the basis of expected production levels given local soil and climatic conditions. These levels of technology are defined as shown in Table 2. Figure 1 shows the FAO's estimate of current technological levels in Africa and other parts of the world based on available information on yield levels and on extent of fertilizer use. With either measure, Africa is shown to be at or almost at the low level as defined by the FAO. It is much behind other developing regions which are roughly one-third to one-half the distance to the intermediate level. In contrast, Western Europe is at the high input level.

Potential population supporting capacities were estimated for 1975 and 2000, with differences between the two years reflecting expected increases in irrigation production from planned irrigation programs, and decreases in agricultural land from expansion in non-agricultural use of land due to population growth. The calculations for Africa as a whole confirm the conventional wisdom: even at low input levels, there is enough land to allow food self-sufficiency for a population 2.7 times larger than the actual population in 1975. This multiple rises to 10.8 at intermediate input levels, and to 31.6 at high levels (see Table 3).

Despite such large potential, there are large inter-country differences in population resource balance. Figures 2 and 3 show the contrast in distributions of potential population supporting capacities and actual population densities. The largest agricultural potential is concentrated in the humid tropical countries of Central Africa where population densities of 100 persons per square km or more can be supported at low levels of input. Carrying capacities decline as you move farther away from this area with still fairly high potential (50 to 100 persons per square km) in semi-humid coastal West Africa and Central Africa. The countries with

1There is at present much disagreement on the validity of the FAO estimates of potential population supporting capacities with respect to both the technical relationships assumed in reaching the estimates and in the interpretation of the results, assuming their technical validity. Among the technical problems are the study's failure to measure the full potential contribution that could be made through water resources development and the uncertain quality of the soil and climatic data used in the estimates. Both these problems apply especially to Africa. In interpreting results, the numbers cannot be taken as absolute criteria for the "optimum" or "maximum" population size of a country but rather as one indicator of possible impending short and medium term (and in extreme cases, long-term) pressures on productive capacity in agriculture.
lowest potential are those in the Sahel, much of East Africa, and the dry zones in southern Africa. The greatest anomaly in population distribution relative to potential is in the high potential areas of Central Africa where the lowest population densities (less than 10 persons per square km) are found. In contrast, higher population concentrations are found in coastal West Africa (especially Nigeria), in the highlands of East Africa, and to a somewhat lesser extent in Ethiopia and Kenya.

The result of this disparity in population and resource distribution is wide variation in population-resource balances of different countries. Table 4 classifies forty SSA countries into three groups according to present and projected population-resource balance at low levels of input. Low input estimates are used because these estimates most closely approximate actual input levels in SSA at present. The three groups are:

**Group 1:** Countries whose actual population exceeded potential population supporting capacity in 1982

**Group 2:** Countries whose actual (projected) population will exceed potential population supporting capacity in 2000

**Group 3:** Countries whose actual (projected) population will not exceed potential population supporting capacity in 2000

Potential population supporting capacities in 1982 are estimated by linear interpolation from the 1975 and 2000 FAO estimates. All countries in each group are then ranked according to severity of the population-resource balance, using the ratio of potential capacity to actual population in 1982 and 2000 for Groups 1 and 2, respectively, and using the year in which capacity will be reached, given 1982 population growth rates and 2000 potential capacity for Group 3.

The table shows wide differences in population-resource balances among SSA countries. On one extreme are countries like Rwanda, Burundi, and Niger with potential population supporting capacities only one- or two-tenths the actual size of their populations in 1982. On the other extreme are countries like Gabon, the Central African Republic, and Equatorial Guinea which will not reach potential even at low inputs for another one or two centuries.

Fourteen of the forty countries had populations that exceeded supporting capacity at low input levels in 1982; another seven will exceed supporting capacity by 2000. Hence about one half of all SSA countries can be said to be at precarious or critical population resource balance. A surprising number of these countries (including Rwanda, Burundi, Niger, Kenya, Somalia and Lesotho) have exceedingly low population-resource balance ratios of less than 0.5, implying that these countries could support less than half their present populations, at internationally accepted levels of nutrition, on a continuing basis. Some of these countries have adjusted better than others to this intense pressure on the land. Kenya and Lesotho,
in particular, have progressed to more advanced levels of technology through increased use of fertilizers and increased mechanization (i.e., tractor use\textsuperscript{2}), among other things. Somalia has also shifted to relatively more mechanized farming methods. Rwanda, Burundi, and Niger have been less able to purchase additional inputs although the former two countries compensate to some extent by very extensive land use, cultivating the fertile but difficult to work marshes as well as steep slopes. In addition, labor intensive soil conservation measures (mulching, countour ditching, etc.) were prevalent in Rwanda and Burundi in the past and are still important factors, although they are becoming less so at present (Jones and Egli 1984). To the extent that their foreign exchange positions permit, these countries rely on food imports to fill the remaining gap; Lesotho and Somalia, for example, are very highly dependent on food imports (79 and 90 metric tons per thousand population, respectively, compared with an average of 12 for all low income countries excluding China and India).

In all these countries with exceptionally low population-resource balance ratios, but particularly in those countries which are less able to adjust to critical land resource constraints through increased inputs and improved cultivation practices, extensive soil mining is already occurring and is bringing them closer to the margin of threatened survival. Soil mining and its effects on agricultural productivity will be discussed in greater detail in the second half of this paper.

The remaining nineteen Group 3 countries are relatively better off than the first twenty-one countries in Groups 1 and 2 although four of them (Tanzania, Sierra Leone, the Gambia and Mozambique) have fewer than thirty years before their populations reach capacity at low input levels. This grace period could be longer if they expect to achieve widespread transformation in agriculture within the next twenty years. On the other hand, this period could be shorter if not all potential agricultural land can be taken under cultivation within the same twenty years, as in fact seems likely. In Mozambique, for example, only five percent of potential agricultural land was under cultivation in 1981 and only six percent of potential was covered in Tanzania. The situation was a bit less dramatic for Sierra Leone and the Gambia: 29 percent for the former and 42 percent for the latter\textsuperscript{3}. Nevertheless, given present rates of expansion in land

\textsuperscript{2}No information is available on the extent to which farmers in these or other SSA countries have switched from the hoe, still the predominant farming implement, to the plow. This information would have been valuable in assessing technology levels since the plow is, in most cases, the logical replacement for the hoe in normal technological transformation in agriculture.

\textsuperscript{3}Potential agriculture land includes all land currently under cultivation or planted to tree crops plus permanent meadows and pastures plus forest and woodland. Better land use data are needed to get a more correct picture of the size of potential agricultural land, the extent to which it is presently under use and the relative productive capacities of the unused portions of the land. The data used here, from the FAO Production Yearbook (1982), give only rough estimates of land use and insufficient information on land quality.
used for agriculture of less than 1.5 percent per year in these countries, it is not likely that complete coverage will be achieved in any of them within that short period.

Most of the untapped land resources of SSA are, in fact, concentrated within Group 3 countries. For these countries, growth in agriculture depends largely on the rate at which expansion into new lands can occur. Consisting mostly of dense tropical forest lands, much of the unopened lands are the most fertile but also the most difficult to clear. In addition, they are plagued with tropical diseases such as malaria, trypanosomiasis (both human and animal forms), and onchocerciasis (Wawer 1984). Spontaneous movement of human populations into these areas have been slow and, although likely to speed up with increasing population, may not expand quickly enough to compensate for the expected pressures on land in more dense areas caused also by rapid population growth. It may become increasingly necessary for governments to help accelerate expansion by providing the large investments in infrastructure (including transportation and health services) needed in these areas.

Do the above differences in population-resource balance indeed lead to differences in agricultural performance as hypothesized at the beginning of this paper? Table 5 suggests that they do. For purposes of this table, Group 3 countries have been split further into two groups, a division that proves most meaningful, as will be seen shortly. These two groups are:

**Group 3a**: Countries whose actual (projected) population will exceed potential by 2030 (9 countries)

**Group 3b**: Countries whose actual (projected) population will not exceed potential by 2030 (10 countries)

Except for the last group, there is a pattern of sharply increasing growth in agricultural production as the population-resource balance improves: from an average of 1.1 percent per year for Group 1, to 2.2 percent for Group 2 to 3.5 percent for Group 3a. There is then a sudden drop in average growth rate to 1.5 percent for the last set of countries, Group 3b. It is reasonable to hypothesize that there are indeed economies of scale that have yet to be obtained through continued population growth in this last group of countries. For the first three groups, however, the implication is that agricultural growth is already slowing down in areas with limited land resources.

Figure 4 illustrates the same results graphically using simple averages, by group, of population-resource balance ratios and agricultural growth rates. Read from right to left, the graph reflects a pattern consistent with the hypothesis of increasing then decreasing marginal returns to labor, reflected in increasing then decreasing rates of growth of agricultural output.

The above data, though based on cross-country comparisons, could also represent regional differences within countries, particularly within
the larger ones that span several soil and climatic zones. Sudan, for example, which has vast unused agricultural potential and would not reach its potential supporting capacity at low input levels until 2027, has marked regional differences with some areas having a poor population-resource balance and others having much excess capacity. The extreme north of Sudan is in the desert and supports almost no population. North Central Sudan is sparsely populated, like most of the rest of the country. Because of its dry climate and sandy soils, however, this region has begun to experience declining soil fertility. Eastern Sudan is also a low rainfall area and was producing very low yields until the large-scale irrigation schemes were introduced in the area. Population supporting capacity has increased considerably in the irrigation scheme areas, along with actual population densities which are higher than the rest of the country, but the non-scheme areas in Eastern Sudan remain low potential areas. In contrast, South Central and Southern Sudan have adequate rainfall and rich soils. Central Sudan has higher densities relative to the rest of the country, consistent with its potential. Southern Sudan, the area with the greatest long-term potential, remains largely untapped and underpopulated. With the appropriate investments in land development and transportation, this region could support much larger populations (Barnes 1984).

Similar regional differences would also be of concern in countries such as Nigeria, Cameroon, Kenya and Tanzania and should be considered in any country-level analysis of the problems discussed above.

3. Population Growth, Technological Change and Agricultural Growth in Sub-Saharan Africa

The FAO estimates of carrying capacity discussed above show that a fourfold increase in carrying capacity could result if SSA agriculture would shift from low to intermediate levels of technology. As shown in Table 6, half of the Group 1 countries discussed in the previous section would have had excess capacity in 1982 had they been at technology levels equivalent to those found in Asia today (which is at 46 percent of the difference between low and intermediate levels). Clearly, advances in agricultural technology could improve agricultural performance in SSA by relieving the pressures on land resources caused by population growth. But is this technological advance occurring quickly enough in SSA to offset population pressure? What happens to productivity as population grows if technology does not advance appropriately?

To answer these questions, it is necessary to understand the evolution of farming systems and its relation to population growth. There is in fact an intimate relationship between population growth and the evolution of farming systems. On the one hand, population growth generates changes in the agricultural ecology that could lead to declines in agricultural productivity. On the other, these same pressures on land resources stimulate the development and spread of new technology that could prevent productivity declines. It is the outcome of this race between ecological degradation and technological advance, both related to population growth, that will provide the answer to our questions.
3.1 Population Growth, Farming Intensity and Soil Fertility

Historical and cross-regional comparisons of food supply systems show that the evolution of agriculture from the earliest stage of hunting and gathering to the most intensive stage of multiple cropping is determined principally by increases in population density (Boserup 1965 and 1981; Ruthenberg 1980; Pingali and Binswanger 1984a). Before agriculture replaced hunting and gathering as man's principal economic activity, much more of the earth's land area was covered with forests than is found at present. With the introduction of agriculture, some of the forest area was cleared for crop cultivation. The agricultural method most appropriate at such low population densities is a system of forest fallow where land that has been cleared is planted for one or two years and then abandoned to allow regrowth with cultivation taken up in another part of the forest. At times, the original forest area is not replanted for an entire generation.

As population increases over time, however, there is a gradual shortening of the period of fallow between croppings, resulting in a reduction in forest density and the replacement of larger trees by bush and smaller growth and, subsequently, by grasses. Eventually, fallows disappear and further increases in population density lead to conversion of larger and larger areas to permanent cropland and then, as is seen in many parts of the developing world, to multi-cropped land with as many as three crops in one calendar year.

A number of factors other than population density affect progression along the agricultural transition, the most important of which are the climatic and soil characteristics of the local area. In the humid climatic zones, leaching and water erosion could lead rapidly to degradation in soil quality as agriculture evolves into more intensive farming systems. Agriculture in much of Central Africa, for example, which is still predominantly forest or bush fallow, could not undergo transition to more intensive food cropping systems in the absence of technological development to maintain fertility in this type of ecology. No such technology is available at present. Historically, the response to increases in population density in these areas has been a shift to tree crop production or expansion to new lands (or outmigration). Arid areas such as the marginal zones of the Sahara and the low rainfall semi-arid regions of East or southern Africa cannot advance much beyond marginal crop production and will support only pastoral systems of food production, supplemented occasionally by cultivation when the rains permit (Ruthenberg 1980). On the other hand, more fertile lowland areas are often left uncultivated until later in the transition because of difficulties of preparing the heavy soils and controlling water and drainage. It is in the semi-arid, semi-humid and high altitude zones where more intensive farming systems are feasible and potentially productive and where the full process of the transition usually takes place.

The shortening period of fallow that marks the agricultural transition results not only in changing vegetation but also in changing soil characteristics. The disappearance of the forest cover to provide material for soil regeneration, the shortening period in which such regeneration could
occur, and increased leaching (in humid areas), soil erosion and dessication (in less humid or arid areas) resulting from the reduced vegetative cover all lead to reductions in soil fertility. Figure 5 illustrates the effect on soil productivity of shortening fallow periods. In panel (a) the fallow period lasts longer than is required for soil regeneration and there is no change in soil fertility. In panel (b) the fallow period is shorter, but is still long enough to restore soil fertility to its original level. In panel (c) the fallow is no longer sufficient to restore soil fertility and the yields per hectare fall. Hence, as fallow periods decline, the system maintains soil fertility at original levels, but only until a particular threshold point is reached. Continued production at this or shorter periods of fallow (i.e., at higher levels of intensity) leads to declining soil productivity moving towards a low-level steady state at maximum intensity. This reduction in soil fertility as fallow periods decline in response to increased population density is at the heart of the relationship between population growth and soil productivity. It explains how agricultural productivity could start to decline even in the earlier stages of the agricultural transition when much land still lies uncultivated.

The relationship among population density, climatic and soil conditions, and farming intensity is described in more specific terms in Table 7. Farming intensity (R) is here measured by the percentage of time in a rotation cycle that a plot of land is devoted to cropping. For example, if land is used for two years and left fallow for eight years, the R-value for this system would be 20. This would be a forest or bush fallow system. A system with three crops in each year would have an R-value of 300, a multi-cropping system.

In South and East Asia where population densities are very high (169 per square kilometer in South Asia and 91 in East Asia) annual and multiple cropping are the predominant agricultural systems and have been so for the last two to three hundred years. SSA is much less densely populated

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4 In Eastern Nigeria, for example, maize yields are at 2 tons in areas of long fallow, slightly over one ton as the length of the cropping period approaches that of the fallow period, and decline to less than a ton when the cropping period begins to exceed the fallow period (Ruthenberg, p.101).

5 Note that use of the term "intensity" in this context (and in much of the farming systems literature referred to in this paper) differs slightly from the use of the term in the more standard agriculture development literature. In the latter, the term "intensive" farming is used in reference to the increased use of inputs on a given piece of land or the multiple cropping of a piece of land in order to increase output. This is usually contrasted with "extensive" farming which covers larger land areas (i.e., more pieces of land) in order to increase output. In standard agricultural development literature, "extensive" farming is believed to occur for as long as some "good quality" arable land remains uncultivated, after which, "intensive" farming methods then predominate. In this paper "intensification" refers to the entire process including the outward expansion in area cultivated (as results, for example, from shortening fallow periods), the increase in input levels, and the multiple cropping of land.
(18 per square kilometer) and agriculture systems there are predominantly forest, bush and short fallow systems (see Figure 6). We know, however, that fallow periods are getting shorter all over SSA as a result of population growth. Hence the picture depicted in Figure 6 which is derived from information available in 1965 will certainly have changed over the last two decades since then. Unfortunately, there is no more recent information on the distribution of farming systems nor are there data to document the rate at which this decline is occurring relative to population growth.

The results of a survey on the bush fallow system in Sierra Leone (FAO 1980) give some tentative evidence on the effects of shortening fallow on soil productivity. A nationwide sample of 562 farmers with a mean length of fallow of 8.8 years were asked to compare yields in the past with present yields. Sixty-seven percent of the sample reported that yields were higher in the past than at present, 19 percent reported comparable yields, and 14 percent reported yields lower in the past. It is difficult to explain the reported decline in yields other than through a decline in soil fertility resulting from shortening fallow periods. If we note that an average fallow of 8.8 years corresponds to a situation where only about 10 to 20 percent of land is under cultivation, we see how declining yields could in fact occur even while much of the land is not in use at any one point in time. Unfortunately, no measure of actual yields was available from the survey to quantify the decline in yields or to measure the correlation between the change in yields and the change in fallow.

Finally, Table 8 (from Barnes 1984) shows how the relationship between changing fallows and changing yields will vary depending on soil and climatic conditions. The table presents results from four farming system studies from different regions of the Sudan. In the Northern Kordofan, which has a dry climate and sandy soil, fallow periods of 4-10 years (with 37 percent of arable land cultivated) are not long enough to maintain soil fertility and yield declines are common. Richer soils and better rainfall in the Nuba Mountain area in Southern Kordofan permit shorter fallow periods of 2-4 years without yield declines. Fallow are much longer in the sparsely populated areas of Southern Sudan and no fallow declines are reported for grain crops; hence, yields remain high. In the White Nile Province of Eastern Sudan where the large scale irrigation projects are located, both fallows and yields are declining in the traditional (non-irrigated) areas where farming must rely on very low rainfall levels. These examples illustrate how the threshold levels of farming intensity (i.e., the points at which yields start to decline) could differ in different ecologies.

3.2 Farming Intensity, Technological Change, and Labor Productivity

Farmers have responded in a number of different ways to declining soil fertility caused by more intensive use of land: they use more of the inputs already in use, such as labor; they replace old inputs with better ones, such as switching from the hoe to the plow at the bush or short fallow stage; they introduce new inputs, such as fertilizers (organic fertilizers in the earlier stages and chemical fertilizers later on) and new seeds; and they combine their inputs in different ways. The response varies depending...
on soil and climatic conditions affecting input effectiveness, farmers' knowledge about various inputs, and physical and financial accessibility of the inputs. Of all the above, an increase in labor inputs is a universal response; as numerous farm studies in SSA have shown, none of the others necessarily follows immediately.

In the transition from forest to bush fallow, the main change in labor use occurs in land preparation, with the need to loosen the soil with a hoe before planting and to supplement ashes (produced from burning, the method used to clear fields) with burnt or unburnt material brought in from other fields. Demand for labor also increases in activities other than land preparation as farming intensity increases. More careful planting of seeds is required to maximize yields. The shorter the fallow period or the longer the cultivation period, the more effort is needed to bring in additional material for soil fertilization. With more intensive farming, household and animal manure are used to supplement ashes. On-farm fertilizer production and fertilizer application can become increasingly time-intensive. While production and transport time can be greatly reduced if on-farm produced manure is replaced by or supplemented with purchased chemical fertilizers, there would be obvious additional cost. From the bush fallow stage onward, the need for weeding during the growing season becomes significant, increasing with farming intensity. And if irrigation is used, even more time is required for irrigation activities.

A shift from the hoe to the plow would improve labor efficiency and restore soil fertility through better land preparation. However, decreasing labor productivity does not immediately lead to a shift from the hoe to the plow. This is an economic decision made on the basis of considerations of expected returns to investment rather than on technological considerations alone. Thus the switch occurs only when the farmer assesses that the expected gains in yield and in reduced work effort would more than offset the cost of acquiring a plow and draft animals plus the costs of maintaining both machine and animals. The higher the acquisition cost of oxen, for example, the later the switch will occur relative to the point at which labor productivity and yields start to decline.  

Table 9 shows the changes in time inputs per hectare required with increasing farming intensity without a change in technique. All four cases presented involved the hoe as the main tool for land preparation and cultivation; fertilizer was not used in any of the cases. Despite a 64 percent difference in labor input per hectare between the Liberia and Ivory Coast examples, output per man hour increases by only 10 percent (from 1.26 to 1.38). Continued increases in labor input in the more intensive systems are not sufficient to even maintain output per manhour which declines to 1.03, then to 0.48 with greater farming intensity.

Regressions on a sample of 21 rice and maize growing farms in SSA show a significant (at 5 percent level of significance) reduction in

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6Pingali, Bigot and Binswanger (1985) present an extensive discussion of the factors determining the shift from the hoe to the plow.
output per manhour with increasing farming intensity if there is no change in technique. All farms in this sample used the hoe as farm implement and farming intensity ranged from \( R=20 \) to \( R=111 \). The estimated elasticity of output per manhour with respect to farming intensity was 0.5. In contrast, results from a separate set of regressions on 52 farms (in SSA and other developing countries) that included hoe, animal traction and tractor users did not yield a significant coefficient for farming intensity when the mechanization variable was included in the equation (Pingali and Binswanger 1984a). Increased farming intensity apparently leads to reduced labor productivity in the absence of a change in technique; the loss in productivity can be reversed by a shift from the hoe to the plow or tractor.

The foregoing discussion completes the argument for suggesting that population pressure on land resources may be causing declines in agricultural productivity in SSA, even at this early stage of the agricultural transition. Increased population density leads to increased farming intensity which, in turn, leads to declining soil fertility. Simply increasing labor inputs to compensate for declining soil fertility may not be sufficient. If changes in technology are not introduced (e.g., increased fertilizer use or a shift from the hoe to the plow or other more efficient power sources), agricultural productivity could decline. Changes in technology could fend off declines in productivity if technological change occurs quickly enough to offset the effects of increased population density. Evidence of declining yields in SSA suggest that the necessary technological changes have not been occurring there.

Figure 7 illustrates this hypothesized relationship among population growth, technological change and agricultural productivity. At low levels of input, the marginal product of labor starts to decline at point \( D_1 \). At higher input levels, the point of diminishing returns occurs later, at a higher population density \( D_2 \). Outward movement along the horizontal axis (i.e., increasing population density) to any point beyond \( D_1 \) accelerates the decline in productivity. Movement from a lower curve to a higher one (i.e., improvement in technology) delays the decline. Hence agricultural development depends ultimately on the relative rates of growth of population and technological change.

Before concluding this section, it is appropriate to draw attention to the positive contributions to agricultural productivity that can be made by population growth. Two very important benefits can be cited: (1) the economies of scale enjoyed at the early stages of the transition, particularly with respect to infrastructure development; and (2) the opening of new markets that motivate surplus production and output maximization by allowing specialization and trade.

During the stages of forest and bush fallow, the population generally moves through a large area of land during a single agricultural cycle without setting up permanent domiciles in any specific place. With shortening fallow periods, permanent settlements become more practical and populations

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7Unpublished results communicated to the author by Prabhu Pingali.
develop not only permanent domiciles but higher levels of social and physical organization. At this point, investment in transportation and communication facilities as well as storage and processing facilities, all of which contribute to improved productivity, become more economic as the population grows. Investments in social infrastructure such as health, housing and education which improve the quality of the human resources and the quality of life likewise become more economic with a growing population. In areas where endemic diseases such as malaria or tsetse fly infestation would otherwise discourage settlement, and therefore use of new land, eradication efforts become economic when large enough populations are subsequently able to settle in these areas. Such positive contributions to productivity occur only in the early stages of population growth, however, and eventually become insignificant, as illustrated in Figure 7. As noted in earlier discussions in this paper, about one-fourth of SSA countries studied (Group 3b countries in Table 5) may stand to gain from increased population density.

Equally critical if not more so than economies of scale in infrastructure development is the influence that increased population density has on opportunities for trade and specialization. When population groups are relatively isolated, agricultural production is done almost exclusively for subsistence purposes. As long as enough is produced to satisfy the group’s food and related needs, there is little incentive to expand production. Increased population density facilitates opportunities for trade and specialization, stimulating surplus production and hence encouraging more efficient production. The development of markets and the additional income earned from surplus production allow greater access to new inputs and technologies thus also increasing productivity.

3.3 Effects of Population Growth on Technological Change

The same factor causing declines in labor productivity - i.e., population pressure on limited land resources - leads also to spontaneous changes in agricultural technology that work to offset the initial productivity declines. Boserup (1964) has documented this relationship between population growth and agricultural technology from historical experience in other regions and from cross-sectional comparisons in SSA. She has shown, for example, how the introduction of fertilizers and of the plow resulted spontaneously from the need to compensate for declining soil fertility and increased labor requirements in regions that passed this stage of the transition centuries ago, such as in Western Europe for example, and suggests that the same changes should happen in Africa as it goes through this same stage.

Can we expect this spontaneous change in technology, stimulated by population growth, to happen in SSA? Yes; it is in fact already happening. In much of SSA, we find increasing fertilizer use and gradual shifts from the hoe to the plow where the latter are available and appropriate. The more relevant question, however, is: Will it happen quickly enough to offset the negative productivity effects of population growth given present high rates of population growth? The answer to this latter question is not immediately obvious but it is possible to speculate on the answer by looking more closely at the nature of the changes that need to occur and by examining
SSA's particular situation relative to the historical experience of other regions.

The technological changes occurring at this stage involve not only increased use of inputs but also fundamental changes in economic organization, particularly with respect to the development of markets for both new and old inputs. As increased farming intensity leads to continued declines in soil fertility, on-farm produced manure may no longer be sufficient to satisfy growing fertilizer needs and off-farm purchases may become necessary. Likewise, as the plow becomes the preferred tool over the hoe, farmers will need to purchase plows from commercial sources usually more remote from the farm; if draft animals must be purchased, they too require access to external markets.

Even more important are the changes occurring in markets for the traditional inputs, land and labor. Early in the transition, communal rights to land usually predominate within tribal or national groups, constrained only by conflicts with neighboring tribes or nations. Individuals enjoy easy access to land which is in abundance. As farmland becomes more scarce, specific plots of land get assigned more or less permanently to specific families, although formal ownership cannot be claimed by the family, and young farmers whose fathers are still alive or stranger families from outside the tribe find access to land difficult. This usufructuary system, which still predominates much of SSA at present, usually exists without a codified set of laws governing ownership. Land disputes, which get more numerous as land becomes scarcer, are usually settled by the tribal chieftain or similar group leader. Gradually, a private market in land develops and pressures on central governments to codify land laws arise. The insecurity about land rights arising from the inevitable conflicts involved with the transition from communal to private ownership is one major factor constraining investment in agriculture in SSA. The institutional and social changes involved in this transition will not come easily or quickly.

Fundamental changes are occurring in the labor market as well. As agriculture becomes more intensive, there is a growing tendency towards sharp seasonal peaks at critical points in a crop cycle. In drier climates, the short period available for land preparation and sowing creates a peak in labor demand; in more humid climates, the peak occurs during harvesting, which must be done quickly to avoid destruction by humidity. This sharp distinction between peak and non-peak labor demand begins to emerge at the late bush fallow or the short fallow stage as the tasks of land preparation and harvesting become more labor intensive. At this stage, markets for nonfamily farm labor also start to emerge.

Periods of excess labor demand particularly with short fallow or annual cultivation systems occur during only a few weeks in the year. Field labor is needed at much lower levels during the rest of the growing period and can come to a virtual halt at other times of the year. Thus, despite the high returns to labor during peak periods, average returns to agricultural labor over a year may remain too low to keep workers, otherwise needed during the peaks, from moving out of agriculture altogether. This situation will not be corrected by additions to the agricultural labor
force through population growth. Access to tools and machines to temper shortages during peak periods, availability of rural-based employment possibilities during the off-season and general improvements in technology to maintain labor productivity in agriculture are more rational alternatives.

Labor shortages in agriculture are even better understood in the light of changing economic opportunities in sectors other than agriculture. In SSA, the appeal of higher wages in mining and industry as well as in a generally overextended government sector draws labor away from agriculture. As a result of this competition, wage demands by the small hired labor force in agriculture during peak seasons rise to levels far in excess of the average return to agricultural labor and are often simply unaffordable to farmers. Hence, even as labor markets start to develop in response to the emergence of peak periods of demand in the crop cycle, wage demands generally make hired labor inaccessible to most farmers.

The necessary adjustments in the various input markets are likely to take place in time in SSA as they did in other regions of the world. There is one important difference between SSA and the rest of the world, however. SSA is the last major region in the world to pass through the forest and bush fallow stages of the agricultural transition. With the exception of the Americas which even today are relatively sparsely populated, most of the rest of the world (Europe, South Asia and East Asia) completed this transformation during the last millenium, starting with gradual declines in fallow about one thousand years ago and ending in the change to annual cropping in the second half of the eighteenth century. At the time of the transition in the rest of the Old World, population was growing at a much slower pace than it is growing today in SSA. Until the eighteenth century, world population was growing at no more than one-half percent per year, increasing to about one percent per year by the first half of the twentieth century (UN 1973).

The unprecedented growth rate of three percent now being experienced in SSA means greatly intensified pressure on agriculture compared with the historical experience in other parts of the world. There is much less time available (one-sixth as much time) for the technical, attitudinal, organizational, and economic changes that need to take place if drastic declines in current agricultural productivity and permanent damage to long-run agricultural potential are to be avoided. It is this difference in time horizon, brought about by much higher population growth rates, that sets the SSA experience apart from the already completed experiences in other regions of the world. In North America, rapid advancement in industry as well as in agriculture have assured growth in agricultural production that has far outstripped population growth. Even in Latin America where economic growth has been slower, more intense pressure on agriculture has been forestalled by the gradual development in industry and other sectors of the economy providing alternative sources of income for the growing population and alternative opportunities for employment for the growing labor force.

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8The African experience differs in very important ways from the experience in the Americas as well. In North America, rapid advancement in industry as well as in agriculture have assured growth in agricultural production that has far outstripped population growth. Even in Latin America where economic growth has been slower, more intense pressure on agriculture has been forestalled by the gradual development in industry and other sectors of the economy providing alternative sources of income for the growing population and alternative opportunities for employment for the growing labor force.
parts of the world and threatens successful transition from traditional to modern agriculture in SSA. It is also the reason why the population-related problems in SSA agriculture could arise not only in areas where population size is large relative to potential but also in those areas where population growth rates are too high to allow the necessary concurrent technological change.

6. **Summary and Conclusion**

Sub-Saharan Africa remains one of the least-densely populated areas of the world. It has immense potential for increasing agricultural output through extension of agriculture to as yet uncultivated areas, through intensification of land use in areas where fallow systems of agriculture prevail, and through advancements in the level of agricultural technology which presently consist mainly of primitive slash and burn and hoe-cultivation techniques. And yet, per capita production in agriculture has been declining, with agriculture growth rates remaining significantly below the average for all other regions and population growth rates among the highest in the world.

The promise of great potential has not eliminated short and medium term shortcomings in SSA agriculture. This paper suggests that the problems of SSA agriculture can be attributed at least partly to population pressures on land, despite the presence of vast areas of unused agricultural land and much improvement to be gained from technological advance. Two arguments are given to support this claim. First, the distribution of population in SSA is not congruent with the distribution of natural resources and there are areas where the population-resource balance has reached a critical stage. Second, in a situation where agriculture is unable to progress quickly enough beyond simple technologies such as slash-and-burn and hoe-cultivation, pressures on the land resulting from shortening fallow periods may lead to early reductions in the marginal productivity of labor.

Even at the present low input levels found in SSA, there is enough land to support a population 2.7 times larger than the actual population in 1975. However, a closer look at individual country situations shows a wide divergence in the population-resource balance from countries like Lesotho and Rwanda whose supporting capacities at low levels of technology are only one-tenth of actual population to a country like Gabon which would reach capacity in the year 2202 given its present population growth rate. The rate of growth in agriculture among these countries was found to increase as the population-resource balance improved but to decline sharply for the least densely populated countries where productivity gains from economies of scale could still be attained.

About half the countries in SSA exceed, or will exceed by the year 2000, their potential population carrying capacity at prevailing low input levels. These are the countries for which population growth should be immediately curtailed until significant advances in technology are attained. For another one-fourth of SSA countries, enough excess capacity remains to allow satisfactory rates of agricultural growth at present; but if current
population growth rates persist, carrying capacity will be exceeded by 2030. For these countries, moderated population growth rates together with population redistribution programs aimed at supporting spontaneous population movements would maintain agricultural growth rates at the highest possible levels while allowing time for the necessary advancement in agricultural technology. For the last group of countries, current high population growth rates may actually accelerate progress in agriculture in these sparsely populated countries but maintaining such growth rates can only be justified if present low levels of health, education and other aspects of the quality of life can be raised as the population grows.

Much of this population-resource imbalance could be eliminated if the agriculture sector would advance to improved agricultural techniques. Studies by Boserup and others of the historical experience in other regions of the world suggest that population growth and its attendant increase in population density inevitably lead to improved levels of technology. Increased density leads to intensification of land use in agriculture (mainly through shortening of the fallow period between crops) which in turn leads to soil degradation and to conditions favorable to changes in technology such as a shift from the hoe to the plow, increased use of fertilizers, and increased labor input. The change in technology reverses the tendency toward declining yields that would occur otherwise with soil degradation. With shortening fallow periods, larger expanses of land are brought under cultivation and total output increases if yields are maintained. Under this scenario, increases in population density result endogenously in increased yield, thus providing a built-in mechanism for maintenance if not improvement of per capita output levels.

In situations where technological change does not occur soon enough, however, it is possible to find declining yields and hence declining per capita output. In SSA there are indications that increases in farming intensity are occurring without the expected technological change. Scattered evidence from across SSA indicate that yields are declining in some areas where fallow periods have shortened below the minimum threshold required for maintaining soil fertility, given local soil and climatic conditions. This paper suggests that the reason for such a difference between the African experience and the earlier experiences in other parts of the world is the much higher rate of population growth in SSA today compared with rates of growth in other regions at the time they went through a similar stage in the agricultural transition. In addition to the obvious acquisition and learning costs involved in a change in technology, other fundamental changes are necessary for successful technological advance at this particular stage in the agricultural transition. These include organizational changes in land tenancy arrangements and labor use, and the development of markets for new inputs (such as fertilizers, plows and draft animals) as well as old inputs that are now becoming scarce (i.e., land and labor). These changes are in fact occurring in SSA at present but apparently not quickly enough to offset the decreasing productivity resulting from rapid intensification of land use, a direct consequence of rapid population growth.

The evidence presented in this paper shows the plausibility of the hypotheses put forward on the deleterious effects of population growth
on agriculture in SSA. From few scattered examples, fallow periods are shown to be declining and yields are also reported to be declining, while technological advances are delayed. Stronger evidence is needed to determine that these declining yields are in fact caused by the shortening fallow periods and the slow advance in technology, to establish a consistent pattern over a wider range of cases, and to quantify the effects of population growth on agricultural growth in order to determine how important it is relative to other factors. Such evidence can be obtained through a closer study of population density and growth data together with data on farming intensity, prevailing technology, land and labor market conditions, and agriculture sector policy for specific locations in SSA. A first cut at such analysis will be made through a group of country case studies being prepared concurrently with this paper. In the meantime, the evidence of unprecedented population growth rates in SSA, increasingly intensified land use, and declining yields present a prima facie case in support of this argument.

Useful policy suggestions can be made for both the population and agriculture sectors on the basis of the tentative evidence presented. The first and most important recommendation is the initiation of a conscious policy on population control, particularly in (but not limited to) those countries where population resource balances have reached or are approaching critical levels. There is need to establish a capacity to understand the dynamics of population growth and population movements within these countries and their effects on agriculture and other development sectors, and then to provide and promote family planning services for effective reduction in population growth. Recognizing that population control may be an important factor in the success of their own programs, agriculture planners would do well to be well informed on the consequences of population growth on agricultural development and to support actively any plans for an organized population control program.

In all countries, whether or not at critical population-resource balance levels, there is need to give closer attention to population distribution issues. This is especially true for countries with wide regional differences in carrying capacities and in population densities. To the extent possible, any population redistribution programs should aim to facilitate movements that would occur spontaneously anyway (usually on a self-selected basis) rather than uprooting large groups of people and transplanting them in a totally new place with perhaps a totally new agricultural environment. Population redistribution programs are generally difficult to implement because they require multi-sectoral cooperation, including participation from the agriculture, transportation, and health sectors. In many countries, however, they may be the key to the upliftment, or even survival, of large segments of the population.

Finally, a conscious effort can be made to target both population control and agricultural assistance programs in those areas where the population resource balance is most threatened. In both sectors, public programs that provide the appropriate technological know-how through extension services and that support the efficient provision of the necessary supplies are recommended. Cooperation and coordination between the sectors both in
terms of the identification of target areas as well as in service delivery would be ideal.

Within the Bank, the most important next step is for agriculture and population staff to jointly assess, for specific countries in SSA, the extent to which agriculture potential has been reached and the rate at which actual output is growing towards that potential; and to study the extent to which population growth is constraining agricultural growth. This would allow population staff to make more solid judgements on the importance of population control policies in individual countries. It would also allow agriculture staff to arrive at a realistic assessment of the constraints they face with respect to time horizons for their agriculture development plans.
Bibliography


## Table 1

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
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<td>375.9</td>
<td>17.6</td>
<td>2.9</td>
<td>1.5</td>
<td>0.52</td>
<td>92.2</td>
<td></td>
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<tr>
<td>Low-income</td>
<td>212.7</td>
<td>16.4</td>
<td>2.9</td>
<td>1.4</td>
<td>0.48</td>
<td>87.4</td>
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<td>19.6</td>
<td>3.0</td>
<td>1.5</td>
<td>0.50</td>
<td>93.0</td>
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<td>645.1</td>
<td>2.6</td>
<td>2.3</td>
<td>0.88</td>
<td>94.0</td>
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<tr>
<td>India</td>
<td>717.0</td>
<td>218.1</td>
<td>2.3</td>
<td>1.8</td>
<td>0.78</td>
<td>101.0</td>
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<tr>
<td>All developing</td>
<td>3,425.5</td>
<td>47.5</td>
<td>2.2</td>
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<td>1.32</td>
<td>113.4</td>
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<td>78.3</td>
<td>2.0</td>
<td>2.5</td>
<td>1.25</td>
<td>113.2</td>
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<tr>
<td>Middle-income</td>
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<td>26.9</td>
<td>2.5</td>
<td>3.2</td>
<td>1.28</td>
<td>113.6</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Bank 1984a
Table 2

| Crops of the assessment | pearl millet, sorghum, maize, rice, wheat, sweet potato, white potato, cassava, Phaseolus bean, soybean, barley, oil palm, groundnut, banana/plantain, sugarcane, grassland |

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Low Input Level</th>
<th>Intermediate Input Level</th>
<th>High Input Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production system</td>
<td>Rainfed cultivation of presently grown mixture of crops.</td>
<td>Rainfed cultivation with part change to optimum mixture of crops.</td>
<td>Rainfed cultivation of optimum mixture of crops.</td>
</tr>
<tr>
<td>Labor intensity</td>
<td>High, including uncosted family labor.</td>
<td>High, including part costed family labor.</td>
<td>Low, family labor costed if used.</td>
</tr>
<tr>
<td>Capital intensity</td>
<td>Low</td>
<td>Intermediate with credit on accessible terms.</td>
<td>High</td>
</tr>
<tr>
<td>Market orientation</td>
<td>Subsistence production</td>
<td>Subsistence production plus commercial sale of surplus.</td>
<td>Commercial production.</td>
</tr>
<tr>
<td>Infrastructure requirements</td>
<td>Market accessibility not necessary. Inadequate advisory services.</td>
<td>Some market accessibility necessary with access to demonstration plots and services.</td>
<td>Market accessibility essential. High level of advisory services and application or research findings.</td>
</tr>
<tr>
<td>Land holdings</td>
<td>Fragmented</td>
<td>Sometimes consolidated.</td>
<td>Consolidated</td>
</tr>
</tbody>
</table>

Table 3

Estimates of Potential Population Supporting Capacity for Africa at Different Levels of Technology, 1975

<table>
<thead>
<tr>
<th></th>
<th>Millions</th>
<th>Ratio of Potential to Actual</th>
</tr>
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<tbody>
<tr>
<td>Actual Population</td>
<td>406.9</td>
<td></td>
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<tr>
<td>Potential Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Technology</td>
<td>1,119.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Intermediate Technology</td>
<td>4,391.5</td>
<td>10.8</td>
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<tr>
<td>High Technology</td>
<td>12,854.4</td>
<td>31.6</td>
</tr>
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Table 4

Sub-Saharan African Countries, Ranked by Severity of Population-Resource Balance, at Low Input Levels

**Group 1:** Countries whose actual population exceeded potential population supporting capacity in 1982, by ratio of potential to actual in 1982

<table>
<thead>
<tr>
<th>Country</th>
<th>Ratio of potential to actual, 1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesotho</td>
<td>0.1</td>
</tr>
<tr>
<td>Rwanda</td>
<td>0.1</td>
</tr>
<tr>
<td>Burundi</td>
<td>0.2</td>
</tr>
<tr>
<td>Niger</td>
<td>0.2</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.3</td>
</tr>
<tr>
<td>Somalia</td>
<td>0.3</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>0.5</td>
</tr>
<tr>
<td>Mauritania</td>
<td>0.5</td>
</tr>
<tr>
<td>Namibia</td>
<td>0.6</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.6</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.8</td>
</tr>
<tr>
<td>Botswana</td>
<td>0.9</td>
</tr>
<tr>
<td>Senegal</td>
<td>0.9</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Group 2:** Countries whose actual (projected) population will exceed potential population supporting capacity in 2000, by ratio of potential to actual in 2000.

<table>
<thead>
<tr>
<th>Country</th>
<th>Ratio of potential to actual, 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>0.6</td>
</tr>
<tr>
<td>Swaziland</td>
<td>0.6</td>
</tr>
<tr>
<td>Togo</td>
<td>0.8</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>0.8</td>
</tr>
<tr>
<td>Benin</td>
<td>0.9</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.9</td>
</tr>
<tr>
<td>Mali</td>
<td>0.9</td>
</tr>
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</table>

**Group 3:** Countries whose actual (projected) population will not exceed potential population supporting capacity in 2000, by year in which capacity will be reached (assuming 1982 population growth rates and 2000 potential capacity).

<table>
<thead>
<tr>
<th>Country</th>
<th>Year in which capacity will be reached</th>
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</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>2003</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>2005</td>
</tr>
<tr>
<td>Gambia</td>
<td>2008</td>
</tr>
<tr>
<td>Mozambique</td>
<td>2011</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>2021</td>
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<td>Liberia</td>
<td>2025</td>
</tr>
<tr>
<td>Guinea</td>
<td>2027</td>
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<tr>
<td>Sudan</td>
<td>2027</td>
</tr>
<tr>
<td>Guinea Bissau</td>
<td>2028</td>
</tr>
<tr>
<td>Chad</td>
<td>2035</td>
</tr>
<tr>
<td>Madagascar</td>
<td>2048</td>
</tr>
<tr>
<td>Zambia</td>
<td>2048</td>
</tr>
<tr>
<td>Cameroon</td>
<td>2050</td>
</tr>
<tr>
<td>Zaire</td>
<td>2055</td>
</tr>
<tr>
<td>Angola</td>
<td>2056</td>
</tr>
<tr>
<td>Congo</td>
<td>2087</td>
</tr>
<tr>
<td>Equatorial Guinea</td>
<td>2114</td>
</tr>
<tr>
<td>CAR</td>
<td>2115</td>
</tr>
<tr>
<td>Gabon</td>
<td>2202</td>
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### Table 5

Average Annual Growth Rates of Agricultural Production, by Severity of Population Resource Balance, Sub-Saharan African Countries

<table>
<thead>
<tr>
<th>Population-Resource Balance Group</th>
<th>Agricultural Growth</th>
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</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1.1</td>
</tr>
<tr>
<td>Group 2</td>
<td>2.2</td>
</tr>
<tr>
<td>Group 3a</td>
<td>3.5</td>
</tr>
<tr>
<td>Group 3b</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**NOTE:**

**Group 1:** Countries whose actual population exceeded potential population supporting capacity in 1982.

**Group 2:** Countries whose actual (projected) population will exceed potential population supporting capacity in 2000.

**Group 3a:** Countries whose actual (projected) population will exceed potential population supporting capacity in 2030.

**Group 3b:** Countries whose actual (projected) population will not exceed potential population supporting capacity by 2030. This group includes: Chad, Madagascar, Zambia, Cameroon, Zaire, Angola, Congo, Eq. Guinea, CAR and Gabon.
Table 6

Changes in Population Resource Balance with Improvements in Technology, Group 1 and 2 Countries, Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Low Inputs</th>
<th>Inputs at Present</th>
<th>Intermediate Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td></td>
<td>Asian Levels (46% of difference bet. low &amp; intermediate levels)</td>
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</tr>
<tr>
<td>Rwanda</td>
<td>0.1</td>
<td>0.33</td>
<td>0.6</td>
</tr>
<tr>
<td>Burundi</td>
<td>0.2</td>
<td>0.57</td>
<td>1.0</td>
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<tr>
<td>Niger</td>
<td>0.2</td>
<td>0.34</td>
<td>0.5</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.3</td>
<td>0.48</td>
<td>0.7</td>
</tr>
<tr>
<td>Somalia</td>
<td>0.3</td>
<td>0.44</td>
<td>0.6</td>
</tr>
<tr>
<td>Lesotho</td>
<td>0.4</td>
<td>0.68</td>
<td>1.0</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>0.5</td>
<td>1.24</td>
<td>2.1</td>
</tr>
<tr>
<td>Mauritania</td>
<td>0.5</td>
<td>0.91</td>
<td>1.4</td>
</tr>
<tr>
<td>Namibia</td>
<td>0.6</td>
<td>1.20</td>
<td>1.9</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.6</td>
<td>1.43</td>
<td>2.4</td>
</tr>
<tr>
<td>Namibia</td>
<td>0.6</td>
<td>1.43</td>
<td>2.4</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.8</td>
<td>1.90</td>
<td>3.2</td>
</tr>
<tr>
<td>Botswana</td>
<td>0.9</td>
<td>2.69</td>
<td>4.8</td>
</tr>
<tr>
<td>Senegal</td>
<td>0.9</td>
<td>2.05</td>
<td>3.4</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>0.9</td>
<td>2.37</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malawi</td>
<td>1.1</td>
<td>2.30</td>
<td>3.7</td>
</tr>
<tr>
<td>Swaziland</td>
<td>1.1</td>
<td>2.94</td>
<td>5.1</td>
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<tr>
<td>Togo</td>
<td>1.4</td>
<td>3.75</td>
<td>6.5</td>
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<tr>
<td>Zimbabwe</td>
<td>1.5</td>
<td>3.85</td>
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<td>Benin</td>
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<td>4.41</td>
<td>7.6</td>
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<tr>
<td>Ghana</td>
<td>1.7</td>
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<td>7.3</td>
</tr>
<tr>
<td>Mali</td>
<td>1.3</td>
<td>3.00</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**NOTE:**

- **Group 1:** Countries whose actual population exceeded potential population supporting capacity in 1982.
- **Group 2:** Countries whose actual (projected) population will exceed potential population supporting capacity in 2000.
### Table 7

#### Food Supply Systems in Tropics

<table>
<thead>
<tr>
<th>Food Supply System</th>
<th>Farming Intensity(^1)/ (R-Value)(^2)</th>
<th>Population Density Group(^2)/ Persons/km(^2)</th>
<th>Climatic Zone(^3)</th>
<th>Tools Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>G. Gathering</td>
<td>0</td>
<td>0 - 4</td>
<td>Humid</td>
<td>axe, matchet &amp; digging stick</td>
</tr>
<tr>
<td>FR. Forest fallow</td>
<td>0 - 10</td>
<td>0 - 4</td>
<td>Humid &amp; semi-humid</td>
<td>axe, matchet, digging stick and hoe</td>
</tr>
<tr>
<td>BF. Bush fallow</td>
<td>10 - 40</td>
<td>4 - 64</td>
<td>Semi-humid, semi-arid, &amp; high altitude</td>
<td>hoes, animal traction</td>
</tr>
<tr>
<td>SF. Short Fallow</td>
<td>40 - 80</td>
<td>16 - 64</td>
<td>Semi-humid, semi-arid, &amp; high altitude</td>
<td>animal traction &amp; tractors</td>
</tr>
<tr>
<td>AC. Annual Cropping</td>
<td>80 - 120</td>
<td>64 - 256</td>
<td>Semi-humid, semi-arid, &amp; high altitude</td>
<td>animal traction &amp; tractors</td>
</tr>
</tbody>
</table>

1/ \(R = \# \text{ of years of cultivation} \times 100/\# \text{ of years of cultivation} + \# \text{ of years of fallow}.\) Source, Ruchenberg, 1980, p. 16.


5/ Description of food supply systems:
   - Gathering: wild plants, roots, fruits, nuts
   - Forest-fallow: one or two crops followed by 15-25 years of fallow
   - Bush-fallow: two or more crops followed by 8-10 years of fallow
   - Short-fallow: one or two crops followed by one or two years of fallow: also known as grass fallow
   - Annual cropping: one crop each year
   - Multi-cropping: two or more crops in the same field each year

Note 1: The above food supply systems are not mutually exclusive. It is quite possible for two or more of the systems to exist concurrently (e.g., cultivation in concentric rings of various lengths of fallow, as in Senegal).

Note 2: The above population density figures are only approximations, the exact numbers depend on specific soil fertility and agroclimatic conditions.

Source: Pingali and Binswanger 1984a.
Figure 3: Population Density in Sub-Saharan Africa, 1982
Population Resource Balance and Growth in Agriculture, Sub-Saharan Africa

Growth Rate of Agriculture

1 2 3 4 5 6 7 8 9 10 11 12

Ratio of Potential to Actual Population

Group 1
Group 2
Group 3a
Group 3b
The relation between length of fallow and soil productivity in shifting cultivation

Source: Ruthenberg 1980
Population Growth, Technological Change and Agricultural Productivity

MP_{\text{Labor}}

D_1 \quad \text{Low Input Level}

D_2 \quad \text{High Input Level}

\text{Technological Change}

Population Density/\text{Farming Intensity}
CHAIRMAN'S COMMENTS

by

Dennis Casley*

The Chairman commented that both papers set their arguments not in the Malthusian context, but in labor supply and productivity terms. The paper by Binswanger gave a sobering assessment of the lessons of history - namely, that irrespective of where a country started from, and taking into account factor endowments and technology, 1.5-2.0% growth rates in agriculture is all that is sustainable over an extended period, whereas the requirement in many countries now was to achieve double these levels. The Chairman surmised that the measures proposed in the paper to break out of the historical trends including irrigation, infrastructure, extension, and research would not cause surprise.

The paper by Ho demonstrated that Sub-Saharan Africa was in an unprecedented situation having jumped to an advanced stage of demographic transition while remaining trapped in an early stage of agriculture transition. Because of this, the paper argued there was no escaping the necessity to treat population growth as a constraint to be addressed if the quality of life in that region was to be improved.

The Chairman posed the question whether the papers presented a hopeful or a hopeless scenario. Was population control the extra dimension needed to supplement the agricultural measures set forward? In conclusion he queried whether the available agricultural statistics for Sub-Saharan Africa were of sufficient quality to allow projections to be made on which sound judgment could be based.

* Dennis Casley, Chief, Monitoring & Evaluation Unit, Agriculture & Rural Development Department, World Bank.
RAPPORTEUR'S STATEMENT

By

Althea Hill*

The Chairman opened the meeting for questions, and a speaker from Latin American Agriculture Projects queried Mr. Binswanger's assumption that governments should be involved in agricultural development. Should this not be left up to individual farmers? Mr. Binswanger replied that sometimes government or community involvement was necessary; irrigation schemes, for example, required community participation, and sometimes soil conservation practices had to be made compulsory. In answer to a further question as to whether he was in favour of coercive government action, he said that he was not, but that there was a continuum from purely voluntary to openly coercive in government programmes, and there were special instances where some form of obligation was necessary.

A speaker from EMENA Agricultural Projects commented that there were many other factors influencing agricultural development besides those Mr. Binswanger had mentioned. Population mobility, urbanization, and population growth were all important factors. So also were land tenure systems, which could often be a limiting factor on development. Land fragmentation resulting from rapid population growth could act as a constraint to technological innovation. Cultural and religious conservatism could play a part through their influence on land tenure systems. At individual project or country level, such issues were perhaps as important as those discussed in the paper. Did the Bank have any policy recommendations in this area? Mr. Binswanger replied that he was aware of the importance of these issues. Land tenure was known to be a constraint on development in Latin America and elsewhere. In Sub-Saharan Africa population immobility even in the face of high densities (as in Kenya) was also sometimes a problem, leading to declining land productivity which exacerbated the problem of raising agricultural production. However, he had not wanted to include institutional issues in this paper. He did note, however, that one reason for slowing population growth was to allow time to deal with these difficult issues, which could not be solved in a hurry.

A speaker from Agricultural Projects raised a number of points. He asked T. J. Ho for a clear definition of soil fertility, commenting that yields in control plots could be 2 or 3 times higher than yields alleged to be obtained by farmers. Surely there were reporting problems here, with farmers underreporting their production and their yields. He also commented that the whole question of utilization of heavy soils and swampland was more complicated than Mr. Binswanger had presented it. There were dangers in extrapolating from the history of Asia and Europe to Sub-Saharan Africa, given the differences in technology and population mobility. Finally, he put a specific question to Mr. Binswanger on a point that had often puzzled him. Why had not Asian farmers developed such efficient types of harness for traction animals as had European farmers?

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T. J. Ho replied to the first point that she understood soil fertility to be the ability of the soil to produce agricultural output on the basis of the nutrients naturally available or restorable to the soil, such as forest refuse. According to this definition, soil fertility would decline as fallow periods decline in length: also, exposed soils would be likely to dry out. She excluded artificial fertilizers from this definition. Mr. Binswanger responded to the other points that he could not deal with all the complexities of agricultural history in half an hour, and had necessarily adopted a broad brush approach, aimed at capturing the major forces at work. Population density was certainly not the only determinant: transfers of foreign technology were also important. Farmers responded to incentives, but not necessarily in an optimal fashion, depending on such factors as land rights, endowments etc. As to the final point, he did not know the reason for the differences in harness development.

A speaker from West African Projects B made two comments. The first concerned the inadequacy of available statistics and criticized the FAO estimates of carrying capacities in Africa. He gave Uganda and Nigeria, both classified as having already exhausted their carrying capacity, as examples. He queried the notion that population growth in these countries had outrun agricultural growth: the recent CEM for Uganda had showed a good record in agricultural growth and development, while for Nigeria nobody knew the rate of either population or agricultural growth. Data on food imports suggested that Nigeria had successfully fed most of its additional population during the past decade despite rapid urbanization. The second comment concerned mechanization, querying Mr. Binswanger's statement that under pressure of land scarcity, farmers moved to ploughs and then to tractors. In many parts of Africa, farmers had adopted ox cultivation in response to new markets even when plenty of land remained but were now abandoning oxen because land scarcity had reduced plots to a size where full-time ox maintenance was uneconomic. How could tractorization be adopted on such small farms?

The chairman interposed at this point to comment that demographers could not be blamed for accepting officially published agricultural statistics, but that the quality of such data was deplorable. He could not believe, for example, that Kenyan smallholder production had declined in recent years, since welfare measures such as child health had improved, yet published Bank papers stated that it had.

Mr. Binswanger replied that on the question of mechanization, there had been a mistake in paragraph 5 of the paper due to over-summarization. Population density was one factor leading to higher intensity of land use, but access to markets was also important as a stimulus to mechanization. This association was strong, though not stressed in the paper, and would be fully discussed in his forthcoming book on the subject. He commented that ox cultivation had been adopted in the late 19th century in Botswana even at very low population densities, because soils were very heavy and tree stumps were not a problem. A central point was that annual cropping was almost always a necessary condition for adoption of ploughs, but not sufficient; other factors were also important. As to the abandonment of oxen due to reduction in farm
size, he had not heard of this trend in Africa. It had not occurred so far in Asia, despite rising population densities. The speaker responded that there were good survey data on this trend for Uganda, Tanzania and Zimbabwe.

T. J. Ho responded on the data quality point that better data would be welcome and should be encouraged, but that it was meanwhile necessary to work with what was available. The FAO estimates were of long-term potential for soil fertility maintenance; therefore Uganda, for example, might now be “mining” its soils, and reducing their long-term capacity to support the population. She emphasized the need for country-specific data; FAO estimates were inevitably broad brush.

A speaker from OPS commented on the need for country-specific analysis with regard to Tables 4 and 5 of the Ho paper. There should be disaggregation by agro-ecological zones. He also noted that Lesotho was a special case, where 95% of earnings were off-farm (90% from outside the country), and which formed part of the South Africa customs area. With regard to Table 5, categories 3a and 3b, the difference was due to forest countries, which all fell in the 3b category, having low agricultural growth rates because of the difficulty in moving from forest to intensive cultivation. Incentives were low, subsistence was easy, governments were weak, and there was little support or infrastructure. As to fallow data, the whole farm must be considered as a unit. There were often intensively cultivated plots around the home, but in land further out fertility was tending to decline as fallow periods shortened. He also noted that in some countries such as Kenya, Zimbabwe and Zambia, the large-scale state farms occupied the best and most fertile land, but were not so productive. There would be pressure to break these up.

A speaker from South Asia Projects commented that the analysis of hand versus animal or tractor cultivation was putting the cart before the horse. The achievement, namely productivity, was important, not the technique. He also noted that the reason why less efficient harnesses were used in Asia and Africa than in Europe was that the more efficient harnesses gave less control of the animal.

Mr. Dudal of the FAO then commented regarding the FAO estimates of carrying capacity, of which he was joint author, that it was difficult to generalize about Sub-Saharan Africa since ecological ones were so varied. He felt that stratification by zones, such as semi-arid, sub-humid, high plateaux etc., would produce more significant interpretation and conclusions. He also noted that T. J. Ho's definition of soil fertility, including the effect of shortening fallow periods, applied only to humid areas. The rationale for fallowing was different in semi-arid areas.

A speaker from the Faculty of Animal Sciences at the University of New Hampshire asked T. J. Ho if she thought that the current famines in Africa due to drought were the result of a climatic change occurring because of the advance of the Sahara. The chairman responded, saying that this question was often asked. He believed that meteorological experts had
a theory that Africa was now moving into a different climatic cycle. Mr. Higgins of the FAO commented that Africa had always experienced periodic droughts, but that the effects had worsened because of population growth. The FAO did not believe that there was any evidence of major climatic changes.

The speakers then concluded with final remarks. Mr. Binswanger noted that his paper had not laid undue stress on the importance of the technology of cultivation, and agreed with Mr. Dudal's point concerning stratification. T. J. Ho made an appeal for more coordination and collaboration in future between demographic and agricultural staff.
What is the Food Security Problem?

Clearly starvation, as we see it on our television screens these last few months, is a food security problem. But, there are also many other more subtle forms of food insecurity. In many parts of the world, there are many millions of households who do not have access to enough food, with the consequence that their children suffer retardation in their physical and mental growth and the adults do not have the energy to function at their potential capacity.

There is now a great deal of concensus in the literature and in international organizations that what I have just described is the food security problem.

But, the term of food security has also come to mean many other things on various occasions, since the term first came into usage about ten years ago. Some consider only the occurrence of a famine as being a food security problem. Others regard the imbalance between the rate of growth of food production and of population as being the food security problem. And still others label the "dependence" on food imports as the food security problem.

While definitions are of course, the prerogative of anyone writing about a subject, it is disconcerting to see that many writers define food security as being the problem of people not having enough food, but then go on making recommendations as if the food security problem was simply a matter of slow growth in food production or too rapid a growth in food imports, and so on.

The most uncharitable interpretation of this tendency to "confuse" the issues is that those who write about food security are only using the term as a convenient selling device to promote their special interests. In some instances, such may be the case. However, another interpretation is that writers prefer to deal with simpler but tangential rather than the complex but central issues. In writing the Bank's food security policy paper, we have attempted to face up to what I believe are the central issues.

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1/ The paper summarizes the present draft of the Bank's Food Security Policy Paper, prepared jointly by the author and Jack van Holst Pellekaan with major contributions by Marcelo Selowsky and Hans Binswanger.
While implementing the changes in policy we recommend may be difficult, let me assure you that the central propositions are straightforward. As evidence, permit me to read to you how an 11-year old boy has captured in an essay to his 5th Grade teacher what food security is all about:

Hunger: Can It be Stopped? The main causes of hunger are: weather and poverty. Weather because plants cannot survive with too much water, as in a flood, or with too little, as in a drought. Or if it is too cold or too hot. Sometimes even if the weather clears up, the soil is left dry and brittle. People are sometimes either too poor to buy food, or too poorly educated to grow food on their own. Sometimes hunger is caused through the reluctance of people to notice that while some have too much food, others do not have enough. People often have food but are unwilling to give it. Or the food is spread too thinly among them because there are too many people. Hunger is in many places. It mostly centers itself in Africa, the Near East, and Far East. Poverty can be reduced by improving old jobs and getting new ones. If rich countries would help poor ones the want for food might come to a stop. And if not good jobs, people could at least make the food prices drop. Again education and distribution might put a stop to the cries for food.

In drafting the Bank's food security policy paper, we have attempted, and I believe with some success, to show how different policies might affect the number of people having to do with less than adequate food consumption. Throughout, we distinguish between the chronic and transitory dimension and food insecurity. The **chronic dimension** focuses on the problem of households and nations which lack the means to either produce or purchase sufficient quantities of food on average, over good and bad years. The **transitory dimension** treats the problem of intermittent disruptions in access to sufficient food by nations and households, as a consequence of the instability in food production, food prices and income. Famines are only one, though an extreme form of transitory food insecurity.

**Chronic Food Insecurity**

How many people suffer from chronic food insecurity? Analysis of national food consumption and income distribution data suggests that in 1980, between 350 to 700 million people had incomes too low to allow them to acquire an adequate amount of energy in their daily diet. They represent between 16 and 34% of the total population of the developing countries (excluding mainland China).

The wide range of these estimates reflect differences in regards to how much energy in the daily diet is regarded to be enough. A standard of intake sufficient to prevent high health risks and growth retardation in children leads to the lower estimate of 350 million people. If by enough we mean an amount of food which permits people to function at full capacity, the higher number of 700 million people is the more appropriate estimate.
Several points deserve highlighting here. One is, that while the share in the total population of what we call the chronically food insecure has declined over the recent decade in all parts of the world, except in Africa, the number of people having insufficient energy in their daily diet has probably increased. This of course is a reflection of development, even where it occurs at a fairly brisk pace, having not been sufficient to offset population growth. This observation has clear implications, when policy options are considered.

The second point is that, while far too many people have to do with energy deficient diets, this aggregated energy deficit is only a small fraction of the currently available total food supply. Even to meet the higher standard of adequacy, the aggregated deficit amounts to no more than 3% of current aggregate consumption in a sample of 35 countries. The implication of this observation is clearly that insufficient effective demand, not the scarcity of food is the central problem.

Finally, food availability at the global level is not the problem, as evidenced by the fact that global food production has more than kept pace with population growth and also the fact that there has been a downward trend in the price of international traded major staples. These trends can be confidentially projected to continue into the foreseeable future, particularly if the agricultural output in mainland China will continue to rise at its present rate. Of course, in regards to national per capita food supplies, we cannot be as sanguine, as the increasing scarcity of foreign exchange in many countries may lead them to reduce their imports and to increase their domestic food prices.

Optimism about the future possibility of meeting global food supplies should not, however, reduce concern about the inability of hundreds of millions of people and of the poorest countries to acquire a modest share of the available food supply, here and now. It is for this reason that we primarily emphasize the food security problems arising from insufficient purchasing power of individual households and of nations, in both, the chronic and transitory contexts. This is not to suggest that the promotion of accelerated food production and of improving food trade and marketing are not important factors. But it does suggest that inadequate household and national income ought to be seen as the major constraint on promoting greater access to food by low income households.

What then are the options a country has for reducing chronic food insecurity?

Let me begin by stating what the Policy Paper says will not work. The frequently advocated options - to increase national food production or food self-sufficiency - are neither necessary nor sufficient conditions for reducing chronic food insecurity. An increase in food self-sufficiency which involves the reduction of imports without having secured an equivalent increase in domestic output is likely to make things even worse.
More food production isn't necessary for improving food security because the food supply can always be increased through higher imports or lower exports or existing food supplies could be redistributed.

More food production is never a sufficient condition for the achievement of food security, because it does not guarantee that the people who need more food will have the ability to acquire it.

Perhaps, or even probably, many countries should be producing more food because they have a comparative advantage which they have not yet fully exploited - but not because their demand for food exceeds production. Certainly, farmers should not be blamed for hunger and malnutrition. Farmers could not remain farmers for long, if they had to feed a population which does not have the purchasing power to acquire what they produce.

The ultimate solution is obviously to provide the chronically food insecure with opportunities to improve their income. This of course means that one of the most important contributions the Bank can make to improved food security is to continue with what it has been doing, to promote economic growth with a special focus on the elimination of poverty.

A food security focus is not an alternative to the poverty focus because there can be no food security as long as abject poverty persists.

Thus there can be also no question that the first priority for countries should be to implement much of the existing policy advice which would improve both, economic growth and reduce poverty. For instance, implementing a shift of resources from capital to labor intensive pursuits, or from industry to agriculture or from large farms to small farms or from export crops to food production is often good food security policy. Not always. But when the incomes of the poorer segments of society are raised, it will improve food security.

At this point, others who write about food security usually proceed to advise on important issues in agricultural development - the under-utilization of fertilizers, irrigation management, the need for better marketing institutions, land reform, international trade, etc., to mention just a few. Some of it is good advice, but it is often also repetitive of what has been said many times before. Sometimes discussion of these issues is superficial and unsatisfactory as the writers and the readers on food security are often not well informed on these subjects. Certainly, the Bank staff does not need another general paper on agricultural development, relabelled as a food security paper.

We proceeded therefore to write about what more than following existing advice might be done and what would need to be done differently when food security is a specific concern. The presumption is, and I am
sure it is a correct one, that food security problems will persist for a long time, whether countries do or do not do all they can to promote growth with equity within the present environment.

What we are then examining here are essentially programs and policies which redistribute purchasing power to the poorest segments of the population to enable them to consume more food. By conventional economic wisdom, it might be said that this means trading off some economic growth for food security. But, this is not necessarily so. There is at least a good presumption, if not all that much empirical evidence, that preventing people from being in poor health and being lethargic, due to inadequate food consumption, means conserving potentially valuable human capital, which will compensate for the retardation in growth of physical capital.

There are of course many different ways to increase the purchasing power of the poor. But generally they fall into two major categories: Explicit or implicit transfer payments. Explicit transfer payments can be in cash or in kind, (particularly in the form of food rations, but also through the supply of rations of subsidized inputs to farmers or subsidized public employment schemes). Implicit transfer payments can be made through policy interventions which change terms of trade (prices). Both types of transfer payments can be made available to everybody in the population or restricted to a particular target population.

I don't have to tell you that economists generally prefer the explicit kind of transfer payments, particularly if eligibility can be restricted to a well defined target population. In principle, in theory, this is impeccable advice. I have done my share of advocating this option several years ago in the joint monograph with Marcelo Selowsky: Malnutrition and Poverty. However, in practice, when we observe how these programs work and contemplate what it takes to implement them, we cannot help but be skeptical. The leakages to unintended beneficiaries and the costs of administration are often very high. Such is the case in countries which have a reasonably well functioning civil service. In countries which do not have a civil service tradition, explicit transfer payments programs would well be nothing less than a bureaucratic nightmare.

Explicit transfer payments to a target population may work when the population to be reached is a relatively small and easily identifiable and accessible group of households. As for transfers in the form of food rations, this pretty much limits such programs to urban dwellers. For the rural poor, if they are landless, some public employment programs may be feasible. If the rural poor own some land and do their own farming, it might be possible to augment their incomes by distributing to them rations of subsidized inputs - water or fertilizer or credit. However, on a large scale - when the intent is to reach 30 or 40 percent of the total population, can it be done? I believe not.

It is of course more feasible to institute programs which provide an explicit transfer payment, say, in the form of a food ration to the
entire population. This would still be a highly progressive form of a subsidy. A food ration worth $20 might augment poor households' incomes by 10 percent while the income of the more well-off households would be augmented by only 1 or 2 percent. It would circumvent the difficulties and costs associated with identifying and reaching particular households and the social stigma associated with having been identified as an eligible household for special assistance.

All explicit transfer payments programs require large fiscal outlays. With most governments already fighting off large deficits, it makes of course little sense to advocate the expansion of explicit transfer programs, without identifying new sources of revenue to finance the government budget. We should not assume that this is impossible. However, if the new sources of tax revenue were to come from taxing exports rather than imports of consumer goods, the benefits may be eroded by increased unemployment and lower wages.

One more point needs to be stressed. Explicit transfer payments are of little benefit to the poor when they result in offsetting increases in the prices of staple foods. This means that without additional food supplies, be they from imports or domestic production, there is little point in implementing such programs. An analysis of India's fairly massive fair price shop scheme shows this very clearly.

How then about implicit subsidies by changing the terms of trade in favor of the chronically food insecure population, that is, by reducing the price of basic staple foods? Such a policy can be implemented relatively easily by simply importing more food and selling it at below border prices or by providing a subsidy on imports to traders. In the case of a country like Thailand, it means imposing an export tax on rice.

Besides the ease of implementability, the option of lowering food prices is also attractive because of its modest additional demands on the government budget. In some cases, for example if food imports can be gotten from food aid or when an export tax is involved, this option can even be a source of revenue for the government.

The drawbacks of this option are well known and have been widely discussed, as many governments are using this option quite indiscriminately. Clearly, the holding down of food prices makes only good food security sense, if the majority of poor people are net purchasers of food, that is when they are urban dwellers or landless rural workers whose wages are paid in cash and small farmers whose production falls short of their consumption. Holding down the price of food (by importing additional food) can be a costly option, if the domestic food supply is price elastic and the country has a clear comparative advantage in food production. Moreover, it may be only a temporary measure until other remedies can be found. This is because with time the food security benefits are partly eroded as domestic production of food is likely to decline and nominal wages adjust downwards.
A better option may be to induce an increase in the domestic food supply and lower food prices by increasing domestic production. This means of course that increases in domestic production must not be offset by reduced net imports. The incentives to produce more food would need to come from investments in infrastructure, technological change and lower prices of inputs. The benefits of explicit or implicit subsidies on inputs would then be captured by consumers paying lower prices for food.

As in the case of increasing the food supply through imports, some of the benefits to wage earners from lower food prices would be eroded as nominal wages will adjust downwards. However, this erosion of wages could be much less than when additional supplies are obtained from food imports, since a shift of resources into agricultural development usually boosts the demand for labor.

Clearly, holding down the price of food is not a desirable option in many African countries, in which the poor have access to land and produce their own food needs and potentially could produce food for sale, lower food prices would increase rather than reduce chronic food insecurity. But even here one should not generalize. Herdsmen who need to purchase staples would benefit too from lower prices of staples.

To summarize. It should be clear, I hope, that there are few general prescriptions across countries and population groups within countries. There are also no miracle cures - no technological fixes, no vaccines.

We know that policies which lead all people to earn minimally adequate incomes are essential. More food production is not required if the country has or can earn more foreign exchange. More domestic food production is certainly not a sufficient condition for achieving food security.

For the short and medium run, only explicit or implicit income augmenting measures can alleviate food insecurity.

Because the costs of explicit targetted transfer programs are high and the implementation difficult, they can be applied only when the problem is of a modest scale and then primarily in middle income countries which have a well functioning public service and the tax base for covering the fiscal cost.

When a large share of the population is in poverty, such as in India, non-targetted transfer payments in the form of a food ration, for instance, may be more appropriate than narrowly targetted programs. But a new source of government revenue or external aid and additional food supplies would be required to prevent the erosion of benefits through higher open market prices.
A workable short-term alternative remedy is to decrease or hold down the price of one or several staple foods by increasing the supply through imports or accelerated domestic production (encouraged by publicly subsidized inputs). If supply is increased through imports, this option can be nearly self-financing (as farmers are taxed in proportion to their marketed surpluses) and is not nearly as demanding of a bureaucracy as are explicit transfer payment programs. However, the benefits may be shortlived as nominal wages will eventually adjust downwards with little improvement in real incomes.

For much of Sub-Sahara Africa, we can only underscore what is common knowledge already. The best way of assuring a high level of security is to raise productivity in agriculture - let me only stress, increased productivity in agriculture - not necessarily increases in food production, except by definition, in the far hinterland where trading is not an option. I doubt, however, that there are many such cases, although much needs to be done to facilitate the movement of goods and people within and between African countries, both for the sake of economic growth and food security.

Finally, difficult as it is to quantify this, we must learn not to view transfer payments which enable households and particularly the children to achieve adequate nutrition, as being detrimental to growth. To the contrary, and particularly when countries need to tighten their belts, let's be sure that the adjustments we ask them to make do not only not come at the expense of the formation of the physical capital required for future growth, but also do not come at the expense of the survival of the poor and their ability to function.

Transitory Food Insecurity

Let's now turn our attention to the transitory food insecurity problem.

The dimensions of temporary disruptions in the ability of households to acquire food are difficult to quantify. While available data on incomes, food production and prices are usually good enough to ascertain trends, the data for any single year are often unreliable and therefore estimates of the magnitude of fluctuations between different years are highly unreliable.

Yet from what we know, say, about the instability in international food prices and in countries' food production and export earnings during the 1970s, we can clearly surmise that the real incomes of a large number of households must have been also very unstable. The better known disruptions in the ability of people to acquire a minimally adequate diet are of course the well publicized famines associated with droughts or floods or civil disturbances. However, there are many less well known cases of transitory food insecurity which arise from a 10 or 20% decline in a country's food production, a 50% rise in the price of food such as, for instance, has occurred in recent years in Brazil due to the drastic devaluation of the cruzeiro, and so on.
Some of these events affect the entire population of a country, but many are of a much more localized and severe nature. For instance, a freeze in the coffee or tea crop may drastically reduce the ability of plantation workers to acquire food.

Instability in food prices, in particular, needs to be appreciated not only for its affect on food security, but also for its macro-economic and political dimensions. While we do not have the data to perform an economic analysis of the full costs and benefits of stabilization, the desire of all governments—be they developed or developing—to take measures which would stabilize food prices is well justified and should be fully respected.

The question addressed in the paper is how stabilization in real incomes can be best accomplished at reasonable cost. Some of the same issues we have discussed in respect to the options for dealing with chronic food insecurity crop up here too. But there are also differences.

Clearly a localized famine situation requires a targeted approach. Assuring a stable national food supply and prices, be it through national buffer stocks or trade policy cannot cure a famine situation, arising from temporary disruption in people's purchasing power. Amartya Sen in his book *Poverty and Famines* makes it perfectly clear that many of the famines in history have occurred in spite of adequate food supplies in the respective countries.

It is also quite clear that in many situations periodic declines in the real incomes of certain population groups (with or without declines in the food supply) are quite predictable. When measures are taken in advance to cope with these situations, transitory food security could be achieved at much less cost than through hastily organized relief operations. We should all get upset when we read that food has been delivered at a horrendous cost by airplanes to drought-stricken areas, when we know that with a little better information system and forward planning, the food could have been stocked up in advance or delivered a little earlier at a fraction of the cost.

I will not dwell here on famine episodes, particularly since the Bank is only marginally involved in these matters, except to make the point that there are many cases in which it is relatively easy to identify on a geographical or sectoral basis the group of people which requires temporary assistance. In these cases, many of the difficulties associated with managing targeted assistance programs are much less. Moreover, this assistance is required on a massive scale which could not possibly be made available through marginal changes in the terms of trade of particular commodities.

Temporary declines in the ability of acquiring food by all poor people associated with a dramatic change in the national food supply, however, are an entirely different matter. What I have in mind here are sharp
fluctuations in border prices of food either due to fluctuations in international food prices or the exchange rates of domestic currencies. In these cases, it is entirely unrealistic to expect that compensatory measures exclusively for the benefit of the lower income group could be made to work.

For instance, if a precipitous devaluation is necessary, or international food prices rise sharply, a consequent rise in prices of basic staple foods, say, by 30 or 50 percent, could result in a very pronounced deterioration in food security. Only measures which exempt the prices of basic staple foods from rising, at least to such an appreciable extent, could prevent this deterioration.

The only two feasible options in these cases are to stabilize the food supply and food prices through national buffer stocks or through trade interventions.

Our analysis suggests that the most effective and probably least costly intervention for achieving a reasonable level of domestic price stability for most countries would be the pursuit of a modified form of free trade, using variable levies. Such a policy can be effective irrespective of a country's policy in regards to the average rate protection. Imports and exports would automatically offset any instability in domestic production, international food prices and the balance of payments.

In order to implement such a policy, the countries need to either operate their own buffer stock in foreign exchange or, alternatively, have access to an international insurance scheme. Food aid and the Compensatory Finance Facility operated by the International Monetary Fund constitute limited forms of this kind of international insurance. It is clearly less costly to provide foreign exchange insurance on an international risk pooling scale than for each country to provide for its own insurance.

One example of a frequently ineffective intervention is the nationalization of internal food trade. Public marketing agency operations are rarely supported by an adequate and reliable flow of information about changing supply and demand conditions at the grassroots level and rarely have the managerial capacity to act on information, even when available, in a timely fashion. Moreover, public marketing agencies are frequently subjected to political pressures from special interest groups. As a result of these impediments, public interventions, which require highly centralized decision-making, often aggravate rather than reduce food supply problems and price instability, by comparison with decentralized open market regimes.

In many situations, large publicly operated buffer stock schemes are also highly cost-ineffective instruments for smoothing out supplies and prices over time. To the extent that countries can confidently rely on access to external markets, and the availability of foreign exchange, it is cheaper to stabilize prices by regulating exports and/or imports than by accumulating and disaccumulating large inventories. Even if world market
prices are unstable, it is rarely advantageous to operate large inventories because storage costs, including the cost of amortization of storage facilities and the interest on tied-up capital in inventories, usually far exceed the gains from acquiring grain internationally.

**Overall Summary**

Let me once more summarize what I would regard to be the major components of a food security strategy:

1. Any policies and investments which lead the chronically food insecure to acquire more income (in cash or in kind) promote food security. In this sense, the growing attention to investment in infrastructure in support of agricultural development and the removal of negative protection from agriculture and positive protection from "enclave" industries are important contributions to long-run food security.

2. To the extent that countries can afford and are willing to pay a price for achieving greater food security, they should be encouraged to use funds for explicit or implicit transfer payments to augment the incomes of the chronically food insecure, not for achieving a higher rate of self-sufficiency which does little for food security.

3. To avoid transitory food insecurity, countries should stabilize domestic food prices, provided that this is consistent with the stabilization of real income. However, they should be encouraged to do this at least cost, through variable levies. Buffer stocks should be primarily reserved for non-tradeable commodities.

4. Transitory Food Security problems arising from drastic reductions in the primary source of income of particular sub-populations need to be addressed separately by income relief measures. A well functioning food marketing system should be in place to handle the physical movement of food to areas affected by natural disaster to local supplies.
BANK INTERVENTIONS IN NUTRITION

by

Alan Berg*

This part of the program is divided into two sections--first, we will discuss what the Bank has been up to in nutrition, what has been learned from that experience and the recent directions from the Operational Vice Presidents on where we go from here. Then, we will try to move on to the links of this to, and the implications for agriculture projects staff and, more specifically, on the implications for agriculture sector work and project design. I will start this off and then Dr. Per Pinstrup-Andersen, an agricultural economist of the International Food Policy Research Institute, will pick up when we get to the design issues.

When the Bank became involved in nutrition in the mid 70's, three questions were commonly raised. Is malnutrition a development problem? If so, are there things that can be done about it? And if the answer to that is yes, are there things that the World Bank can do to help?

Bank staff was then given a cautious mandate to learn what it could about nutrition, including trying a few of what turned out to be largely experimental projects, following them closely, and seeing what happens.

For much of the intervening period interest in the subject was sparse and an atmosphere of uncertainty clouded the operational work in nutrition. This in part was because of the lack of a sound theoretical base, partly because of early problems with nutrition projects, and partly because efforts by a number of other agencies to improve nutrition seemed not to have lived up to expectations.

For a variety of reasons this attitude appears to be changing, partly because of recent research findings, but also sparked by UNICEF's recent major thrust in this field, by IFAD's recent involvement in nutrition, by PAHO's assignment of nutrition as a top priority, by CGIAR's interest in the subject, as reflected in the last Directors' meeting, by the Bank's ongoing work on food security that underscores the importance of work in this area, and, what we will largely talk about today, by the very encouraging evidence from recent evaluations of Bank nutrition projects.

For example, in a project now underway in 9,000 villages in the Indian State of Tamil Nadu there is, after controlling for income and other variables, 40% less severe malnutrition among 1-to-3 year olds in project villages than in control villages. By the age of 5, children who have been through the program are nearly 4 pounds—a nutritionally significant amount—heavier than children from control villages. This is a program which involves regularly monitoring the growth of children (and 90% of them participate) and identifying those in need of special nutritional food supplements for a 90 day period. The combination of the supplement with

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the nutrition education the mother receives during the growth monitoring and the selective feeding period is designed to allow the child to progress to a condition in which he or she no longer requires the special feeding. In fact, relapse rates have been under 25 percent and the portion of children requiring feeding in the first place as a result of growth monitoring and nutrition education is only 43 percent of that when the program began. As a result of the completed project there will have been 107,000 fewer severely malnourished children, according to conservative projections, and over 12,000 deaths will have been averted.

Not all the project work has had such clear-cut nutritional impact—at least the evaluations were not as well done and the findings less conclusive. In any case, last year the Bank stepped back to take a look at its work in nutrition. This resulted in a paper discussed two months ago by the Operational Vice Presidents, a paper that tried to piece together the lessons of four self-standing nutrition projects, a large number of nutrition components in other projects, nutrition sector work in 16 countries and some 55 pieces of Bank sponsored nutrition-related research. Research and operational experience by others during this period also was examined.

What was found? First, the body of work clearly demonstrated malnutrition was a development issue. Research in Nepal, Colombia, China and Brazil all showed that malnutrition affects not only mortality and sickness but also learning and school performance. Bank research in Kenya and Indonesia demonstrated that nutrition dramatically affects productivity and earning capacity.

From the sector studies, the evidence is strong that nutrition problems are serious, that for low-income groups in most countries nutrition needs will not be met in at least a generation, even with a substantial expansion of food production, and, in most cases where time series data are available, the nutrition status of the poorest has been deteriorating. Seasonal malnutrition was found to be of particular importance in nearly half of the countries.

One of the surprises emerging from the sector work is the discovery of the size and speed of a shift from the traditional locally produced grains (like millets and sorghum) to polished rice and refined wheat, both often imported. Administered prices, favoring refined unfortified wheat flour and rice, are a common feature behind these shifts. In some countries pellagra and other serious micronutrient problems have been detected, probably stemming from these shifts. This is potentially a major nutrition danger that deserves attention.

As for operations, the early nutrition projects, like the early rural development projects, were not without their problems. For a variety of reasons the first three nutrition projects were too complex; while malnutrition does indeed have multiple causes, we have learned the hard way that a single project will be more effective if directed at only a few of the causes. Also unlike, say, agriculture or education or health, lack of a single responsible entity within countries for dealing with nutrition increases the difficulty (for Bank and borrower) of managing nutrition projects.
Nonetheless, even though the nutrition projects did not do everything they were supposed to do, experience has demonstrated that (i) although malnutrition is part of the poverty syndrome, much nutritional improvement is possible without major income increase, and (ii) there are several efficacious, affordable means by which Bank nutrition projects can make an important contribution in this regard.

In addition to the Tamil Nadu project, substantial portions of the other nutrition projects have been successes--countries have taken them up and enlarged them on their own. Some of the activities have been expanded, to a national scale, and certain of them have been observed and taken up by other countries. In Brazil a Head-Start type program, in which pre-school age children were brought to a school setting for nutritional and educational stimulation to better equip the child to cope with a school situation when he reaches school age, began in a single state was extended at government expense to every state and territory. The Brazil program had a statistically significant effect on both subsequent school dropout and repeater rates. Colombia and Mexico are planning similar efforts, and Bolivia has shown interest.

A highly targeted consumer food subsidy program in Brazil has been broadened (with modifications made as a result of the initial evaluation) from an experiment in Recife to every state in the Northeast. Another component in the nutrition project that was designed to reduce prices through efficiencies in the food marketing system has been replicated in three other Bank projects, and the government of Colombia recently introduced a large program modeled on it.

An experiment in providing short-term, seasonal credit to very poor farmers with an eye toward improving nutrition in the Brazil project has been picked up as part of seven of the ten Bank-assisted rural development projects in Brazil's Northeast, and social extension agents in 15 Bank-assisted rural extension services now perform the kinds of nutrition services introduced in that component.

In Indonesia the package of nutrition activities tested in combination for the first time in a village level pilot effort has been adopted as a national package that is expected to reach 70,000 villages in the next five years. This is the keystone to a second nutrition project, being appraised in March. Gardens have become a regular part of the agricultural extension service program, in part at least as an outgrowth of the home and village gardens component.

One of the more impressive outcomes of the project in Indonesia has been the spontaneous response of villages. Communities near project villages have organized themselves and established similar programs with their own resources.

Some totally new communications concepts were tried in the nutrition education component in Indonesia--ways to involve the villagers' own words in the messages and field testing the concepts before introducing them. (Examples) An evaluation, after controlling for all the things you control for, showed that weights for program children were higher than for
non-program children and there were half as many severely malnourished children in the program group. The messages and the concepts have now been adopted by the government for a national program.

Despite overcomplexity and slow starts, each of the first three projects (Brazil, Indonesia, Colombia) finished or is finishing rather well, and Tamil Nadu, with a more focused designed that benefited from experience with the preceding projects, is being smoothly implemented. The projects all were important catalysts in attracting both policy attention and resources to the problems of malnutrition; also, they demonstrated the potential of nutrition projects for contributing substantially to the development of primary health care and family planning programs.

Compared with earlier style nutrition interventions (which generally had either indiscriminate coverage or, if targeted, often involved expensive one-on-one treatment and oversight from highly trained professionals), the large-scale concepts tried under the Bank-assisted project efforts appear to have shown the feasibility of pushing per capita beneficiary costs down to relatively low levels. In some instances these costs could be met through restructuring of existing programs. However, even if entirely additive, at these levels most of the interventions appear to be affordable if extended to a national scale. The low-cost nutrition education as practiced in Indonesia looks particularly attractive. That it was cheaper than programs requiring food commodities comes as no surprise; the question is whether it is effective. The evidence has shown that nutrition education alone can make a difference in improving nutritional status. Nutritionists have long held out the promise of this possibility; the Indonesian experience is the first time it has been demonstrated in an operational setting.

The Tamil Nadu project now covers one-third of the state; when projected statewide, costs will be 1% of the state’s revenue budget. Even at the high end of the cost spectrum, a consumer food subsidy program if targeted properly may, at about 2%, be affordable in certain contexts. (This is in contrast to the 15% to 20% not uncommonly spent on subsidy programs.) Project experience suggests it is possible to minimize leakage. Vitamin A programs to prevent blindness clearly are cost effective. Brazil’s preschool feeding and stimulation program is costly relative to other nutrition interventions but less costly than added construction and other conventional approaches to strengthening an education system. (The Brazil PROAPE concept is based in part on the notion that there has been, in the past 20 or 25 years, a dramatic growth in investment in primary school education in developing countries without a concomitant improvement in the academic performance of children and that the problem may not be with the quality of education but with the quality of students.)

The nutrition projects when judged by disbursements and other quantitative measures have improved over time. They generally stack up well against Bank projects in other sectors, particularly first projects. They have outperformed or equaled Bankwide projects in estimating costs and project completion, compliance with loan conditions, and procurement and have done less well in disbursements, management performance, and reporting.
Experience has shown that some governments are ready to commit substantial resources to nutrition and are interested in collaboration with the Bank. Eleven countries have expressed interest in nutrition projects. A request for a follow-on loan, of course, does not necessarily reflect satisfaction with a first project performance. But, it is worth noting that in three of the four countries second nutrition projects have been requested, and that in the fourth, Colombia, there is under preparation a health project that includes nutrition and was made possible by groundwork for primary health care laid by the first nutrition project.

So where does all this come out, as a result of the review and the recent OVP meeting?

Future health projects and population projects involving MCH and primary health care will be expected to include nutrition components aimed at preventing and treating severe cases of malnutrition, particularly among mothers and young children. Most commonly this would consist of nutrition education (concerning breast feeding, weaning foods, food hygiene, family food distribution, and related practices), growth monitoring, oral rehydration therapy, and selective supplementary feeding and rehabilitation of seriously malnourished children.

The Bank also will be prepared to lend for free-standing nutrition projects. Three operationally implementable project concepts emerged from the review and subsequent discussion. These, of course, are not mutually exclusive.

First is nutrition to reduce infant and child morbidity and mortality and promote child growth--the Tamil Nadu model.

As malnutrition and undernutrition are major underlying causes of infant and child morbidity and mortality, the provision of food supplements (or "food as medicine") for a limited period to those identified with faltering growth may often be a cost-effective means of addressing major infant and child health problems.

Second is nutrition to improve human capital formation and labor productivity. In countries concerned about nutrition of other members of the family as well as the very young, consideration should be given to food delivery projects aimed at enlarging the family food basket and contributing to the physical and intellectual development of family members, rather than being of a curative nature. The intent would be to increase the availability of food to the household without simply waiting for economic development; indeed, a major rationale for such interventions is, as Ed Schuh said yesterday, that by increasing the productivity of labor, they will help to increase the rate of economic growth. This type of project might range from institutional feeding to targeted subsidy programs in the commercial market to efforts to lower prices through improvements in the efficiency of the food marketing system. Except for the latter, all involve important recurrent costs.

Third is control of the important micronutrient deficiency diseases -- iron deficiency anemia, iodine deficiency goiter,
and vitamin-A deficiency induced blindness. Major inroads are now possible. A low-cost technology now exists that makes large-scale fortification of salt with an iron compound feasible and attractive. (In very large countries, a single component project on this may be appropriate.) Sugar can be used as the vehicle for vitamin A, and mass doses are also a well-established approach to meeting vitamin A needs. Goiter has long been controllable with fortified salt.

Some of these same activities could also be considered as nutrition components in health or population projects or projects in other sectors.

The above directions are not new, in the sense that policies permitted them already. They are, however, new in the following ways:

(i) the attention given to nutrition in population and health projects will be more systematic and more rigorous than in the past; and

(ii) free-standing nutrition projects will be more narrowly focused than the early broad multisectoral projects. The Bank now has concrete models for nutrition projects. In short, as a result of the experience and the review process, concepts have been clarified and interventions have been operationalized.

The "food as medicine" and micronutrient project types clearly fall within the province of PHN. Consumer food marketing, though, is an activity that falls between the cracks in the Bank organizational structure. PHN is not staffed in this area, but other departments appear at the present time to be no better equipped than PHN to deal with this. The main consumer food marketing activities to date have been undertaken in the experimental nutrition projects.

Many countries, particularly those in sub-Saharan Africa, are not yet capable of absorbing nutrition projects of the free-standing type. We should be alert, however, to opportunities to include preparatory work (for strengthening institutions and for studies leading to subsequent project development) as components in projects. Also, as many of these same countries are in need and recipients of food aid but often are limited by their logistical capacity to absorb the quantities needed, appropriate Bank projects could include components designed to help expand that capacity.

Other departments of the Bank may be better equipped to take the lead in some nutrition projects, provided they are willing. Pre-school programs like Brazil's program aimed at broader developmental needs of young children at times may more appropriately be undertaken by the education divisions since the ministry of education is likely to be the implementing agency and school facilities and staff will provide the backbone for the program. Agriculturally-oriented nutrition interventions like those in certain of the projects would better be handled by agricultural divisions, unless there is some demonstrable comparative advantage in having them carried out within the framework of a nutrition project. Perhaps we can go into this more during the discussion.
Nutrition components in agriculture and rural development projects have been a mixed bag and certain criteria have been developed, as to when they might make the most sense. Experience suggests that nutrition components should only be considered for non-PHN projects if they are directly related to basic project objectives, can compensate for changes caused by the project that may be nutritionally negative, can be used to prepare for a future free-standing nutrition project, or can contribute to expanding programs already developed in the country. They are most likely to be successful where there is a strong political interest in improving nutrition, where the components are sufficiently large to attract the attention of Bank staff, and where local managers are capable of implementing multisectoral projects.

Building nutrition considerations into the design of appropriate agricultural and rural development projects is potentially more important than adding nutrition components. In 1980, the Policy Review Committee encouraged analysis and broadening the scope of agriculture project planning to include nutrition considerations such as the choice of crops to emphasize in research, storage, and extension projects. At a minimum, projects were to be examined to insure that their effect on food supply, food prices, or incomes did not contribute to a worsening of nutritional status (including the status of groups who were not direct project beneficiaries). Projects judged to have potentially deleterious effects were either to be reoriented or to have nutrition components added to offset the negative effects.

Guidelines were developed and several projects were designed with food consumption concerns given explicit attention. The Second Nepal Rural Development Project was based on increasing food consumption levels to meet nutrition requirements and the project components flowed from this. The Southern Highlands Project, in Papua New Guinea, which caused a shift from subsistence to crops coffee and tea, was modified to provide extension services to increase production in family food gardens and to include other assurances that the modernization effort would not be nutritionally negative. The South Kelantan Resettlement Project in Malaysia was designed to help settlers meet their nutritional needs during the years before rubber trees could be tapped -- a portion of land was withheld for food crops, the government helped to build and stock community fish ponds, and nutrition education was offered.

However, agricultural projects generally have not had nutrition integrated into their framework whether because agricultural staff either thought that malnutrition is for the most part being addressed (as it often clearly is) through increasing food supply, or that nutritional issues that go beyond are social welfare problems outside their province, or do not have time (and, in some cases, the training to feel comfortable) to deal with it. Overcoming malnutrition is commonly used as justification for agricultural projects in appraisal reports, with the projects' effects on nutrition assumed to be beneficial. (In fact, this is not always so clear.) But nutrition goals rarely are more explicitly considered.

Although there are exceptions, by and large the efforts to add a nutrition dimension to agriculture work in the Bank have not been
successful. There are probably several reasons for this, including inadequate prototype design, promotion and follow-through by us, limitations of time and interest of agricultural projects staff, and concerns by staff about decreasing rather than increasing project complexity. It also, however, reflects the way the Bank is structured and staffed along sectoral lines and the Bank's reward system.

PHN's potential to contribute to the condition is, of course, modest relative to the impact of other sectors, particularly agriculture. Dr. Pinstrup-Andersen will pick up this theme here...
Traditionally, solutions to nutrition problems in developing countries have focused on direct intervention programs targeted on individuals believed to be malnourished. Other programs such as nutrition education have focused on improving the nutrition-related household decisions. Common to most past efforts to improve human nutrition was their isolation from broader government policies and programs including agricultural development projects.

It appears that the conventional wisdom has been that nutrition problems were to be solved by nutrition programs while broader policies and programs had little to contribute. Yet, the nutrition effects of such policies and programs may totally overshadow the effects of direct intervention schemes. Poorly conceived food policies and agricultural projects may have negative nutrition effects which by far outweigh any positive effects of direct intervention programs. On the other hand, well conceived agricultural policies and programs have been much more cost-effective in improving nutritional status than direct intervention schemes.

This is not to argue that food and agricultural policies and projects should be designed exclusively for the purpose of nutritional improvements; merely that the potential nutritional considerations should be explicitly incorporated into decisions as to which food and agricultural policies and projects should be pursued and how they might be designed to accommodate various goals including improved nutrition. If trade-offs between the achievement of nutritional and other goals are explicitly considered, informed decisions can be made on the extent to which nutritional goals could be accommodated in the choice and design of policies and projects without unacceptable negative effects on the achievement of other goals. A general decision criterion might be that nutritional improvements should be pursued through broader policies and projects only if such improvements cannot be accomplished in a less costly alternative manner, such as through direct intervention schemes.

What I am suggesting is that the alleviation of nutrition problems in developing countries should be dealt with through a combination of direct nutrition intervention programs and broader food, agricultural and health policies and programs. Nutritional deficiencies are so closely linked with poverty that attempts to alleviate them in isolation from other factors which influence poverty make little sense.

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The most appropriate combination of narrow and broader programs and policies will vary among the particular situations. In general, broader food and agricultural policies and projects are particularly appropriate in cases of widespread mild and moderate malnutrition while they may have little to offer in more severe cases.

In cases of widespread mild and moderate malnutrition the nutritional status is very sensitive to: food prices in general; the relative prices of the various food commodities; incomes and to some extent who in the household controls the budget; food production among subsistence and semi-subsistence farmers; fluctuations in food availability, prices, and real incomes, and certain other factors (Figure 1). Traditional direct nutrition intervention programs have relatively little impact on these factors. In contrast, broader food and agricultural policies and projects may have a large positive or negative impact. We can ignore this fact and leave the nutrition effects of those policies and programs to chance or we can make an effort to ensure that the best possible nutrition outcomes, with due consideration to the achievement of other policy and project goals, will be attained.

Although the reasons for calorie-protein deficiencies differ among countries and population groups, the primary reasons are likely to be low household incomes and high food prices. Changes in any of these factors are likely to influence food consumption. From a nutritional point of view, only changes in food consumption by households within which some or all members are now malnourished or in which the risk of malnutrition is significant are of interest. Thus, changes in food supplies affect the nutritional status only to the extent that the food consumption of malnourished or at-risk individuals is affected. The degree to which expanded food production is translated into expanded food consumption by the malnourished varies depending on the crop or livestock species of which production is expanded, the nature of the project that brings about the expansion, and who produces the increase. Thus, total production expansion is likely to be a poor proxy for nutritional effect.

Ideally, project preparation activities would include the estimation of how the nutritional status of the poor would be affected by the project formulations under consideration and efforts should be made to identify ways of strengthening the positive effects through either modifications in project design or complementary policies and projects. Although this may be possible in a few cases, it is not likely to be feasible on a routine basis because of the many other demands placed on project preparation staff. What may be feasible is a rough assessment based on what the poor and malnourished currently consume and how the consumption patterns would be affected by the proposed project and possible alternative project formulations. For such a rough assessment data would be needed on: (1) expected impact of the project on: (a) incomes of poor farmers, (b) employment and incomes of agricultural workers, and (c) food prices, (2) current consumption of each of the major foods by groups of poor people likely to be affected by the project either as consumers, producers, or workers and (3) likely impact of changes in incomes and food prices on total food consumption by groups of poor people, e.g. poor consumers, producers, and workers.
Ways in Which Agricultural Projects May Influence Human Nutrition.

- Household Incomes
- Food Prices
- Agricultural Production Systems
- Risk and Fluctuations
- Nutrient Composition of Individual Foods
- Income Composition
- Intra-Household Income Control
- Womens Time Allocation
- Labour Demand and Energy Expenditures
- Infectious Diseases
Data under point 1 are not specific to nutritional concerns and are already collected as part of the preparation of many agricultural projects except for the price effect which is often assumed to be negligible.

Most countries have undertaken at least one nation-wide household consumption survey during the last 10 years. In some cases data from such surveys would be sufficient to cover the data needs under points 2 and 3 while in other cases the surveys provide an insufficient coverage of the particular project area. In spite of the large investments in household consumption surveys in many developing countries and the potential utility of the survey data for the design of projects and policies, very little use has been made of the data. One way to make better use of this data for the purpose of assessing the nutrition effects of various project formulations would be to incorporate the appropriate survey data into the agricultural sector work and thus make them available to project preparation activities.

Where existing surveys do not provide the necessary data, such data could be collected by means of a household survey in the proposed project area. Such a survey and the associated data analysis can be completed in 6 - 8 months. Thus, if initiated during the project identification phase, the results would be timely for deliberations regarding project design.

The above data collection and analysis is focused on the effects brought about through project impact on incomes, employment, and prices. In addition, it is important that more qualitative assessments be made of the potential positive or negative nutrition effects of various project formulations which may be brought about through other factors shown in Figure 1. Such assessment should be done as early as possible in the project cycle and might be built into the project identification mission. This assessment would identify: (1) those factors shown in Figure 1 which are most relevant for the particular project, and (2) potential modifications in project design which would eliminate likely negative nutrition effects and enhance positive ones.

In summary, it is argued that explicit consideration of nutrition implications as part of the design of agricultural projects would be likely to identify ways of reducing existing malnutrition which are more cost-effective than direct nutrition intervention schemes without unacceptable effects on the achievement of other project goals. Paying attention to nutrition implications need not involve a great deal of additional work during the project preparation phase if the effort is focused on obtaining rough guidelines rather than precise estimates. Some of the data needed for this effort are the same as those needed to assess the project impact on farm incomes, employment, etc. Others may be obtained either from existing household surveys or new limited surveys carried out in the project area as well as qualitative assessments undertaken during project identification and/or preparation missions.
CHAIRMAN'S COMMENTS

by

Leif E. Christoffersen*

Mr. Christoffersen opened the session by pointing out that the topic of Food Security embraced both the production and consumption of food. Thus, it was closely related to other similar concepts such as Food Policies and Food Strategies. In the Bank's experience, the objective of stimulating food production alone was a major effort that dealt with complex economic, political and technical issues and which called for a high degree of commitment at the highest levels of government. At the same time, it was clearly also important for national governments and donors to be concerned with the consumption patterns of food, including whether lower income groups were able to obtain minimum food requirements.

A basic problem in trying to reconcile a proper balance between food production and consumption was that some of the measures essential to ensure adequate incentives for food producers might have detrimental effects on food consumption for the most vulnerable groups. When producer prices were set at too low levels to make farmers produce more food, a common situation in most of the Sub-Saharan Africa countries, then price increases for food might have an adverse impact on nutrition if consumer prices rose to levels beyond what poor people could afford. A major focus for efforts to deal with this problem would be how to generate income growth among the poor. Hence, food security is a concept closely linked with the Bank's poverty policy which stresses measures that can make poor people more productive. It cannot, therefore, be discussed in purely technical or social terms, nor solely within a physical planning framework. The resolution of basic food security issues calls for decisions on major economic policies and for high level political commitment. It is clearly a major area that goes beyond agriculture and rural development and has, in many cases, a direct bearing on a country's willingness to implement major institutional changes and national reforms. Outside the Bank, the World Food Council has, for over a decade, stimulated discussions on these issues in various forms. Similarly, considerable work has been done at the International Food Policy Research Institute (IFPRI). FAO and EEC have also been active on these issues. Within the Bank, a specific food security policy has not yet been formulated, but efforts have been under way for some time to formulate policy proposals in this area. The first speaker, Mr. Reutlinger, has just completed a draft policy paper on the subject for discussion.

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RAPPORTEUR'S COMMENTS

by

Tariq Husain*

Food Security Issues

This session dealt with Food Security and Nutrition issues. The essential point of the Food Security paper was that increasing the real purchasing power of vulnerable groups was the primary route to increasing food security. Four interlinked instruments - direct food transfers, and/or direct purchasing power transfers, and/or reduced food prices, and/or increase incomes - were suggested and it was indicated that efficiency losses may have to be incurred in order to make gains for the food security objective. The recommendation was to choose that set of instruments which minimized these (possible) efficiency losses. The focus of the subsequent discussion was on the possible effects of lower food prices on domestic producers of food, need for positive protection for agriculture, and the political dimension of food security issues.

Nutrition Issues

The two nutrition related presentations argued that while conventional wisdom has been that nutrition problems of vulnerable groups are best solved by targetted nutritional programs the lessons of experience are that broader agricultural and food policies may totally swamp the effects of direct nutritional intervention programs. In fact, poorly conceived food and agricultural policies and projects may actually have net negative effects on nutritional objectives. The recommendation was that nutritional considerations should be explicitly incorporated into decisions about and/or formulation of food and agricultural policies. For example, in case of widespread mild and moderate malnutrition the nutritional status is very sensitive to (1) food prices in general; (2) relative prices of various food commodities; (3) level of household incomes and, to some extent, who controls the household budget; and (4) extent of subsistence or semi-subsistence food production. This is the same argument as in the Food Security Paper, but from the nutritional side.

The speakers argued that paying attention to nutritional implications would not involve a great deal of additional work during project/policy preparation. Need for analysis of existing household expenditure surveys or data from limited new surveys (which, it was stated, may be done in 6 to 8 months - including analysis) was recommended strongly.

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Discussion

Food Security: A participant enquired as to how much we (in the Bank) knew about price and income elasticities of consumers in, say, Sub-Saharan Africa, or even generally. He further asked whether by itself "increasing the real purchasing power" of vulnerable groups would be a sufficient condition for improving nutrition or whether consumer education would also be necessary. Mr. Reutlinger replied that there is adequate knowledge in the Bank about income and price elasticities; in any case, if vulnerable groups spend upward of 70% of their incomes on food - then lower prices (or other real income increasing actions) must have significant beneficial effects on these groups. Mr. Reutlinger agreed that consumer education will be helpful. Another participant asked why did the Bank need a Food Security Paper and not just an Agricultural Policy Paper. Mr. Reutlinger replied that if the Bank or the international community is concerned with food issues, then these cannot be handled by agricultural policy alone. Trade and income distribution policies are also needed to meet short term crises as well as long term food supply needs. The Chairman in his opening remarks had also suggested that food security issues also have a political dimension and while this dimension was not discussed in Mr. Reutlinger's paper it was an important reason to have a Bank view about food security since Governments may follow general import and price control polices which may decrease food security.

A participant suggested that there might be an ambiguity in Bank policies - for example, lower food prices help to accomplish food security objectives for net buyers of food, while higher food prices assist net sellers of food (farmers). This question was asked in the context of a statement in Mr. Reutlinger's paper (Page 18, para 52) advocating caution "before advocating positive rates of protection on food". The answer was that the draft paper under discussion was not yet a Bank policy paper and so the ambiguity question can be reformulated in terms of what the policy ought to be. The facts are that if the proportion of poor net consumers of food is high - it is 35% of the total population in India - then lower prices of food would help this large group. The food producers will, of course, benefit from higher food prices. The choice of the right policy will depend on the relative weights of these two groups. All the paper is saying is that recommendations to raise food prices quickly and significantly should be made with caution. The need for positive protection for food in sub-saharan Africa has to be judged in the above context. However, considering the extent of negative protection for agriculture in sub-saharan Africa the case for positive protection is still quite a way. Given significant sizes of poor populations in Sub-saharan Africa we must exercise caution when recommending positive rates of protection for food.

Another participant, however, argued that the policy of "cheap food" in Africa has resulted in less food availability and this has led to high (black market) prices. So, what the paper was recommending amounted to ensuring lack of food security. Mr. Reutlinger said that he agreed with the above statement ie consumers on a selective basis benefit from negative
protection while the majority of consumers are hurt. However, this does not automatically translate into an argument for positive protection of food products. Another participant added that it is not just a question of negative rate of protection for food; one has to look at positive protection provided to non-agricultural and agricultural tradeables. Should food not get equal protection? Mr. Reutlinger said that these are complex trade policy issues and the food security policy paper is not the right instrument to deal with these issues.

Nutrition: Some participants questioned the availability of data (household expenditure surveys — existing or new) to assess nutritional impacts of policies and projects. The Chairman also mentioned whether relevant data was really available and/or whether new surveys could be carried out in six to eight months. The reply was that consumption data sets do exist and are more carefully done than production data sets. And that reasonable estimates of nutritional impacts could be made in six to eight months. A participant enquired as to how does one incorporate nutritional considerations in framing policies and projects. The reply was that there is no generalized approach; one has to be aware of the implications and then appropriate institutional solutions can be found.

On the political dimensions of food security and nutrition it was noted that political support is needed for policies and projects to work. Such support would not be likely if the targetted population was a small proportion of the total. So, it is essential that larger population proportions be targetted through incorporation of nutritional considerations in agricultural projects and general food and agricultural policies.

Summation The Chairman thanked the speakers and the participants and noted that the major objective of the session seemed to have been accomplished. The main message was that poverty removal was central to the provision of food security. That means, general economic growth is a sine qua non for food security in the medium time run. In both the short and medium time frames, however, appropriate income distribution policies would have to be followed to protect vulnerable groups.
SESSION IV: OPERATIONAL IMPLICATIONS OF FOOD AND POPULATION POLICY

RAPPORTEUR’S COMMENTS

by

Jack van Holst Pellekaan*

The following is a summary of the panel discussion chaired by Stephen Eccles, Assistant Director of the Western Africa Projects Department, held after the presentation of the first eight papers of the symposium. The purpose of the discussion, in which the authors, the panel and the audience participated, was to examine the operational implications of food and population problems and policies examined in the papers. The question raised was how could food and population issues be more explicitly integrated into Bank lending, especially in the agricultural sector? The rapporteur, having briefly outlined the main points of the papers presented so far, suggested discussion could focus on the following questions, which arose from the earlier part of the symposium:

- Are land carrying capacity ratios useful for sector work and relevant to operational problems?
- What are the organizational implications of including resource inventory assessment and land use management in Bank operations?
- How should population growth issues, e.g., migration vs. investment in low potential, densely populated areas, be addressed in economic and sector work?
- Did the need to give high priority to resource management also mean that the Bank’s traditional techniques for economic analysis needed adjustment, for example, through downward adjustment of discount rates?

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1/ Panelists: Messrs: Jeremy Warford, Economics Adviser, Projects Policy Department
- Paul Isenman, Senior Economist, Western Africa, Office of Director
- Martin Staab, Deputy Division Chief, Eastern Africa Projects Department
- James Greene, Senior Nutrition Specialist, Population, Health and Nutrition Department
- Altaf Hussain, Division Chief, Eastern Asia & Pacific Projects Department

Resource Persons: Mesdames: Nancy Birdsall, Teresa Ho
- Messrs. Shlomo Reutlinger, Alan Berg, Hans Binswanger, Rudolph Dudal, Graham Higgins
What type of public sector interventions should be introduced if autonomously generated farmer production intensification efforts are not taking place rapidly enough to keep pace with the need for income growth?

To what extent should the Bank be involved in long-term investments such as research, extension, roads, etc. vs. short-term investments?

Does the Bank have a role in ensuring that the public sector's activities support and guide rather than subvert private initiatives?

How can food security and nutrition objectives be introduced into Bank lending and sector work?

How can concern for food security issues, which it has been argued is predominantly a question of the level and growth of real income, be pursued in operations?

The discussion which followed did not cover all these issues; furthermore, some additional issues were raised. The record of discussion follows the main subject areas covered.

**Should More Funds be Invested in Areas of Low Potential?**

A member of AGR asked whether the Bank should put more funds into areas where resource endowments are low compared to other areas of high potential productivity. Viewpoints differed on this matter. According to a senior country economist, the idea is becoming less prevalent that people should be taken care of "in situ", especially in low potential environments. He further proposed that before agricultural projects with low rates of return are accepted, they should be compared with likely rates of return to human resource interventions in the same areas.

The alternative to investing in areas of low potential/high population density is to support the migration of people out of these areas. A member of PHN suggested if migration is spontaneous, it is easier to justify economically than if it is planned. Planned migration involves complex administrative logistics, and, even with political commitment and resource availability, can move only slowly, as is the case in Indonesia. In Indonesia people cannot be relocated fast enough to siphon off the growth in population. The Chairman suggested that possibly migration was too late in Indonesia, whereas in Africa where population density is low, if one acted immediately, migration might be more successful.

Yet there is always the question of where to relocate a population. Someone from AEA suggested that people from Rwanda would eventually be forced to migrate to less populated areas in Zaire. Yet apparently, the reverse is happening, because policies have resulted in favorable incentives for agriculture in Rwanda.

However, migration across international boundaries is obviously not always a possibility and it is only in exceptional circumstances that an underpopulated, high potential area exists within a nation. There were some examples, however, and the Chairman mentioned the example of Burkina where certain areas have recently been cleared of River Blindness making them now areas for inward migration and of high growth potential.
A staff member from AGR proposed that with migration there is the further difficulty of teaching people to change their farming methods, in order that they make the best use of their new location. Finally, there are also many social and moral questions associated with planned migration, especially when people are sensitive about leaving their land or nations.

Should the Bank Direct Resources to Long-Term or Short-Term Problems?

It was asked whether the Bank should respond to short-term problems or whether it should be more involved in the long-term consciences of governments. A decision on this question would have implications for the analysis of resource development. It was proposed that the Bank should continue to invest in long-run projects and not let short-run interests drive out the long-run. It was agreed that since Bank resources are increasingly limited, it is more appropriate that Bank lending for agriculture focus less on short-run production projects than on those that have a long term impact, such as transport, marketing, water supply infrastructure, land conservation and irrigation, i.e., the types of projects which are concerned with future growth of the economy and its population.

A commentator from AGR noted that the long range benefits of investment in human capital, especially education, are now generally recognized as being crucial for agricultural development. This becomes particularly evident when making the comparison between the achievements in South Asia's agricultural sector and the disappointments in Africa. Another staff member from AGR noted that there is an interplay between short term policies that are required for long term benefits. He made the point with the example of producer pricing policies, often adjusted year by year, which support long term investments in the farm sector.

Analytical Framework

An important concern of both panel members and the audience, however, seemed to be how to ensure that analytical techniques used in the Bank were appropriate to the questions and discussions related to resource management. Questions were raised about appropriate discount rates and whether the standard rate of return analysis was appropriate for resource management projects and for investment choices where data was inadequate or non existent. A member of the panel insisted that the standard framework was appropriate, but care needed to be taken with the estimation of benefits and costs. The Chairman advocated that calculations of rates of return are not appropriate for projects where there is no reliable data on which to base the analysis. Instead common sense should be applied to reach conclusions on project justification, although, he made it clear, after a question from the floor, that projects should be subject to strict rate of return analysis when possible. He stressed that his previous statement was only to discourage the generation of benefit and cost estimates where the nature of the project prohibits any realistic data. One agricultural staff member offered that despite low economic rates of return he had an intuitive feeling that agricultural projects, in particular irrigation, merited priority. A panelist rejoined that there was nothing per se that warranted special treatment. Staff members from other sectors had exactly the same feelings about projects in their areas, therefore careful economic analysis was important regardless of gut feelings about projects. Several participants also noted that the Bank may have to shift to more long-term investments directed at improving resource management. But this may also involve the Bank in more financing of recurrent costs.
Public vs. Private Investment

As the Bank and other development institutions are beginning to place more emphasis on the role of private enterprise in stimulating economic growth, and in its ability to provide populations with goods and services more efficiently than public institutions, it is important to remember that the governments still have an important part to play in the development process.

The comment of an AGR staff member from the floor that private gain is not always synonymous with the public good was illustrated by the problems of getting farmers to practice land conservation measures without the short term prospect of increased production. Governments' activities should be for the public good, i.e., the state should enable and encourage farmers and entrepreneurs to increase productivity in sustainable ways. For example, government policies should encourage investments in items such as agricultural research and infrastructure development. A speaker from AGR added that the point of getting government pricing policies "right" is to get the government out of activities that can be more effectively influenced by the market. The resources which are saved can then be invested in areas of long term social benefit, e.g., infrastructure, conservation and irrigation. Such government investments are more likely to lead to improving labor productivity than many other government interventions in the market.

Another participant raised the difficulties of accomplishing this in Africa, where there are currently military dictatorships that favor large scale mechanized state farms over smallholder rainfed agriculture. An AGR staff member mentioned the success of local farmer cooperatives in Europe and suggested that the Bank do more to encourage the development of these "grassroot" community associations, since they had, in his view, been shown to deliver services more efficiently than state enterprises. This point was echoed by a number of participants in the audience. A panel member interjected, however, stating that in Africa, the reason the state got involved in agriculture and the market in the first place was because the cooperative movement had failed. Another participant added that the few cooperatives which exist in Africa were actually state-controlled, because the government fears autonomous organizations. A panel member raised the further question of how the Bank, which by its nature has to work through government channels, can support local community organizations.

Should Nutrition and Population Issues Be Introduced into the Agriculture Sector and Projects Work

The Chairman wanted a response from agricultural staff on whether they felt it was important and/or possible to take into account nutrition and population problems in their operational and sector work in agriculture. The initial reply to the question, from a technical staff member of AGR, was that because increasing agricultural production is not a necessary condition for solving food security and nutrition problems, perhaps we should look also to other sectors, such as education, for solutions.
Staff members of PHN acknowledged the difficulties of considering the nutrition and population impacts of agricultural projects for agriculture staff who had little experience in nutrition and population issues, although it was suggested that PHN could be called on for guidance. However, it was emphasized that agricultural sector missions should make ministries dealing with agriculture more aware of the connection between growth in agriculture and population growth, particularly as it related to labor productivity in their dialogue on projects and sector work.

According to the Chairman, most agriculture staff raise population and nutrition issues only when they are obvious, as is the case in the Sahel. It was proposed that agriculture staff themselves might need more education in these issues and that missions should be more adequately staffed to deal with these matters.

The Chairman suggested agriculture staff needed an example of the value of including nutrition and population issues in their projects. He felt it would help to show staff an example of an agriculture project which had been more successful because it had responded to nutrition and population problems. Practical experience would be better at convincing the skeptics than theoretical papers on the subject. According to a panel member from PHN, the Bangladesh Medium Term Food Production Plan would probably have dealt more with nutrition issues if the results of the Bangladesh Food and Nutrition Sector Review (carried out by PHN recently) had been available at the time of the plan design.

There was concern, however, from an AGR commentator that if nutrition issues were more heavily incorporated in project work, the Bank would be returning to integrated rural development projects, which have already been demonstrated to be extremely difficult if not unsuccessful. He emphasized that the whole thrust of most of the earlier papers had been that the key to improving a household's nutritional status is increased income. Population and nutrition considerations should not just be attached to every project indiscriminately unless there is specific justification. Besides, these issues are already supposed to be addressed under the Bank's focus on poverty.

In discussions of the food security issue, it was also pointed out that, while, an increase in household income usually results in an increase in the nutrition level of all individuals within the household, intra-household income distribution should be taken into account. In some cultures, the nutritional level of the household does not increase with income because the male head rather than the female receives the additional income. It was acknowledged that although this was a relevant issue, the purchasing power of households was the key factor influencing food security.
SESSION V: POLICY BASED LENDING IN AGRICULTURE

POLICY BASED LENDING AND THE WORLD BANK

by

Vinod Dubey*

Introduction: The Bank and Policy Reform

The Bank since its inception has been interested in the economic policies and performance of its member countries. Even as it evolved into primarily a project lending institution making loans for specific investment projects with demonstrable high economic returns, there was an increase in its wider concern with country and sector policies. Country economic and sector work absorbed growing amount of resources and the depth and quality of the studies continued to improve. In subsequent years the Bank also undertook and supported a large volume of research on issues of development policy.

However, the link between concern for country policies and operations was not direct or very strong. Lending was not viewed as a vehicle for initiating and supporting policy reforms. That role was played by a policy dialogue carried on with the member country to which the country and sector work contributed. Clearly because of creditworthiness and country assistance strategy considerations, country policies at the extreme (i.e., if they were very poor or very good) did affect the level of lending and, perhaps, its composition. Also, to a certain extent, project and sector lending was associated with conditions such as agreed tariff changes or development of an institutional framework the impact of which went beyond the specific project. Further, there were occasions when the Bank did take a strong stance on policies and put its lending on the line in support of its position. Examples of this are the case of India during 1964-1966, and of some Latin American countries in the latter half of the sixties. However, such examples of an explicit and strong link between policies and lending were exceptions. The Bank generally tended to be content with developing a policy dialogue in order to recommend—rather than push—policy change.

Generally speaking, lending for projects has serious limitations as an instrument for policy change for three reasons. Firstly, the major discussions of the project loan are conducted primarily with the line ministry concerned with the sector in which the project lies, while policy changes generally require the involvement of the macro-oriented ministries like Planning, Economy and Finance. Often the discussions occur largely

1/ These are documented in Messrs. Mason and Asher's History of the Bank.

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with the project authority which has even narrower perspective than the sector ministry. Hence, the occasion for a project loan is not the most appropriate to discuss policy changes. Traditional sector loans have a similar character though to a lesser extent than project loans. Secondly, individual project loans have their own preparation and implementation cycle, while policy changes are usually most effective when undertaken as a package. Specific policy changes linked to projects closest to these changes would tend to be intermittent and (if projects are delayed) uncoordinated. Thirdly, once a project is under implementation, it is not possible to effectively link disbursements to specific policy actions without seriously disrupting implementation. There have been many occasions when the dynamic of project construction led the Bank to agree to the erosion of financial and other covenants agreed when the loan was approved. The Bank's focus after the mid-1960s was, therefore, more on the improvement of project design and of project evaluation and post evaluation rather than on improving the policy aspects of project lending.

Program lending has been a lending instrument used by the Bank from its first days when program loans were made for reconstruction purposes. However, it was used in special circumstances, and primarily to support a "program" which the Bank had reviewed and approved. These terms were used in quite a broad sense and often the loans tended to become "routine" — witness the eleven annual import credits to India between 1964 and 1976.

Structural adjustment lending, therefore, marks a new stage in the Bank's relations with member countries in that the link between lending and policy change is explicit and direct. The SAL was a response by the Bank to a special situation. The worsening international economic situation in late 1970s (deteriorating terms of trade; recession in the OECD countries; very high international commercial lending rates) intensified the need for structural adjustment. It became evident that often good projects in poor policy environment do not yield the requisite benefits. The need to improve the efficiency of resource allocation became increasingly urgent. The SAL loans were in support of programs of structural adjustment which may be very comprehensive. But they include specific measures and institutional steps that are to be undertaken within particular time periods both before the loan is approved and as conditions for the release of later tranches of a SAL (or occasionally for the approval of another SAL). The initial SALs (e.g., Philippines, Turkey, Kenya) originated as program or sector loans already being processed, but were recast in the new mold. There was a process of learning within the Bank which is still going on regarding SALs. However, from the experience so far, two conclusions are fairly clear. Firstly, the SALs are a limited lending instrument applicable only to selected country situations besides being not acceptable to a few. So far SALs have been made to sixteen countries of which twelve are still active. For a period of five years, this is not a large number of active countries since structural adjustment problems of some kind are clearly prevalent in almost all the borrowing member countries. Secondly, they have shown that the Bank can effectively influence/support/accelerate policy and institutional changes in both low and middle-income countries.
(from Thailand to Togo). This has generated an increased interest in other instruments of lending linked explicitly with policy and institutional reforms which like SALs also are, "specific, time-bound and monitorable" and which are more widely applicable than the SAL. Policy linked sector lending is one of a variety of policy linked lending instruments that are being developed. (Public Investment Rationalization and Public Sector Rehabilitation loans are others.)

Issues for Policy Based Lending

The Need for an Analytical Framework

A fundamental issue concerning policy based lending is the analytical framework within which the policy and institutional package is designed and evaluated. At present no explicit framework even broadly similar to that incorporated in the methodology of project evaluation used in the project lending exists. There is an implicit framework provided by neoclassical economic theory which underlies the series of reforms supported - that prices that reflect scarcity values would improve the efficiency of resource allocation; that trade liberalization by improving the balance of incentives between exporting and importing will improve efficiency and the balance of payments; and so on. However an explicit, at least partially quantifiable, analytical framework does not exist which would enable the results of alternative policy packages to be evaluated even in broad terms and permit the investigation of trade-offs between the short term and the long term and between the attainment of competing objectives (e.g., employment and productivity growth). Consequently, it becomes difficult to question and evaluate the balance and the even approximate optimality of the policy packages associated with a particular SAL or other policy linked loan. It is clear that we are not seeking a vast economic model of the economy which would answer the questions raised above. Even if such a model could be developed - and one may be skeptical that it could - the data basis for validating such a model exists in almost no developing country. More fundamentally, while a program of structural adjustment is being considered, the values of the parameters and the structural coefficients of the model will be changing. Without a complete and integrated model, however, much progress has been made by pursuing within the framework of a SAL an interrelated package of policy reforms resting on partial equilibrium analysis.

The "Success" of the Policy Package

In the absence of a comprehensive analytical framework, how does one determine whether a specific policy based loan was well designed and if it has been successful? There is a large element of judgment at all stages of the process. The implementation of agreed measures at the agreed time may be one index for judging success of an operation. However, even this is not always easy to determine. For example, consider an agreement to reduce protection by carrying out certain specific changes in QRs and
tariffs. Suppose these measures are carried out in a SAL in a modified fashion (not in the form agreed) and with a delay of six months. Was the agreed measure implemented? It is essentially a matter of judgment. Much more important is the difficulty in determining whether the measures actually carried out achieved what they were intended to achieve. How was/or ought the objective of the measures to be defined? Measured? And finally even if we did have the answer there is the problem of determining what part of the actual development was due to the policy measures and what part to other factors (weather, international developments, measures not in the Bank program). Supposing that all this were done, there is the final question of constructing the "without the policy change" scenario as the base with which the actual outcome has to be compared. It is evident that the whole process involves a major element of judgment at all stages. Hence, the only conclusion I come to is that if in the long run the country is not having a reasonable trend growth performance in a reasonable international economic environment (let us hope that it will emerge) then the policy package(s) supported by us in that country should be judged to be a failure. (This as distinct from the success or failure of specific policy based operations which is the counterpart of the project by project evaluation of the OED-type.)

**CESW and Policy Change**

The Bank has devoted a large volume of resources - from one-fifth to one-fourth of the operation budget - to country economic and sector work. However, this work has been geared to meeting the needs of the Bank and other donors and to providing a basis for economic and sector policy dialogue. It has not been directed towards the design of specific policy and institutional reform packages. It is a major step from having a good analysis and diagnosis of the problems in the economy or sector (which itself is a tall order) and making general recommendations about needed policy changes, to designing specific measures which are both effective and feasible. It involves much detailed and indepth work and a understanding of the institutional and socio-economic framework. It consumes time and resources and may also take the Bank into areas where it does not necessarily have a comparative advantage. Time and again the experience has been that major studies necessary for designing policy change are not available. At the same time, one cannot help feeling that sometimes studies reflect a decision to postpone to undertake certain necessary changes and it may make more sense to start with first approximations - changes in the right direction - and leave fine-tuning until the results are available of more detailed studies.

**The Balance between Policy and Institutional Change**

Policy based lending is intimately linked to institutional reform. The adjustment programs supported by the Bank invariably have a large institution building component. In fact the objective, given the medium-term perspective of the Bank, is to institutionalize the policy adjustment process so that the distortions and problems being tackled do not emerge again. For example, in the case of agriculture, the Bank
supports measures to change specific prices which are out of line with (say) "world" prices. But it also strives to establish an institutional framework in which these prices are periodically reviewed and changed in the light of changing circumstances. Questions arise regarding the relatively long time perspective over which institutions can be developed and strengthened, the pressing nature of the problems in the countries that need to be addressed and the possibility of having an immediate impact by policy measures. Essentially, it is a question of balance. Even in the area of policy reform there are measures like increases in specific prices which can be implemented in the short term and the reorientation of investment priorities which may take longer. There is no general view possible on the appropriate balance between policy and institutional change except that it is likely to differ from country to country, at different times for a given country, and from sector to sector.

The Commitment of the Government to Reform

The question is often asked that if the policy and institutional changes being encouraged by the Bank are in the interest of the country, why does the government need a loan linked to policy changes to undertake them? There are many possible answers to this — and all of them may be applicable in certain situations. Governments may not be convinced that the reforms would bring about the results being indicated, perhaps, because their judgment about the magnitude of the response mechanisms is different from ours. Governments may have a very different time horizon (rate of time discount) in evaluating the costs and benefits of the changes, with the short term costs receiving relatively greater weight. Governments may also have a quite different set of concerns in their objective function — including political concerns and group interests — from those which the Bank promotes. The policy linked loan from the Bank, therefore, can be viewed in terms of support to offset short term costs, "sweetener" to compensate for other concerns in the governments' objective function, "earnest money" to demonstrate the Bank's conviction that the policy measures are sound and will lead to net beneficial results and so on. However, the important operational by product of the question raised relates to the commitment of the government to sticking with the reform program which has a fundamental effect on the likely success of the program itself. The economic adjustments the Bank is primarily concerned with are long term in nature and consequently a program "imposed" by circumstances on a reluctant government which is not convinced about its appropriateness is unlikely to be successful. Consequently, ultimately the role of the Bank is to support, through its lending, a government's own program and persuading and convincing the administration, and during the process of adjustment over a period of time, is a key element for a successful policy loan. This process is ongoing and does not stop when the loan is appraised and negotiated. Lending is not the only instrument through which this process is carried out.
Size of the Operation

There is no simple analytical technique or guideline for determining the size of a policy loan in relationship to the policy package being undertaken. Clearly the size of the economy or the sector in which reform is being supported is relevant. In some situations (e.g., liberalization of the protective system), the notion of the short term effects on the balance of payments provides a peg on which to "hang" the issue. More generally the need to offset the short term transition costs of policy changes may be used for this purpose. Another element to consider is the judgment on the level of Bank support for the reform program that is necessary to make the support "credible". This is a subject on which perhaps more thinking needs to be done, though I suspect that a large element of judgment will always be required in deciding on the appropriate size of a policy linked operation, within the constraints (e.g., country lending allocations and the approved country assistance strategy) that the Bank usually operates under.

Some Special Questions Concerning Policy Linked Sector Loans

As mentioned earlier, experience has shown that comprehensive economy wide reform programs supported by the Bank are appropriate only in relatively limited number of countries. The reasons are to be found on both the demand (country) side and the supply (Bank) side. Also, countries are eligible only for a limited number of SALs and the institutionally set limit has been reached for Turkey. After the series of SALs is completed policy linked sector loans take over and these, therefore, are increasingly in evidence. There may also be a more positive reason for the growth of such loans. Specific and more narrowly focussed policy reform, supported by a sector loan, may be judged to be a more effective approach to successful adjustment in certain situations. A package of such sectoral loans, a la Pakistan, may be an appropriate structural adjustment approach. Some hypothesis may be ventured about situations in which sector policy loans can make sense and are worth exploring. First, as a precursor, or a successor to more comprehensive adjustment programs supported by a SAL. Second, in some large complex countries (e.g. Brazil, India, Mexico) where a comprehensive program may well nigh be beyond the capacity of either the Bank or the country. Thirdly, in situations where broadly concurrent sectoral policy changes can be carried out. Fourthly, situations where there is a particularly dynamic team and appropriate circumstances to secure reform in a sector or subsector, but little hope of government acceptance of a comprehensive program. Fifthly, situations where there is a major policy issue in a sector—e.g. agricultural interest rate subsidies—which is having serious effect on project lending and cannot be addressed by it. There are obviously other situations in which the appropriateness of sector loans need to be pursued. However, in addition to the issues which have been discussed, there are some others associated with a sectoral or subsectoral approach to policy reform. Is it appropriate to tackle the structural adjustment problem of a country piece by piece or are there advantages in a mutually supportive package approach
to policy and institutional change? This is a question which cannot be answered in a general fashion. Much depends on specific situations and the policy areas considered. Where the objective is related to reorienting the policy stance of a government — say from an interventionist approach to one relying more on market forces — it may be difficult to successfully carry out a program for encouraging market orientation in a sector within an overall government policy framework wedded to intervention and control. Similarly, if the object to improve the investment decision-making process in one sector and hope that the improvement will stick and not revert to system norm. The judgment on this question has to come from experience.

Relation between Project and Policy Based Lending

At first sight, project and policy based lending would appear to be substitutes. Funds going into policy linked loans in a given country are not available for project lending. However, this would be a misleading conclusion. With the worsened international economic environment, many countries are faced with an urgent need for adjustment which cannot be postponed. In many countries there was as a consequence a drastic reduction in investment — particularly new investments. Policy reform by helping to restore the country to its medium-term growth seeks the revival of investment. Consequently in a number of countries, lending linked to policy changes helps create the conditions in which project lending can continue and expand. For example, in Jamaica which has received three SALs so far, there has emerged a very close complementarity between the structural adjustment program and the Bank's project lending. The President's Report of SAL III for Jamaica states "As the SAL process has continued, the relationship between SAL lending and project lending has become closer. This is a two-way process; in some areas the SAL is creating a framework which makes project lending more possible, for example through improvements in the viability of certain enterprises; in other cases, the SAL process is identifying certain project lending needs, such as the recently approved Public Administration Reform Project; and yet in other areas, the implementation of projects reveals policy areas that need to be addressed, and it is through the SAL that the action programs are designed" (para. 61). In more and more countries, the real challenge is to develop this symbiotic relationship between policy linked lending and project lending in order to maximize the Bank's contribution to the development of the country.

Processing Issues

There are a large number of issues regarding policy based lending relating to internal Bank organization and procedures. A number of these are raised in the discussion of specific experiences, and they are clearly issues to be resolved in the interest of economy, efficiency and effectiveness. First, there is the question of how the existing organization of the Regional Offices in Projects and Programs departments affects the processing of such loans. SALs have generally been prepared with the lead role being taken by Programs but an important input being provided by Projects. Policy linked sector loans are generally the primary
responsibility of Projects. In some Regions coordination of inputs at all stages has been secured by setting up a "core group" of Programs and Projects divisional and front office staff. Experience needs to be reviewed and lessons disseminated. Secondly, concerns about the appropriateness of the expertise and experience of existing staff for policy based lending have been expressed. The skill requirements for developing and negotiating a policy loan are usually considered to be distinct from those the Bank has built up through project lending. There is an element of truth in this. However, experience indicates that policy based lending requires very large role for technical experts. For example, the review and rationalization of investment programs which is a key element in SALs requires a major involvement of technical staff. The role of technical staff in policy based sector loans is likely to be even larger. Thirdly, with policy based lending the Bank needs to coordinate its activities much more closely with the Fund. Structural adjustment and stabilization in many situations have to be undertaken simultaneously and the complementarity between the Fund and the Bank supported program has to be ensured and conflicts resolved. This has not always been easy and absorbs time and resources. Fourthly, the existing procedures for processing loans may not always be appropriate for policy linked loans. Some distinctions are already in place. For example, the Loan Committee meets to discuss initiating memoranda for such loans to provide guidance to the Region on the policy package which is considered to be associated with the loan. The initiating memorandum is also a useful device from bringing about a coherent institutional view of the policy adjustments to be sought in the specific operation. The IMF which has been in the policy linked "lending" business for a long time has evolved a system by which the missions have a large degree of freedom to negotiate conditionality in the field, within the limits set out in a "negotiating brief" approved by the Managing Director. However, this is possible partly because the concerns of the Fund are largely macroeconomic and short term and their performance criteria related to controls on 'credit' expansion, the government budget and external borrowing are capable of quantification and relatively straightforward monitoring. At the same time, and not necessarily contrary to what has been just said, the IMF Board apparently has a significant role in determining the broad framework of the IMF-supported program. Finally, there is a perception among Bank staff and perhaps also among some governments that the institution's overall lending objectives tend to put pressure on staff to deliver planned levels of lending, particularly towards the end of the fiscal year. This clearly undercuts the process of persuading reluctant governments to undertake policy reform.

Conclusion

The above outline of the experience of the Bank with SALs and other policy based loans clearly shows that there are more questions than answers at this stage. The Bank is in a process of learning by doing and is dealing with problems in a pragmatic fashion while accumulating experience which would help it to design more effective policy linked loans with a more economical use of its staff resources. In terms of parallels, policy lending is where project lending was in the 1950s, when the evaluation methodology used was rudimentary and the best guarantee of success was the common sense and pragmatism of a technically high quality and committed staff.
Statement of the Policy Issues

Although there are numerous agricultural policy issues included under the Pakistan SAL (and other lending) operation, three interrelated aspects of the pricing policy issue are highlighted below.

(a) Fertilizer Price Subsidies - Relatively high and escalating subsidies on the retail price of fertilizers were becoming an unsustainable burden on Government's budget, diverting substantial funds from other priority investment programs in the agricultural sector, and were being questioned as necessary for maintaining continued growth in agricultural production.

(b) Irrigation O&M Subsidies - One of the major reasons for the physical deterioration of the vast INDUS irrigation system has been due to an increasing shortfall in O&M funding levels as against the requirements. Although there is not a direct connection between irrigation O&M expenditures and recoveries, overall domestic resource constraints led to the growing realization that the above shortfall has been attributed partly to highly subsidized irrigation water charges.

(c) Process of Formulating Agricultural Pricing Policies - Pakistan's agricultural pricing policies inevitably have been guided by multiple objectives that are sometimes conflicting. GOP's process of setting prices of key inputs and outputs has been somewhat subjective and has not contributed systematically to achieving balanced pricing policy objectives and strategies. Therefore, GOP pricing policy interventions have required the establishment and strengthening of an appropriate institution to provide consistent and timely recommendations on appropriate crop and input prices based on a continuing and objective analysis and assessment of effects of such policies.

Overall Context - Country, Sectoral, and Institutional

Overview. Notwithstanding a favorable economic performance of the overall economy and agricultural sector in the late 1970s, GOP was increasingly aware that sustaining the high economic and sector growth rates would require policy reforms in the economic sector. Escalating oil prices in the 1970s resulted in unsustainable pressures on Pakistan's balance of payments position and GOP's budgetary resources, leading Government to reassess its sectoral strategies and policies. This difficult period coincided with the publication of the Revised Action Program

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(RAP) Study on Irrigation Agriculture, which was a UNDP-financed study executed by the Bank. The recommendations of the study comprised the basis of a sector reform program formulated by GOP in early 1980 called the National Agricultural Policy (NAP); it aimed to reorient GOP's approach to increasing agricultural production. A key element in the NAP involved addressing the three aspects of the pricing policy issue outlined above.

**Fertilizer Subsidy.** GOP's fertilizer budgetary subsidy had increased from US$32 M in 1974/75 to about US$200 M in 1979/80, representing 33% and 64%, respectively, of GOP's total allocation for the agricultural sector investment program. Since these subsidies were a part of the capital budget, funds were being diverted from other priority investment programs in order to cover the escalating fertilizer prices following the second "shock" of petroleum world price increases in 1979. Also, by 1980 Pakistan had managed to sustain relatively high growth rates in the agricultural sector for a number of years, which was assisted by high growth rates in fertilizer consumption (e.g. 20% per year) and a relatively high proportion of farmers in Pakistan that had already come to adopt the usage of chemical fertilizers. Fertilizer subsidies were also influenced by GOP's policy to expand the domestic production capacity of fertilizer plants, and therefore, a relatively high proportion of the fertilizer subsidy was being used to subsidize high-cost fertilizer plants. As a result, the fertilizer subsidy policy involved federal agencies in the agricultural and industry sectors as well as public and private sector fertilizer plants.

**Water Charge Subsidies.** The RAP study findings and GOP's NAP statements highlighted the need for and policy of investing additional financial resources in rehabilitation and stepped-up O&M activities of the irrigation system as a strategy to providing low-cost quick-generating agricultural benefits. Partly because irrigation O&M expenditures and recoveries were the responsibility of Pakistan's four Provincial Governments, it was difficult for GOP to address these matters effectively or to force the Provinces to implement the policy guidelines issued by the Federal Government. Given the Federal/Provincial financing arrangements, Provincial Governments did not have much incentive to generate additional revenues, including increases in water charges. There also appeared to be an underlying assumption by many Government officials that O&M expenditures would be covered by "general revenues" and that increases in water charges would represent an "excessive" burden on farmers who are already overtaxed.

**Process of Price Formulation.** The growing strains on the country's and sector's economic performance as outlined above, the increasing complexities and uncertainties of the world market, and GOP's intent to maintain its export competitiveness, lead GOP to be receptive to establishing an institution that would help guide agricultural pricing policy strategies and decisions of key inputs and outputs. Since this responsibility, except for setting irrigation water charges, belonged to the Federal Government, it was feasible for GOP to address the above institutional pricing issue.

**Bank Lending Operation**

The above three agricultural pricing issues, along with other key sector issues not included here, were addressed by the Bank-assisted SAL I operation. It was identified in about early 1981, approved by the Board in mid-1982 (US$140 M
Loan/Credit), and was supported by a Technical Assistance (TA) credit (US$7 M credit).

The main origins of the agricultural pricing conditionalities included under SAL I can be traced to the RAP recommendations, GOP's NAP statements, a Bank-supported operation approved earlier, and an irrigation sector project being processed at about the same time as SAL. The IDA-assisted Fertilizer Import Credit (US$50 M equivalent) was identified in late 1979 and approved by the Board in mid-1980, and included the following main pricing conditionalities: phasing out fertilizer subsidies by mid-1985; periodic reviews of progress and effects of phasing out such subsidies; periodic reviews of output prices and agreement to provide adequate producer incentives; and agreement to establish the Agricultural Prices Commission. Given that the Fertilizer Imports Credit was closed (9/82), and that GOP was still in the process of phasing out fertilizer subsidies and establishing/strengthening the APCOM, the Bank included these items under the SAL operation.

The IDA-supported Irrigation Systems Rehabilitation (ISR) Project had its origins in the RAP recommendations, and provided funds (IDA Credit of US$40 M) to each of the four Provinces for deferred irrigation maintenance, equipment, and technical assistance. Given the sectoral nature of this operation, it included two covenants that were closely interrelated and agreed with each Province, involving: (a) provision of targetted irrigation O&M funding levels of the surface irrigation system through FY85; and (b) increase in water charges periodically or making other appropriate financing arrangements to achieve full cost recovery of irrigation O&M expenditures according to agreed target dates for each of the Provinces. Except for Baluchistan, the dates had already been agreed under previously approved IDA-assisted projects located in each of three Provinces. The ISR Project was processed at about the same time as the SAL operation. ISR negotiations were about six weeks prior to SAL negotiations; GOP's Federal Secretary of Water and Power was a member of GOP's delegation under both operations. Therefore, to a certain extent, these two operations were mutually reinforcing.

SAL covenants included essentially the same ones agreed under the two IDA-supported operations cited above, with the following main additions: (a) while SAL did not include an additional covenant on fertilizer pricing, as recorded in the minutes of negotiation, GOP agreed to review further financial measures to reduce the fertilizer subsidy, including target levels from FY83-85; (b) the irrigation cost recovery covenant introduced a definition of periodic increases in water charges, meaning, "at intervals of not more than two years, subject to any necessary legislative approval"; (c) the measures to strengthen the role of APCOM and its work program were discussed extensively and agreed, and supported with funds from the TA credit.

The related objective of providing a quick disbursing operation was achieved by the SAL operation. Out of the US$140 M Credit/Loan, $90 M was disbursed at credit effectiveness (fall of 1982), and the $50 M was fully disbursed during the first half of 1983 following the Bank's second tranche review mission.
GOP Receptivity, History of Negotiations, Political and Administration Context

In general, GOP was quite receptive to the SAL operation, partly because it involved reconfirming and refining policies and agreements it had adopted on its own and/or through earlier IDA-supported projects. This was also an important political consideration, since the military-backed Government was under some political pressure to hold national elections and did not want to give the impression that the Bank was "dictating" policies or having "undue" influence on sovereign and sensitive matters, such as pricing policies. This political context influenced partly GOP's unsuccessful attempt during negotiations to re-negotiate the fertilizer subsidy target of mid-1985, particularly considering the SAL agreement to increase substantially the domestic price of natural gas, therefore, making it more difficult to phase out subsidies by the agreed date. The Bank's efforts to get the GOP delegation to clarify during negotiations the significance of "other appropriate financial arrangements" was unsuccessful partly because this wording had been reached already during negotiations of the ISR Project held only six weeks earlier, and more importantly, because this was a Provincial matter. None of the Provincial officials participated directly in the formulation and negotiations of the SAL operation. Regarding the agreements reached for APCOM, there was full agreement between Bank and GOP, which was facilitated largely because APCOM was a federal entity and was expected to assist GOP address some of the dilemmas inherent in pricing policies.

Implementation of the Conditions

The main pricing action required prior to the Bank's second (and final) tranche release was GOP's submission of a report regarding its agricultural input/output pricing decision for the 1982/83 winter cropping season. This report was submitted on a timely basis and it informed the Bank of GOP's decision to increase fertilizer prices by an average of 15% and wheat procurement price by 10%. The Bank's main mission to monitor GOP's progress in fulfilling the SAL agreements, including the pricing covenants, was conducted in late 1982 in the form of a second tranche review. Although the mission reported satisfactory progress, the Aide Memoire left with GOP identified further actions required by GOP to maintain satisfactory progress over the following year. Partly because of Bank staffing constraints and to deferral of the proposed SAL II operation, the Bank has not maintained formally its supervision and dialogue of the SAL I agreements. Further analyses and discussion of the agricultural pricing issues, however, have been conducted through sector work and project lending operations. Since the tranche review mission nearly two years ago, GOP has fallen somewhat behind in phasing out fertilizer subsidies, partly because of factors beyond its control (e.g. depressed world market output prices, poor weather, pest attack). Continued progress in raising irrigation water charges has varied according to Province and has been influenced by the recent introduction of an agricultural Islamic levy ("Ushr"), a poor crop in the last year, the upcoming national elections and resulting uncertainties. APCOM staffing levels and work output generally have progressed satisfactorily.

Future Expectations of Implementation and Future Related Policy Conditionality

Based on past performance and current policies, it is expected that GOP will continue to implement the pricing agreements reached under SAL. However, it is possible that in practice the pace of reaching the agreed targets may extend
beyond the target dates originally agreed due partly to unforseen events and the inherent difficulties of implementing politically sensitive issues. For example, O&M funding levels correctly have increased substantially in real terms after the target dates for full recovery were set by the earlier Bank assisted projects approved in the late 1970s, therefore introducing an unforseen "moving target" in the recovery covenant. Also, GOP has not yet clarified how Usfr funds collected from farmers are to be used. This situation, coupled with GOP's continuing need for sound policy advice and encouragement on each of the above pricing decisions, provides the Bank with the opportunity to continue its policy and technical dialogue with GOP, as well as the basis for follow-up policy lending during GOP's process of structural reform in the agricultural sector. Currently, the Bank and GOP are in the early stages of preparing a proposed Agricultural Sector Loan. Notwithstanding GOP's progress toward implementing the above pricing issues, it is expected that further refinements and monitorable action plans for each of the issues, along with other conditionality involving investment priorities and institutional improvements, would be included in the proposed operation.

Lessons Learned and Recommendations

**Government Receptivity and Required Follow-Up.** Inclusion of and overall satisfactory progress in each of the pricing policies cited above in a policy based lending operation was possible primarily because: GOP had taken favorable policy decisions prior to the operation's negotiations, some of which were influenced by the Bank's previous policy and technical dialogue; and of GOP's need for quick disbursing foreign exchange resources. These preconditions made it possible for the Bank to introduce an action program to encourage Government to implement essentially its own policies. Experience shows, however, that the time frame for implementing most of the policies extends beyond the disbursement period. Therefore, there is a need for the Bank to follow-up by using various instruments -- sector studies, project and non project lending -- to strengthen both the technical and policy dialogue with Government and to ensure adequate progress toward implementing the agreed policies. At the same time, policy-based lending should not be based merely on repeating or renegotiating past covenants unless there are justified reasons or a dated monitorable action program not covered by past operations. This suggests the need to ensure that policy-based lending remains focused and based on sound technical and policy analysis, and supported by adequate Bank staffing arrangements.

**Formulation of Issues and Administrative Arrangements.** The SAL experience also highlights the importance of being selective in the issues addressed and broadening the policy dialogue by involving the concerned agencies during the formulation and implementation period of the agreed covenants. In Pakistan, this is complicated by the fact that agriculture and many of its issues, such as irrigation cost recovery, are essentially a Provincial responsibility. Even the setting of fertilizer and output prices, which is primarily a decision made by the Federal Government, needs to consider the views of each Province and various affected groups that exert considerable political pressure.
The Crisis of 1978: Background

The rapid accumulation of capital in Arab oil exporting countries following the oil price rise in 1973, the goodwill generated by measures taken in 1972 by the Government of Sudan to end the eighteen year old civil war and the expectations of developing Sudan into the "bread basket" of the Arab world led to an unprecedented flow of capital into Sudan in the first half of the seventies. The freedom given to autonomous Sudanese entities to contract foreign loans without clearance from the Ministry of Finance or Central Bank, the attraction of "prestige" projects which did not generate income needed to repay foreign debts and the failure of Government to raise domestic savings to support such investments (let alone existing capital) led to imprudent borrowings on one hand and lack of repayment capacity on the other. Even though by the mid-seventies such capital inflows had slowed down, Government continued on its capital intensive development track, having recourse to indiscriminate commercial borrowing and drawing down heavily on foreign exchange reserves. Concurrently, there were pervasive problems developing in Sudan's cotton sub-sector such as neglect of maintenance of assets, shortage of machinery and other farm inputs and lack of producer incentives, affecting foreign exchange earnings from the principal export crop of the country.

Irrigated cotton production started with pumped irrigation along the Nile at the turn of the century, and the first large scale gravity irrigated agriculture project was started in the 1920's in the Gezira, which is now, with an area of over 2 million acres, the world's largest irrigation scheme under single management. The Bank helped develop the Managil extension of the Gezira (cofinanced with the Bank of America) and the Roseires storage on the Blue Nile, both in the late fifties/early sixties. Using Roseires storage, the Bank also developed the 300,000 acre Rahad scheme in the seventies. The Bank intensively studied all aspects of the Gezira Scheme in the mid-sixties (the well-known Rist Commission), but the study did not lead to a project because of lack of agreement with Government on the recommendations of the Commission.

Today, more than 4 million acres are under irrigation using Nile waters, with over a quarter of the area under cotton. The six major schemes are operated by agricultural parastatals and are divided into around 200,000 tenancies of uniform size within each scheme. The parastatals provide most inputs and machinery services, the Ministry of

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Irrigation (MOI) supplies the water and the tenants supply the labor, tend the crop, apply irrigation water, pick the cotton and transport it to the ginnery. The ginned cotton is handed over to the Cotton Public Corporation for sale in world markets.

The production of cotton declined sharply in the seventies, dropping to 306,000 tons of seed cotton in 1980/81, compared to 659,000 tons in 1974/75. The cropped area fell by 13%; the rest of the fall was due to lower yields. The dominance of cotton in Sudan exports is demonstrated by the fact that its share was 56% even in 1980/81.

The main reasons for the decline in cotton production and productivity, were:

first, low and declining producer prices and incentives. This resulted from: (a) overvaluation of the exchange rate; (b) export duties on cotton; (c) an unofficial export tax imposed by the exporting parastatal through its margin, which was transferred to Government; (d) a revenue sharing formula between Government, the parastatal and the tenant (known as the Joint Account and operated for over sixty years) under which Government siphoned off 36% of total revenue as its share and the balance was distributed in a manner which imposed a penalty on the more productive tenant; (e) delays in payments to tenants, sometimes for as long as two years, diminishing the link between effort and reward; and (g) the further bias created in the minds of tenants against cotton, because input costs of other crops (groundnuts, wheat and sorghum) which were privately marketed were recovered from cotton revenues since cotton was marketed by a parastatal and it was easier to collect dues through this system.

second, shortage of the foreign exchange and local currency required by the parastatals and MOI to replace and maintain assets and run their operations. This resulted from: (a) low cotton prices, leading in turn to shortfall in recovery of costs; (b) diversion of Government budgetary resources to new investments rather than providing for maintenance; (c) an overall shortage of foreign exchange; and (d) neglect of the maintenance and rehabilitation requirements of existing schemes by external development agencies, which preferred to invest in new projects.

third, poor performance of parastatals. This resulted from: (a) the flight of senior and skilled personnel to the oil producing countries where job opportunities were much more attractive; (b) poor and inadequate management, handicapped by civil service rules and procedures and supported by weak information and accounting systems; (c) government interference in the working of these parastatals; (d) traditional hostility, now heightened by performance failure on the part of both, between the agriculturalists running the parastatal and the irrigation engineers running MOI preventing the needed coordination of water supply activities; (e) inefficiencies in the provision of agricultural services by the parastatals leading to low rate of application of known technologies; and (f) severe pest
infestation in cotton, difficult to control with the available technology.

Fourth, inappropriate division of functions and responsibilities between the parastatal and the tenant. This resulted in the tenant having very little say in decision-making at the farm level thereby diluting the link between the tenants' own efforts and the level of their output—which depended largely on the performance of the parastatal.

The following extract from a BTO of a Bank Identification mission for the Gezira project captures the flavor of the situation obtaining in June 1979.

"Present Status. The Gezira Project is in poor shape with conditions in the Managil extension (financed by the Bank in the sixties) being distinctly worse. Irrigation canals and drains are very badly silted. A comprehensive drainage system is conspicuous by its absence, impairing productivity, efficient water use, human health and the road network. Both irrigation and agricultural machinery are being underutilized for want of spares. Depreciation of equipment based on historical costs has prevented adequate accumulation of capital resources for replacement. Besides, such funds have been diverted for use as working capital. Again, the demands of other projects and paucity of resources at Governmental level have prevented budgetary transfers for investment; the profit sharing system in vogue also does not provide for build-up of investible funds. Therefore, replacement of overaged equipment has not taken place systematically for want of funds. Field water management systems have been disrupted by total breakdown of the telephone system and the water indenting mechanism is non-functional. Crop cultivation techniques require considerable improvement. Input services and machinery systems have been overstrained by the burden imposed by intensification of area during the mid-seventies, and lack of investment has compounded the problem. Processing machinery has deteriorated while marketing arrangements call for considerable streamlining. Transportation of fuel and inputs into the area is a bottleneck, because the Sudan Railways has almost ceased to handle traffic beyond Khartoum and road transport vehicles are difficult to secure. The Gezira Light railway too is in disarray with overaged equipment and lack of spares. A sense of helplessness pervades the once dynamic Sudan Gezira Board and this loss of morale and deteriorating operating conditions are mutually reinforcing."

The Crisis of 1978: Government Response

As a result of the various developments detailed above, by late 1978 the balance of payments situation reached crisis proportions, with the current account deficit reaching 12% of GDP, external debt rising to four times annual exports and the debt service ratio crossing the 40% mark. Faced with this situation, Government reconsidered its development strategy and embarked on a Financial Stabilization Program (FSP) developed with the IMF and an Export Action Program (EAP) prepared with Bank involvement. The IMF and Bank then worked closely with Government on the formulation of a medium term economic recovery program, designed to achieve stabilization and structural change through emphasis on rehabilitation, export growth and
import restraint. The Consultative Group mechanism, with the Bank in the lead, and rescheduling of debt exercises through the Paris Club arrangement and commercial bank involvement were activated. While the FSP targets were in terms of GDP growth rates, inflation rates, levels of current account deficit and external payment arrears, the target of the EAP was to achieve a 7% annual growth in the volume of cotton exports during the period 1979/91. The EAP envisioned (i) an injection of external assistance to satisfy the immediate import requirements of the major irrigation schemes, (ii) a series of rehabilitation projects in the 1980's covering all major irrigation schemes, and (iii) policy and institutional reforms directed at removing the major constraints inhibiting higher cotton production and productivity.

The Bank Intervention

On receipt of President Nimeiri's request for program assistance in September 1978, the Bank laid down three pre-conditions for processing a program credit: first, agreement with the IMF on the EFF; second, agreement with the Bank on a three year public investment program; and third, agreement with major creditors on the debt problem. Government registered satisfactory progress in these areas, and the ARP I Credit was appraised in July 1979. Conditionality relating to events up to signing covered continued progress in these areas, progress on procurement start-up activities and the revision of the EAP to reflect appraisal mission recommendations. ARP I was approved in March 1980 and May 1980 for the IDA and EEC Special Action Fund contributions of US$65 and US$11 million respectively. IDA declared the project effective on May 12, 1980. The Bank also revised its lending program to reflect the EAP, and projects to rehabilitate the major irrigation schemes and provide continued program support were included.

ARP I

ARP I was born before the SAL was fully conceived and was designed as a hybrid between a Program Credit and a traditional project, with greater emphasis on policy conditionality than either of its precursors. Its policy conditionality can be grouped under three areas: the first, relating to progress on the stabilization program worked out with the IMF, the second dealing with short-term supply side priorities such as producer incentives, improved performance of parastatals and quick injection of investment and the third covering the medium term structural changes needed in the dominant cotton sub-sector as envisioned in the EAP. The first and third areas were pre-conditions for the credit and continued to be monitored during the implementation period, particularly during second tranche release. These areas reflected a meeting of minds between the Government and the Bank on both the short term adjustment process and the medium term structural reforms. The first area naturally involved specific decisions and actions while the third area dealt with a general approach to sector development issues without the comprehensiveness or rigour involved in a pure SAL operation. In the second area, ARP I provided technical assistance and an opportunity for Bank staff involvement in three key studies in the areas of (i) cotton pricing and marketing, (ii) production relationships and cost recovery, and (iii) Government supervision and support of parastatals. Also, agreement of Government had
been secured prior to approval of ARP I by the Board that production relationships "need to be restructured" to make growing export crops more attractive, to reward those producers with higher yields and to ensure adequate cost recovery; but the specific actions and mechanisms were expected to emerge from the studies. Further, on the investment side, ARP I preparation documents had spelt out to the last detail a list of around 2,000 items of equipment, machinery and spare parts to be procured. The credit was tranched to safeguard against failure of the studies to produce desired results, among other risks.

Results of ARP I

Government actions emanating from the studies and dialogue triggered by the IMF and the IDA Credit operations exceeded expectations. These included abolition of the export tax on cotton, improvements in the exchange rate applicable to cotton exports, application of export parity principles for determining the domestic cotton price, replacement of the Joint Account system by the Individual Account System for each crop, announcement of producer prices prior to harvest and prompt payment for cotton supplied by tenants. As a result, the tenants' for the first time in over half a century, were able to estimate incomes from cotton reliably since distortions caused by uncertainty over prices, unpredictable cash flows and adjustment of non-cotton costs against cotton sale proceeds were eliminated. Besides, the tenant was placed in a position to lobby for and negotiate a price for cotton and thus secure an adequate price, unlike in the past, when implicit and explicit imposts on cotton denied producers their legitimate share. These far-reaching measures combined with the targeted injection of US$70 million worth of equipment and spares and stable weather conditions resulted in the spectacular revival within two years of cotton production in Sudan shown below:

Table: Production and Yield of Seed Cotton in Sudan

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (000 tons)</th>
<th>Yield (kantars/feddan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980/81</td>
<td>306</td>
<td>2.2</td>
</tr>
<tr>
<td>1981/82</td>
<td>461</td>
<td>3.7</td>
</tr>
<tr>
<td>1982/83</td>
<td>573</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Bank missions to Gezira in 1983 noticed the mirror image of what the June 1979 mission reported: tenant prosperity, keen tenant interest in the cotton crop, clean canals, farm machinery operations in full swing and high staff morale; ARP I had been a resounding success.

Ingredients of ARP I Success

These can be briefly described as follows:

First. The selective approach taken to secure immediate actions which were "specific, time bound and monitorable," on the most serious constraints to adequate cotton production paid rich dividends. The actions taken covered the establishment of an adequate domestic producer price for cotton, the elimination of tenant bias against cotton caused by the Joint Account System, prompt payment to tenants for cotton supplied by them and
injection of urgently needed spare parts and equipment. These actions formed part of a framework developed for dealing with several of the other constraints in a systematic way in the medium-term through appropriate lending instruments and it was this framework which helped identify the most serious constraints for attention first.

Second. On both Cotton Pricing as well as Cost Recovery, sector work was carried out by Sudanese task forces or committees. Participation of Bank staff and foreign consultants was based on a genuine Government request; it was not imposed. The participation was limited and low-key. The calibre of the task forces, particularly the competence of its Chairman, were the key to the success of this approach. Further, the building of a national consensus on these contentious issues was encouraged by Government and facilitated by broad-based Sudanese participation in the task forces. Without this, it would have been impossible to foster changes in a sixty year old system which was resisted by Government and the tenants alike since the Rist Commission advocated them in 1966. Changes, when experimented on Gezira in 1979, triggered a tenants strike because reforms in cost recovery were not meshed with reforms in output pricing and tenants were not given the opportunity to fully appreciate the implications of the reforms.

Third. IMF played a key role in persuading Government to change existing systems and while their work on cost recovery and the relationship between exchange rates and supply responses in the cotton sector was truly monumental, the inherently directive style of IMF operations resulted in Government initiating the change before all the actors involved were persuaded and all the complementary actions needed were taken. This led to the costly tenants strike mentioned above. However, a supportive Bank style combined with the directive IMF style and proper coordination between IMF and the Bank produced the desired results the next year.

Fourth, within the Bank, the operating staff of different departments spoke with one voice. This meant that clear signals were given to the other donors, to the IMF and most importantly to the Government. Such harmony within the Bank is unusual because the Bank's internal organizational design, with the split of Bank staff into Programs and Projects all the way down below the RVP, works against this. In fact, unless Projects and Programs working level staff forge a common view on an issue, matters get escalated with little result till the RVP level is reached. The absence of a manager empowered to overrule both Projects and Programs staff at a lower level than RVP - a level at which adequate time can be given to gain sufficient knowledge of the subject matter, is a serious problem in the Bank. Fortunately in the ARP I operation, there were hardly any instances of disagreement at the operating level and there was a common perception and understanding among key staff of the socio-economic framework and the political forces at work.
Fifth, Government's commitment to speedy procurement backed by teamwork between PAS, Projects and Programs led to the design of perhaps the most successful procurement operation in Africa despite problems in recruiting technical assistants conversant with bank procurement rules and procedures. The procurement of in a two-year period of over 2,000 items of spare parts and equipment worth over US$70 million was an impressive achievement by the Government.

Sixth, the processing speed and design flexibility marking this operation was an important factor contributing to its success.

**ARP II and Other Projects**

Building on the success of ARP I, IDA rehabilitation projects for the Gezira Scheme, the New Halfa Scheme and a project each for the White and Blue Nile pump schemes were appraised during 1981/83 and are now under implementation. A Cotton Processing and Marketing project and a Research, Extension and Training project have been appraised in FY84. All these projects support the Export Action Program; conditionalities in these projects address those constraints facing the cotton sector which can be eliminated only in the medium run - aiming to achieve better management, an improved research and extension approach, a more meaningful role for the tenant, the resolution of technical problems facing cotton and other crops on the irrigated schemes, the development of better farming systems, and the improved processing and marketing of output. These projects have strong conditionalities in them in order to preserve and maintain the gains of ARP I in the area of producer incentives. ARP II was developed against this background, to provide critical recurrent inputs (fertilizers, pesticides, herbicides) for the cotton crop, with conditionality focused on continued performance on the financial stabilization program and the Export Action Program. The Credit of US$50 million was proposed in October 1983, appraised in February 1983, and approved by the Board in June 1983. It was fully disbursed within a year of effectiveness despite formidable procurement problems involved in pesticides in regard to measurement of cost-effectiveness and environmental hazards. Specific conditionality in the Credit related to improved aid coordination, better access for schemes to needed foreign exchange for recurrent inputs, improvement in the cost-effectiveness of pesticide operations (the largest single cost item in cotton production) and improvement in the management information systems of key parastatals. Since the period covered by ARP II was only one year, its success in terms of solving problems covered by its wide-ranging conditionality was limited, but its covenants were honored by the Government and it reflected credible Bank support to maintaining the momentum of policy reform. The Government updated its medium term recovery program and gained widespread support for it during the CG meeting held in December 1983. Cotton production and productivity increases continued to be impressive reaching levels forecast in the Export Action Program and the Economic Recovery Program reached its high-point.

**The Crisis of 1984**

The lending program envisioned an ARP III project in FY85 to finance recurrent inputs needed for the 1985/86 season and to encourage further progress on the Export Action Program. Processing of this project
began in late 1983 and agreement was reached (after six months of work on reconciling differences) between Programs and Projects that conditionality on the credit, besides focussing on areas supported under ARP I and II, should also address certain specific national level problems encountered in the implementation of ongoing IDA projects and encourage the Government to pay greater attention to diversification into rainfed mechanized and traditional farming. In the meanwhile, conditions in Sudan began to decline from the beginning of 1984 and to nose dive from April 1984 and Sudan is now back again in a crisis situation - The Crisis of 1984. The sudden introduction of Islamic Law led to disruptive consequences such as replacement of several existing taxes by a Zakat tax and welfare system, alienation of the South, abolition of interest etc, which has thrown the Economic Recovery Program off-track and jeopardized the gains of ARP I and II. The Bank has found it difficult to conduct a productive dialogue with Government because the division of economic decision-making powers between the Minister of Finance and the Governor of the Central Bank, both reporting directly to the President, has resulted in conflicting signals emerging from Government. Besides, levels directly below the President appear to be unable to fully comprehend his decisions. The escalation of law and order problems in the south destroyed expectations of crude oil exports in the late eighties – a critical assumption of the debt rescheduling exercise. The imposition of a state of emergency with reports of inequitable punishments instantly meted out by "courts of prompt justice" created panic and was accompanied by a flight of capital from Sudan, particularly savings of traders. Drought conditions worsened in Sudan and the rainfed crop failed for the third year in succession. On top of all this, Government failed to negotiate an IMF standby operation being unable to comply with IMF recommendations on the stabilization program for political reasons. Also, Government fell in arrears in repayments to the IMF (expected to reach US$80 million by end '84) with little prospect of these arrears being cleared in the coming months.

With the financial stabilization program off-track, the rationale for ARP III disappeared. The Export Action Program has been jeopardized because (i) the current overvalued exchange rate is unlikely to yield an acceptable cotton producer price for 1984/85 and this might destroy incentives for cotton producers, (ii) cofinancing arrangements for major irrigation rehabilitation projects have broken down since Government has defaulted in repayments to several donors, and (iii) in the absence of ARP III and a viable framework for economic recovery and debt rescheduling, external assistance of the program type to finance recurrent inputs for the next year's cotton crop may not materialize.

The Bank's Dilemma

The Bank has encouraged Government to use Donor financing for critical agricultural inputs, rather than earmarking of a portion of export earnings for import needs of export-oriented projects in order to safeguard IDA investments. The Bank however finds itself unable to finance recurrent inputs or urge other donors to do so unless the Economic Recovery program is brought on track once again. Yet, if recurrent inputs are not financed, cotton exports will drop and the economic recovery program will go further off-track. Also, promising and hitherto successful IDA projects in the irrigation sector would most likely come to grief for lack of inputs. To
be in a position to finance recurrent inputs, donors would need to come to an understanding on the macroeconomic program with Government, which is difficult to achieve in the absence of an IMF program. Equally elusive is the answer to the question: Who is in charge of economic policy making in the Sudan?

At the time of writing this paper (December 2, 1984), it is not clear whether the ARP operations in Sudan can be salvaged or must be recorded as an operation that was successful though the patient ultimately died.

Some Areas of Concern

The purpose of this paper is limited. It sets out experience gained from the Agricultural Rehabilitation Credits in Sudan in order to facilitate a broader discussion on policy based lending in the agriculture sector. In the context of this wider exchange of views, it is appropriate to mention four issues which impinge on the efficient use of Bank internal as well as lending resources.

First, should the Bank lend large sums of money on IDA terms for recurrent inputs which do not create lasting assets but yield only "one shot" benefits? Should and can such benefits be earmarked for application to pre-determined uses e.g. financing the next round of inputs, repaying creditors etc.? With the advantage of hindsight, would it have been appropriate for the Bank to have insisted on earmarking of export revenues in the ARP II case for financing critical recurrent imported inputs in order to safeguard past Bank investments? To what extent can production projects supporting the economic recovery program in a country be insulated from the risk of collapse of the program itself?

Second, is the design of the organization structure of the Bank which divides authority and responsibility for policy based lending between regional projects and programs departments optimal, having regard to the demands placed by our dialogue with the borrower, coordination with the IMF and rapport with other donors? Does the departmentalization lead to failure to resolve conflicts at a level where full knowledge of the issues involved and the required time is available? Does it lead to lack of integration between economic work and sector work? Does it result in conflicting signals to Governments and other co-donors? Should the new emphasis on country focus lead to the integration of the two departments at say the Assistant Director level rather than the Vice Presidential level, with Directors performing the role of the Vice President within a sub-region? How should those project divisions which cannot be split on a sub-regional basis be handled? Why has reform of organizational design in the Bank not kept abreast with the recent flurry of activity in systems, leadership development, product mix, human resources development and physical resource management?
Third, should the Bank encourage more sector work by Borrower officials and institutions by themselves or jointly with the Bank, allowing the country to work through their own problems rather than work them out for them and confront them with solutions? Should the Bank pay greater attention to building policy capacity and data bases in the country rather than within the Bank itself? How should local efforts be underpinned by technical assistance of the "right" type? What is the profile of the successful Technical Assistant in the policy area? Do Bank staff have adequate insight into the political constraints facing policy makers in our countries and their non-economic aims? Is the present staff profile in the Bank appropriate for the emerging tasks?

Fourth, is there a danger that the alleged "overdesign" of Sector and Project work in the Bank would extend to policy lending? Can the trend of Bank staff resources being increasingly applied to the internal Bank process rather than problem-resolution in the country be reversed? Will the concern that "SAL's lack an articulated framework for policy analysis comparable to the one for project evaluation" lead to the heavy hand of bureaucracy stifling the innovation and dynamism that policy lending potential offers to Bank staff and lead to products that are intellectually immaculate rather than those that will work? How should the trade-off between rigor and flexibility of design be addressed in the new Bank product?
PHILIPPINES: AGRICULTURAL SECTOR/INPUTS PROJECT
by
John Macgregor*

This paper describes the Agricultural Sector/Inputs Project of the Philippines, the process of its evolution, its current status and a number of observations and lessons based on the project which are relevant to prospective future policy based lending operations.

I. The Project

The project has three major objectives: first, to help maintain agricultural production by ensuring a supply of imported inputs; second, to introduce or identify policy reforms which would improve efficiency, restore incentives or mobilize financial resources for agricultural development; and third, to improve the institutional framework for the formulation and implementation of agricultural policies and programs.

The first objective is to be met by providing nearly US$150 million for the importation of feedgrains (about US$50 million), fertilizer (about US$45 million), agricultural machinery and spare parts (US$20 million), pesticides (US$15 million), veterinary products and biologics (US$14 million), breeding stock (US$4 million) and vegetable seeds (US$1 million). The import needs of the sector go beyond this, of course; loans from the ADB, the U.S. Commodity Credit Corporation and Ex-Im Bank, the Japanese OECF and other bilateral agencies cover the remaining import requirements.

The second and third objectives are to be met by a package of agreed reforms and studies carried out between loan negotiations and the release of the second half of the loan (which is to be disbursed in two equal tranches). The reforms are as follows (completion dates in parentheses):

(a) Reorganization of the Ministry of Agriculture into a Ministry of Agriculture and Food (MAF) with new responsibilities for fisheries and national food policy planning (Board presentation);

(b) Representation of the MAF on the Boards of the Philippine Coconut Authority and Philippine Sugar Commission (Board presentation);

(c) Removal of price controls on poultry, eggs and pork (prior to second tranche release);

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(d) Opening up to private entities the import and export of animal feeds (prior to second tranche release); and

(e) Reduction of import tariffs on poultry (prior to second tranche release).

In addition, the Government undertook to prepare a prioritized consolidated public investment plan for the agricultural sector (1985-88), with an associated budget. It also undertook a two to three year program to install within MAF the managerial capacity and systems necessary to carry out its expanded responsibilities. Finally, it undertook to complete six policy-related studies prior to second tranche release, in the following areas:

(a) **Coconuts**: to determine the extent to which present institutional, marketing and processing arrangements are efficient and equitable, and propose improvements;

(b) **Sugar**: like the coconut study in general objectives, but with emphasis on sugar industry-specific issues;

(c) **National Food Authority (NFA)**: to evaluate NFA’s policies and performance, propose improvements and specify the steps to implement recommended changes;

(d) **Fertilizer**: to assess the efficiency of the present distribution system and policies, and propose improvements;

(e) **Irrigation**: to assess the viability of the National Irrigation Administration (NIA) under different policies regarding irrigation fee structure, crop diversification, debt servicing requirements and support of system operation and maintenance; and

(f) **Agricultural Credit**: to determine how best to increase the volume of agricultural credit and reduce the average cost of delivering it to farmers.

II. Evolution of the Loan

The economic situation of the Philippines has deteriorated seriously in the last few years. A host of economic problems which need not be detailed here converged to create a full-blown crisis in 1983. The situation was of particular concern partly because of the threat it posed to ongoing development efforts and the risk that agricultural production would be crippled by shortages of imported inputs, which would perpetuate and worsen the crisis. At the same time it was clear that the Government was more interested in policy and institutional reforms than it had been in the past. These concerns and this opportunity lay behind the project that eventually took shape.

**Identification.** Initial discussions of a possible project began in the Bank in August 1983. The Government’s interest in a quick-disbursing loan with policy conditions was confirmed at the Bank-Fund Annual Meetings in September. The identification procedure began in
earnest immediately thereafter. The major emphasis was on assembling a menu of potential policy and institutional reforms. Fortunately, past sector work in general agriculture, irrigation, credit and agricultural pricing suggested a wide range of possibilities, which was supplemented by information from recent policy dialogue with the Government and by experience with ongoing projects. Identification also involved assessing which imported inputs were appropriate for Bank financing, the optimal length of the project, the means of channeling funds, etc. Projects and Programs staff worked jointly on these questions of mechanics as well as on loan policy questions.

Guidelines. Before the preparation mission departed in November, Regional management laid out several guidelines:

i) Objectives should be clear and include institutional reforms.

ii) Reforms effects (magnitude and incidence) should be identified.

iii) Loan conditions should be amenable to immediate, monitorable action.

iv) Some major policy and institutional changes should be introduced prior to Board presentation.

v) The size of the loan should depend on the domestic momentum to take decisive actions and on the expected disbursement period.

vi) Other major ODA sources (particularly ADB and USAID) should be brought in with us on the policy package.

vii) The loan must be linked with provision of adequate local funds for ongoing Bank projects, which requires that IMF agree to treat our loan resources as additional to those already counted in its reckoning of foreign exchange available to the Government, such that they exactly balance the increase in expenditures which provision of more local counterpart funds would entail.

Applying these guidelines to the reform possibilities already identified, the mission saw the ingredients for an unusually effective loan which would not only achieve substantial reforms but also facilitate ongoing projects. The mission later found that it could not adhere strictly to some guidelines -- of particular note, time was too short to assess reform effects, and IMF was unwilling to consider the proposed Bank loan as falling outside the scope of the budgetary guidelines agreed in connection with its standby agreement.

Preparation/Appraisal. The preparation and appraisal missions worked in an atmosphere of urgency which permeated the upper levels of the government agencies with which they dealt. Bleak economic conditions probably helped to improve the Government’s acceptance of the proposed policy and institutional reform ideas. As preparation proceeded these ideas evolved from a lively debate between the mission and our hosts. After assessing the gaps in our data or analysis, and the political sensitivity of some of the proposed reforms, we agreed to policy-oriented studies in
six areas noted above. These studies are needed in order to establish a firm basis for reforms in the six areas. Several reform proposals formed the basis for official expressions of government policy and intent which appeared in a wide-ranging Agenda for Action in Agriculture rather than as loan covenants.

Internal Processing. Report preparation went quickly. The biggest questions encountered prior to negotiations concerned not policy conditions but what the loan would finance and how. After a lengthy internal Bank debate, vigorous objections to the financing of feedgrains were overruled. Long discussions on procurement of proprietary pesticides (for which ICB would normally be used but might yield a result which might not have proved satisfactory in terms of local market needs) ended in a practical compromise. The major issue concerning policy conditions came just before negotiations, when management decided that conditions were too numerous. Therefore we decided to pursue three conditions by other means and went into negotiations with what were called "core" (non-negotiable, more or less) conditions. At negotiations the core conditions, slightly modified but basically intact, were agreed upon.

Soon after negotiations, the Government informed us that it could not meet an agreed condition of Board presentation, that the Minister of Agriculture be made Chairman of NFA. It explained that the same goal (of inter-institutional coordination) was to be attained by transferring NFA's food policy and programs functions to the new MAF, and that it planned to reconstitute NFA as primarily a food marketing corporation. Although this coordination arrangement is less monitorable than the original condition, the Bank accepted it as a good-faith commitment preserving the original intent. Board presentation was delayed over two months to answer Executive Directors' concerns over the adequacy of conditionality. The loan became effective on October 22, 1984, seven weeks after Board approval.

Status of the Loan. At latest report (December 1984), procurement of goods was proceeding at less than half the rate expected because currency devaluations and high interest rates have raised the local prices of inputs financed without a corresponding increase in product prices, and thereby depressed demand. The loan is now not expected to be fully disbursed until the end of 1985. Implementation of studies was on schedule. Initial reports from two relatively sensitive studies (sugar and NFA) indicate that well-reasoned reform proposals may emerge. We plan to review all first drafts in detail and ensure that final versions address all key issues. The sectoral planning exercise and the MAF institution-building program seem to be moving more slowly than was envisaged. The institutional reform conditions are about half met, poultry and pork prices have been decontrolled ahead of our expectations, and the NFA Council has voted to allow private traders to import and export feedgrains. The conditions for second tranche release are likely to be met before April 1985, when the first tranche is now expected to be utilized.

III. Observations and Lessons

Preliminary Evaluation. A cursory review might credit the project with four benefits. First, it provides a necessary condition for the maintenance of agricultural production. Second, it wins desirable changes in
trade and price policy which enhance the prospects for overall agricultural development. Third, through the studies it lays the groundwork for future reforms. Fourth, it provides quick balance of payments support. It is too early to assess definitively these benefits, but experience to date suggests questions about them which are relevant to most similar loans.

**Production Impact.** Maintenance of agricultural production is not the main justification for a policy based loan, but if it figures in loan rationale the demand-supply gap in input financing should be assessed carefully. The completeness of such an assessment will depend on the time available, and the methodology described below may need to be severely curtailed in a loan addressing an acute crisis. On the demand side, it is not enough to project previous years' imports into the future; effects of likely price changes (including effects of the crisis on inflation and interest rates) on demand for production inputs (or demand for final outputs) should be considered. On the supply side, we need to take full stock of other likely ODA and commercial credit. Comparing this with demand projections, we calculate a gap. Can the existing system of foreign exchange allocation be expected to fill this gap? Are expected devaluations or commodity price swings likely to generate more foreign exchange (or reduce other sectors' demand for it)? We may find that in the without-loan case, some or all the foreign exchange needed probably would be made available for so vital an activity as agriculture. In that event, part or all of our loan would be financing something of a lower priority. To the extent that this is the case, it is a good thing to recognize it; it is realistic, and should help us focus our attention on the central rationale of policy reform. In the Philippines case we could have improved our analysis by paying more attention to the likely supply and use of foreign exchange in the absence of the loan. There is evidence that its effect will be more on the balance of payments (and government liquidity) than on specifically agricultural production.

**Reform Benefits.** Much more to the point in policy based lending is the assessment of incremental net benefits of reforms. This task should precede all else since it prioritizes the reforms, enabling us to concentrate our efforts on the highest-yielding ones. Realistically we cannot expect to quantify all reform benefits, particularly for institutional reforms, but wherever possible for policy reforms our sector work should attempt to provide rough estimates.

Following a ranking of reforms, the next logical exercise is to ascertain whether the Government is proposing to implement some reforms even without a Bank loan. If such reforms involve substantial resource costs, these costs might be financed from the loan. But benefits of these reforms are not attributable to the loan, and to the extent that they cost the Bank some bargaining power in winning other reforms, these reforms should not be subjects of loan conditions. In the Philippines case, the discussions during (and preceding) loan preparation were said to be instrumental in the Government's decision to adopt a two-tier (crop-based) irrigation fee system in order to improve overall fee collections. Discussions following our report on the rural credit system were an important factor in the lifting of interest rate ceilings on commercial rural credit, which also took place during loan preparation. Neither reform was attributed to the loan; each stood on its own merits and was
adopted because Filipinos were persuaded of its value. On the other hand, two reforms (formation of MAF and removal of price controls on pork and poultry products) which were made loan conditions had sufficient government support that they may ultimately have been implemented without being conditions of the loan. The appraisal team's ex ante judgment was that the loan's leverage was necessary for these reforms. The lesson here is, When in doubt about an important reform's prospects for adoption, make it a covenant.

Following up this cautionary stance is one final lesson on reform benefits derived from the Philippines loan. An important achievement of loan discussions was the agreement to open up the import and export of grains (except wheat, for NFA's financial reasons) to the private sector. For the present, however, this reform is still not effective since NFA retains its privileged tariff and sales tax rate at 15% while private importers must pay 60%. We intend to address this issue before the midterm review. The lesson is, When the Government and the concerned agency continue to have reservations about the proposed changes, cover any likely avenues of circumvention in the Loan Agreement.

Studies. The value of well conceived studies, oriented towards identification of feasible reforms and carried out by competent people respected by the Government, should not be underestimated as a means of preparing for future reforms. But absent any of those characteristics, they can cause more harm than good. In the Philippines loan the six studies may have received as much attention in drafting TORs and arranging of review procedures as all the reform conditions combined. We agreed to the Government's use of in-house staff to conduct most of the studies, and provided for review by outside experts where necessary to ensure that all major issues are dealt with adequately. Reliance on government staff to produce the studies seems likely to pay off in terms of government commitment to the studies' recommendations.

Balance of Payments. The Philippines loan is a good example of a dual motivation: it was meant to disburse US$150 million quickly, and it was also meant to provide leverage for several reforms. At times these motives conflicted, and when they did, the strength of what may be called the balance of payments motivation was apparent. The lesson is, The more policy reform oriented research and dialogue is conducted before a crisis-motivated loan comes up, the better the prospects for a strong policy package.

Observations on Policy Based Lending

Efficiency. The following observations reflecting the author's personal views are not derived specifically from the Agricultural Sector/Inputs Project but from general discussions with staff working on policy based loans in all Regions. The premise from which these lessons are drawn is that Bank lending is intended to finance development, and do so efficiently. That means it should maximize development impact per unit of investment. All prospective Bank lending can and should be judged by this criterion, whether it be policy oriented or not, program type or project type. The development impact may be difficult to quantify in many cases, but that does not prevent us from seeking to increase it for a fixed
investment size, or to hold it constant while reducing the investment. We expend untold effort to adhere to this efficiency criterion in preparing and appraising standard projects; it is equally important to do so for policy based loans.

Dilemma. One lesson from our collective experience is that policy based lending faces a dilemma. One horn of this dilemma is that underlying most such lending is the assumption that governments are unwilling to adopt reforms unless they are paid a reward for doing so. If implementing a reform would involve a substantial resource cost, then such a position is justifiable. But if a government (or a powerful interest group responsible for the existing policy) simply disagrees with the reform, how long will it survive after the loan is disbursed? The only case in which we can hope for a reform to survive long is when the reform leads to swift and visible benefits to a part of the domestic polity strong enough to defend the reform against those who perceive themselves to lose from it. Clearly we should be seeking reforms with this potential. The other horn of the dilemma is that in the happy circumstances that a government intends to implement a policy reform which the Bank also favors, there is no incremental benefit to our making the loan conditional upon that reform.

Triage. In many cases there may be no way to avoid being caught on one horn or the other of the dilemma, and policy based lending in either case would violate the criterion of efficiency in fostering development. But in most cases there is another path to policy oriented lending. It begins with a strong country economic and sector work program oriented explicitly toward analysis of existing policies and identification of a very well evaluated menu of possible policy reforms. The second (actually overlapping) step is to present the case for each reform to relevant parties in the country, get responses, correct any errors in our own analysis which may thereby become apparent, present and get responses on any modified reform arguments, and from the responses conduct a kind of triage. Some proposals may provoke strong opposition from powerful groups and could not be expected to survive long after full loan disbursement; some of these should be developed and supported through further research (with the borrower's participation, if possible), variations proposed, and eventually made conditions of a loan when the political or economic climate gives them a good chance of taking root. An alternative approach, which is appropriate if the reform is expected to generate adequate additional domestic support after its adoption, is to present the reform firmly as a loan condition. Other proposals may meet with immediate approval; on these we should wish governments well in making the necessary changes, and offer to help with technical assistance if necessary. We should offer loan financing for reforms which involve substantial costs of adjustment. The third class of proposals comprises those which receive a mixed reaction; for these we should intensify our efforts to convince the doubters that the proposal is worth supporting. Such a policy dialogue, backed up by research by local experts, Bank staff and respected consultants, may occasionally result in a policy change without any associated loan, and that is to be preferred. If it is clear that the borrower is almost evenly divided on the proposal after our best efforts to persuade, then we might raise the possibility of a policy based loan.
Tactics. The principle of maximizing development impact per unit of investment should guide our strategy from this point. This principle has several tactical implications:

(a) Foremost, we should be willing to wait (while continuing an active dialogue) for a policy package that has both a substantial development impact and a good chance of surviving long after the loan is disbursed. Pressure to lend within some preordained time period is the worst enemy of effective policy based lending.

(b) Concomitantly, we should be willing to bargain at the margin. Loan size and tranching should be bargaining tools, influenced more by strength of policy reforms than by balance of payments needs. On reform issues, we should be ready to give up efforts to convince borrowers in some areas if doing so would tip the balance in favor of other reforms of at least equal impact.

(c) We should concentrate on noncrisis issues in our loan-oriented discussions, basic issues whose importance will remain after any immediate crisis has passed. This is most relevant in cases where the loan is sought in connection with a short-term payments crisis, and should increase the chance of agreed policy changes surviving after loan disbursement or after the current crisis has passed.

(d) If possible, we should associate the policy changes with an investment project. A quicker-disbursing alternative is to link policy changes with financing of all or a very large portion of the costs of ongoing Bank-assisted projects (or a subset of them). The rationale for either alternative is that no matter how careful we are in negotiating policy reforms, or how sincere our negotiating partners are in pledging their agreement, such reforms are inherently unstable. They may not be held sacred by future governments or even by existing governments if powerful interests oppose them. By associating reforms with present or prospective projects which stand on their own merits, we are assured of some remaining development effect from our investment should policy changes be undone. Thus, financing such projects serves our purpose as a development finance institution better than financing imports of annual inputs or consumption goods would. The option to increase the Bank's share of costs is a logical extension of the Special Action Program policy of raising disbursement percentages. By speeding completion of projects, many of which may be stalled by lack of local funds, we would be reducing their final costs while bringing their benefits on stream up to several years earlier.

(e) We should match more closely the repayment period of the loan to the payback period of the investment being financed. This principle of finance requires judgment in its application to policy based loans, where "payback" is difficult to quantify and depends on reforms being maintained for at least a certain span of time. It implies, however, repayment periods shorter than those for standard projects.
(f) Finally, once a policy based loan is made, we should be stricter than we have been with traditional projects in enforcing its legal provisions, and inform our borrowers in advance that failure to honor policy related covenants will jeopardize the loan and any similar future loans. This will be nothing new to the borrowers, and in itself probably won't inspire much more discipline in adhering to covenants. Only after we demonstrate our seriousness about covenants can we expect borrowers to treat them seriously.
Section I - Background

Bank Group's Strategy and Constraints to Lending

As you know we have not been active in the Agricultural Sector in Senegal since 1983. Until then, project lending promoted productivity improvements for traditional food and cash crops, together with diversification into new crops and new regions. This effort had led IDA to finance an Agricultural Research Project focusing on agricultural systems improvements, aimed at giving new impetus to extension services and leading to a more integrated approach to rural development in semi-arid areas. In addition to the cotton/food crop project for the rainfed Eastern Senegal and Casamance regions, IDA was also consider support for a Fourth Irrigation Project that would rehabilitate and expand existing medium-sized irrigation perimeters; and new activities in the Groundnut Basin depending on further progress with structural reforms in input distribution, crop marketing an agricultural credit. (see status of Portfolio, Annex 2).

By end 1983, however, it had become clear that it would be very difficult, not to say impossible, to find "bankable" (i.e. economically viable) projects unless fundamental structural and policy reforms were effected. We felt, that:

1) any increase in agricultural production was hampered by the low competitiveness of local products as compared to imports (in particular cereals); the latter pricing out the former;

ii) this situation was as much the result of monetary, institutional and policy causes as the reflection of adverse natural condition (poor resources and drought).

It was therefore decided to hold up temporarily further project lending until agreement had been reached on satisfactory agricultural development strategy, policy and institutional reforms and a program of implementation. The Fourth Irrigation Project was then kept in abeyance pending agreement on reforms of the pricing policy for rice and of the objectives, organization and finances of SAED. We also decided simultaneously to engage in an active policy dialogue with Senegal involving as much as possible the other major donors.

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Evolution of the policy dialogue: achievements and risks

Over the past year the Bank participated in a series of meetings (November 1983, January 1984, June 1984) with the Senegalese authorities and the other main donors (mainly CCCE, FAC and USAID and to a lesser extent FED and IFAD) and in a meeting with President Diouf in March 84 (see Annex 3). These meetings helped to define a series of policy measures to be taken urgently by the Government. The rationale for requiring policy action was as follows: supporting the expansion of agricultural production, while such production is not or only marginally competitive, is too expensive for the Treasury which cannot meet the cost of subsidies combined with the losses of the regional development companies; this situation aggravates the constraints on production and makes less and less possible the foreign financing of low return investments.

The donors' meetings proved quite successful (to be sure at a relatively high price in terms of Bank resources) since they allowed the creation and endurance of a coherent "donors' front", thereby largely depriving the Senegalese of the possibility of playing one donor against another. Through discussions with the various ministries (notably Rural Development, Finance and Plan) and services or companies involved, and the preparation of joint Aide-Memoires by the donors, there emerged a series of concrete recommendations for policy action backed by offers for the financing of the associated adjustment or of the necessary studies. The recommendations revolved around the following basic themes (See section II Policy Issues below):

i) the price of imported cereals, most notably rice, at the consumer's level is defined on the basis of the import price plus a mark up to the benefit of the Treasury, and remains considerably below that of locally grown cereals; it is considered as an instrument of taxation and acts as a disincentive to production. Instead, it should be used as a demand management tool through increases reestablishing a balance with local products;

ii) generally, price relationships have been distorted by subsidies to inputs, price fixation and other Government intervention in the sector. This entails a growing financial burden that can hardly be afforded given the general disequilibrium of the economy, and leads to a need to reduce imbalances and restore incentives to private initiative;

iii) many functions attributed to public companies could be carried out better and at a lower cost if they were given to the private sector.

In the course of the dialogue, the attitude of the authorities, the Ministry of Rural Development in particular, changed from hostile at the end of 83 to quite cooperative in September 84; eventually, the bulk of our suggestions was incorporated in the draft CG
documents. However, many obstacles remain to bring to the implementation stage the reform program which we advocate.

The difficulties which remain in spite of agreement on the objectives to be pursued and the principles underpinning future reforms, must not be underestimated; they stem from:

i) the pluralistic nature of the "Senegalese democracy" where powerful pressure groups of both political and economic nature flourish;

ii) the consequent lack of authority of the Ministers and to an extent even the President, as well as the heads of many parastatals, to enforce changes; (agreement with one or several parties (be it the President himself) does not necessarily entail the genuine commitment of the Government as a whole;

iii) the inefficiency and lack of organization of the bureaucracy where information, ideas, and instructions are slow to percolate, making it possible for low ranking officials to frustrate efforts at a higher level; and

iv) the pervasive "interventionist mentality" of most civil servants; and last but not least

v) the lack of enthusiasm of Mr. Collin for reforms in the Agricultural sector.

We must therefore recognize the somewhat uncertain nature of the "agreements" we reach with Senegal, where delays, unexpected difficulties an even temporary reversals are always to be feared; we must also recognize the risks the President faces in promoting the reforms we advocate, political risks when attacking entrenched habits or privileges rooted in the price - subsidies system, and risks of not being able to deliver because the administration is not able or willing to follow up on his decisions. As a consequence we must show patience and seek only incremental, even though steady progress on the policy front.

There is also some danger that bilateral donors succumb to political pressure and break ranks. So far, only minor differences of opinion or attitude have surfaced, USAID and CCCE (Paris headquarters rather than their Dakar office) remaining staunch supporters of the Bank. We have been extremely careful to maintain complete information and as close a cooperation as possible with other donors, and to assure them of our flexibility and understanding of their (political) constraints.

The New Agricultural Policy

In parallel with the efforts of the donors and partly as a results of these efforts, some basic changes took place in the
government's policies at the initiative of President Diouf. Aware of
the on-going policy dialogue, the President called a seminar to discuss
policy issues with the major donors in March 1984 (see Annex 3 Mr.
Blanchi's memo). Eventually on April 16, and in spite of the opposition
of the Minister of Rural Development, he made a number of policy
decisions which constitute the so-called "Nouvelle Politique Agricole"
(NPA). The minutes of the cabinet meeting during which these decisions
were made are at Annex 4. The basic principle of the NPA is the
winding down (déperissement) of the various public companies in the
agricultural sector to reduce their cost to the budget and increase the
role of the private sector considered more efficient. The major
measures decided cover:

i) reduction of the responsibilities and staff of rural
development companies;

ii) improvement in the supply of fertilizers;

iii) management of the stock of groundnut seeds by the oil mills
(and later the farmers) and consequent disappearance of SONAR,
the parastatal in charge until now; and

iv) creation of a domestic market for local (coarse) cereals.

To be sure, these measures fall short of what we could
consider a satisfactory set of policy principles in that they do not
address the issue of pricing, in particular for rice. They nevertheless
constitute a considerable step forward which should be exploited and
built upon. Further progress should be encouraged, which calls for a
delicate honing of our position, balancing each further requirement
against its perceived political cost and the assistance we can provide.

Section II - Elements for a Sectoral Adjustment Program

A. Policy Issues

The economic rate of return issue One of the major problems
which is at the root of the lack of efficiency and profitability of the
Senegalese Agriculture (and the rest of the economy) is the
overvaluation of the CFA franc; this is a politically loaded question
which we have only raised by implication in our discussions with the
Senegalese authorities and/or the donors. It must be kept in mind that
it will somehow have to be tackled and that ignoring it only makes
matters more difficult in terms of economic policy. A second major
problem is the agreement of the Senegalese Government and in particular
of President Diouf, to the principle (already mentioned para 4 above) of
using the price of cereals, most notably rice, as an essential and
flexible tool of demand management, and therefore the commitment to
increase progressively the price of rice until some degree of
profitability is given back to domestic cereals, and to adjust it
permanently thereafter. While this agreement has not yet been received,
the following assumes that it will be given to the international
community at the time of CG, since in its absence the remainder of the
adjustment program would not be sufficient to restore the profitability of investments in the sector.

Short term adjustment issues and measures. Several major agricultural policy issues, as well as the measures which ought to be taken to address them were analyzed with the Senegalese authorities during the donors' meetings of the last year. They were put together in the form of an action program in a paper in French titled Agriculture et Politique Agricole (Annex 5) prepared to help the Senegalese draft the CG documentation and largely incorporated in it. Four types of issues were identified that concern:

i) the organization of the rural world, i.e. the liberalization of the cooperative system;

ii) inputs policy, fertilizers and seeds;

iii) the parastatals essentially SONAR, SAED and CPSP, and

iv) the cereals policy.

The original cooperative system is largely authoritarian and politicized; as a result it never was an adequate base for creating a viable agricultural credit organization. For long the donors requested that farmers' group be created on a voluntary basis to foster initiative and ensure a higher degree of solidarity. The creation of such group was a condition of effectiveness of our credit for the Eastern Senegal Project. Eventually in April 1984, a law was enacted allowing the creation of farmers' group. Since farmers have no experience in the matters, the donors have agreed to envisage to incorporate technical assistance components in their on going projects to help develop the capability of farmers' group. (Annex 5 paras 5 to 7).

Broad agreement has been reached on drastic changes in the current inputs policy. Concerning fertilizers (Annex 5, paras 8 to 14) there should be a progressive liberalization of pricing owing to the introduction of cash and credit sales (in addition to the present compulsory levy system) to eliminate to Government subsidy and allow an increase in supply. The donors could help finance the transition, over about 4 years to a true market price, a move that could be facilitated by improvement in the operation of the local supplier. This operation, however, can only succeed if an appropriate pricing policy is applied that makes the use of fertilizer profitable for the producer. With respect to groundnut seeds (Annex 5 paras 16 to 26) we support the general orientation of the Government's policy, i.e. disappearance of the parastatal in charge of collecting, stocking and distributing seeds (SONAR) and the immediate transfer of its functions to the oil-mills. The oil-mills are also Government owned and the savings at this stage may not be that substantial, but the move is a first stage towards eventually transferring the management of seeds to the farmers themselves. This last objective has been accepted during our discussions on the occasion of the Annual Meeting but may not receive unanimous support within the Government. The program as it stands now
links the progressive transfer of the management of the seed stocks to the farmers to a program of construction of village silos or granaries and advocates the creation of buffer stocks, which the donors could both help to finance. In addition, efforts should be made to improve the quality of foundation seeds, responsibility for the production of which will remain with Government services.

We fully support the objective of "winding down" the parastatals in the agricultural sector, while recognizing that the task is not easy and that a uniform approach cannot be applied. During the first, immediate stage, we propose to tackle the most urgent and costly cases such a SONAR (para 12 above); CPSP, the price stabilization fund, and SAED whose reorganization is a long term endeavor with however an almost immediate impact on the inputs and cereals pricing policies (Annex 5 paras 29 to 39). The case of the other companies, half a dozen at most, could be treated over the next year. We are prepared to help in all cases. Concerning SAED a joint FAC-IDA mission is in the field helping to draft the company's next contrat-plan, which will define the necessary changes in the company's objectives and operation for the next three years as well as outline orientations for the longer term. The elements of SAED's reform program are given in detail in Annex 7 (paras 29 through 39). They basically aim at:

i) the rapid (about 3 years) disappearance of SAED's "structural deficit" compensated by a Government subsidy, through a liberalization of prices of products and services and the transfer of many SAED's responsibilities to the private sector;

ii) a winding down of the company; and

iii) the review of SAED's irrigation techniques to lower capital and recurrent costs and the development of a longer term strategy for the Senegal Valley.

Agreement on the above points would enable the donors to envisage helping Senegal to finance the structural adjustments within SAED as well as a Fourth Irrigation project. With respect to CPSP whose finances are far from transparent and a substantial drain on the Government's resources, we are expecting agreement from the Government on the TORs of a consultant's mission that would (i) recommend specific measures to establish adequate accounting and financial control systems, and (ii) analyze the ways and means to limit CPSP's role to perequation and price stabilization (as opposed to import, marketing and intervention in the management of other agriculture related parastatals) and eliminate its deficit (Annex 5 paras 40-41). As for the other companies we are finalizing with CCCE a proposal to be made to the Government to help, with the assistance of consultants to redefine their objectives and organization and lay down the principles for the reduction of their staff.

The recommendations in the field of a cereals policy are based on the premise that the price of imported rice will be adjusted
permanently to ensure that coarse local cereals will again be competitive with it and will regain a share of the market. As mentioned above (para 9) this is still a potentially contentious point, since the required immediate price increase entails political risks, and that the magnitude and timing of future adjustments increases cannot be determined. We are convinced, however, that the manipulation of the price of imported cereals is the only possible course of action to restore the viability of investments in the agricultural sector (in particular in the case of Irrigation IV and SAED) since an exchange rate adjustment cannot be envisaged (see Annex 6). Obviously, the promotion of local cereals would also require a number of additional measures to boost production, transformation and marketing: preliminary discussions have taken place with the donors to outline the conditions and components of a possible cereals project (Annex 5 paras 43-47).

**Longer term Strategy Guidelines.** This aspect of the adjustment of sector policies seems so far to have received little attention from the Senegalese administration even though it is mentioned at our request in the draft CG documentation. We advocate

i) more effort to arrest soil degradation (desertification and to improve rainfed cultivation;

ii) a thorough review of the irrigation potential and of the techniques used so far to reduce costs; a master plan of the Senegal river basin should be prepared now since the regulating dams under construction will become operational in 2 or 4 years respectively; and

iii) agricultural research should be strengthened and accelerated.

**B. The Administrative Mechanisms**

The Senegalese Government organization is ill suited to implementing reforms which require flexibility, speed and imagination. Following the declaration of the NPA, the Government set up a number of committees to study the implications of the new policy and prepare implementation measures; in a number of cases they requested the assistance of the donors and, as mentioned above received positive responses. However, the system will remain cumbersome and slow, and has to be modified in at least two directions:

i) a special temporary structure has to be organized to monitor the implementation of the reforms and keep the President informed; it may take the form of a limited interministerial committee (e.g.: Rural Development, Plan, Finance, Commerce) or a special unit at the Presidency,

ii) the "cellule des contrats-plans" has to be completely revamped and revitalized, with a new manager, clearer TORs (less legalistic) and presumably strong T.A.; it may also have to be moved away from Plan to the Presidency during the period of preparation of the winding-down of public enterprises.
Announcing that ad hoc mechanisms and structures have been put in place to further the implementation of the reform program would certainly give a favorable impression of the Government's earnestness to the CG participants.

C. The Commitment to Reforms

This question has already been addressed in general terms in para 5 above. Our assessment of what we have achieved should not be overoptimistic. Our relations with the authorities today are considerably better than they were a year ago; we can discuss openly subjects that could not be raised; a number of our ideas have been accepted and we have agreed, at the working level, on draft CG documents which are by and large satisfactory. However, our role in the drafting of these documents has been so important that they may not reflect a genuine commitment of the Senegalese administration (this applies in particular to the winding down of public companies and to the pricing of cereals). Our next rounds of meetings should be the occasion of gauging the strong and the weak points of commitment of the Government at all levels and to try to the extent possible to define and agree on specific schedule for all the actions we are promoting; in a number of cases, SAED, SONAR, CPSP what we request would be well nigh irreversible, thus making future progress easier.

D. Possible future assistance to the Agricultural Sector

Conditionality

Resuming project lending is predicated upon the Government at least committing itself to taking measure that would progressively restore the economic viability of investments. Our core conditionality is thus entirely centered around measures aimed at reducing cost and price distortions. Steps towards increasing the price of imported rice constitute a basic condition; but the reform of SAED (see Annex 5, paras 31-37) is also indispensable, as is that of CPSP because of their demonstration effect and their impact on public finances. Certainly we could not go ahead with any lending either for structural adjustment or investment if agreement on cereals pricing is not reached. Similarly, an Irrigation IV project would not be possible in the absence of an acceptable "Lettre de Mission" (see Annex 7 TORs for SAED Second "lettre de mission"), and agreement on the longer term objectives of the company. Linkage between lending for Agriculture and a possible SAC will largely depend on our assessment of the commitment, preparedness and ability of the Government to carry out macroeconomic reforms (see para. 25 below).

Sectoral Adjustment

We conceive of future lending to Agriculture as a sectoral adjustment program where reforms are, as often as possible, based on the financing of associated investments. This would allow us to have (i) more leverage on the implementation of the adjustment components since
disbursements would be linked to the control by us of progress towards reforms; and (ii) more continuity, since disbursements would be spread over time. To the largest extent possible we would associate other donors to our effort. The short to medium term program we envisage can be broken down in two parts:

i) a series of sectoral adjustment measures in the fields of inputs, winding down of public enterprises, and development and implementation of a cereals policy; and

ii) the Irrigation IV project.
Context

Amongst the medium income countries, Turkey in many ways has been a testing ground for the Bank. This applies equally to new concepts for project lending (for instance, T&V Extension principles were first incorporated in the Seyhan Irrigation Project) and to experimentation with new lending approaches. Policy based lending, strictly defined, was initiated in Turkey with the advent of the SAL Program in FY79. Indeed SAL I was approved even before the SAL Policy Document had been reviewed by the Board. Subsequently, four additional SALs were approved, one each year, between FY80-FY84.

With approval of SAL V, which was the last one, the Region initiated preparation of policy based lending at the sectoral level, commencing with the agricultural sector adjustment loan (ASAL).

Concept and Design

The ASAL is intended to broaden and deepen the structural adjustment process in agriculture. In the areas of economic policies the ASAL attempts to pin down mechanisms to ensure maintenance of reforms achieved by the SALs. These include an extensive liberalization of trade (nearly total for agricultural products), price policy reforms, reduction of subsidies, interest rate and cost recovery reforms, and a curtailment of public investment growth. These essentially aim to stimulate primary production, rationalize public investment for agriculture and pin down sectoral economic and financial reforms initiated under the SALs. The core program therefore is both extensive and broad,1/ and will be implemented in the context of agreed five-year programs covering (i) inputs pricing and distribution (principally seeds and fertilizers), (ii) public expenditure programming and monitoring, principally irrigation development and village infrastructure including a reprioritization of investments, (iii) reorganization, consolidation, regionalization and decentralization of extension and research, and (iv) reforms to strengthen the agricultural credit system and the financial capabilities of selected parastatal. The implementation and monitoring of these reforms would be facilitated by specific agreements to strengthen the Government's planning and policy analysis capabilities, and to improve the methodological basis for revising the trade regime and producer price policies from time to time.

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1/ The loan is presently being appraised.
To implement these reforms, institutional strengthening is required. The ASAL will therefore disburse on the basis of a positive list for consultants, training and a slice of the public investment streams, as well as for imported inputs. Tranching will be utilized, which will be tied principally to actions to improve the programming of public infrastructure investment.

Repeater Operations

It was recognized that such a broad program of reforms for Turkey's complex agricultural sector could not be completed quickly, within a disbursement period of comparatively short duration -- which is another feature of sector policy lending for Turkey. Moreover, a single operation in isolation would not likely to provide enough leverage to see the program through. We have thus programmed repeater ASALs for FY87 and FY89, to be able to provide a more attractive overall package, and to permit continuous monitoring of undertakings agreed in the first ASAL.

Antecedents

The process of formulating the Turkey ASAL was perhaps different from some of the other operations discussed today. Firstly, the accomplishments under the SALs had an important influence on both its design and format. Secondly, the ASAL drew from a major CESW effort in Turkey during the SAL period, which included a comprehensive agricultural sector survey, 1/ reviews of public investment and trade policy, a financial sector survey, and numerous other reports. Thirdly, it drew from lessons learned from project implementation, including recent operations for irrigation development, extension and applied research, credit, horticultural export development and rural development. The design was therefore strongly influenced by the results and accomplishments of an ongoing process. It also was influenced by the continued macroeconomic exigencies in Turkey, and the fact that the institutional structure for supporting agriculture is already largely in place and has been for a number of years. What emerged is a hybrid -- an investment based policy loan -- which will probably be the format for all of the post-SAL sector policy loans to Turkey.

Process - Bank

The final design resulted from a two-legged process of articulating the Bank's concepts with Government's perceptions. The process consumed the better part of two years and was instructive for both sides. Within the Bank, there were considerable differences of view about how these post-SAL operations should be structured. Programs initially favored a sectoral SAL, Projects favored a more slowly disbursing subsector type loan, while -- in parallel -- the entire concept of policy-based lending was being debated by the Board, Senior Management and within OPS and the Region.

1/ Turkey - Agricultural Development Alternatives for Growth With Exports (Report No. 4204-TU).
To compound our internal debate the wheels of government were grinding slowly (and not very finely) during Turkey's transition from a military to an elected government in 1983. Thus, at one stage, there was not even a client with whom we could effectively dialogue.

Within the Bank, the debate over format was most intense about the time the Country Policy Department became operational. CPD's subsequent input provided a useful perspective, helped to crystallize differences in concept, and, ultimately, helped EMENA to forge a unified view. In parallel, the Projects Department took the lead, prepared a sector strategy paper and a concept paper which was accepted by Programs, then fielded a series of management-level missions during the spring and summer of 1984 to review these with the new government.

Process - Government

Having found a client to deal with (the new Government), we quickly discovered that profound differences of opinion about sector policy lending also existed between the planning and finance undersecretariats on the one hand, and the more traditional line ministries -- such as the Ministry of Agriculture, Forestry and Rural Affairs (MAFRA). Within MAFRA, an air of distrust toward the Bank had developed over recent project supervision problems. The Ministry's failure to appreciate the seriousness of Turkey's continuing foreign exchange shortages compounded the problem. To gain MAFRA's active support, and to get the preparation process moving, an informal appeal was made by Treasury to the Deputy Prime Minister, who apparently conveyed the message to cabinet-level meetings and convinced the MAFRA that it should help prepare the ASAL operation.

Since then, MAFRA's cooperation has been both extensive and very fruitful. A large preparation mission in September/October 1984 was able to have very frank and open discussions with the Minister and MAFRA's senior staff and MAFRA literally opened its data banks for our review and analytical work. Most important, the Ministry now seems to appreciate that the Bank's objectives and the approach being followed through the ASAL corresponds to its own sectoral objectives, and will improve MAFRA's ability to "manage" agriculture during the Fifth Five-Year Plan period (1985-1989).

Lessons to Date

The main lessons of the ASAL process in Turkey are the following:

A. The need, at the outset, for clearly defined government policies, and acceptance of policy-based lending.

B. The need for clearly defined Bank strategy and approach.

C. The crucial role of the core agencies (Treasury/State Planning Organization) for:

1. Focus of dialogue, especially the macroeconomic aspects
2. Agreement on design
3. Coordination of preparation.
D. The format and design will be influenced by:

1. The country lending strategy and need to pin down, broaden, deepen and institutionalize SAL agreements
2. Ongoing reforms (macro and sectoral)
3. The preparation effort per se
4. Macroeconomic stabilization requirements
   (a) Loan amount
   (b) Rapid disbursement
5. The need for possible repeater operations for monitoring
6. Policy requisites and preparation requirements for future lending.

E. In spite of extensive previous CESW, the sophistication of the borrower and of the economy/sector requires an intensive preparation effort.¹/ However, the availability of old style sector work is an essential input for constructing a policy package of ASAL magnitude.

Whether these lessons can be generalized to all countries and policy-based operations for agriculture is doubtful. However, they may be instructive for the preparation of agricultural sector policy loans in similarly situated medium-income countries -- viz. ones which have gotten used to the idea of policy based lending through a program of SALs, have already initiated the necessary macroeconomic reforms, and have the basic institutional structure in place at the macro and sectoral levels to support an ASAL-type program.

¹/ Including large staff week allocations for technical specialists.
RAPPORTEUR'S COMMENTS
by
Ridley Nelson*

The six papers prepared for this session (papers 8 through 13) were used as background material for a panel discussion that was later opened to the floor. This is a summary of both the panel and the floor contributions.

The Chairman, Mr. Harris, opened the session by stressing that there was no single model for policy-based lending operations because of wide variation in country circumstances. Operations to be discussed range from a Sector Policy Loan in Turkey designed to deepen and institutionalize a policy dialogue begun under a series of five SAL's to a series of Agricultural Rehabilitation Program Credits in Sudan where the prerequisites for structural adjustment lending do not exist, to a "non-lending" strategy in Senegal designed to create a sectoral policy environment conducive to the successful implementation of agricultural projects. Throughout these diverse operations, however, run a number of common themes—the links with more traditional macroeconomic, sector and project work, and the identification of specific, time-bound, and monitorable actions as a basis for policy-based lending.

Mr. Dubey then summarized his paper. He stressed that there were no generalizations on policy-based sector lending. The achievement of SAL's had been that they had brought policy from the periphery to the center of operations. A more recent out-growth of SALs were the policy-based sector operations, the subject of this symposium session. So far, these new sector operations had, in some respects, raised more questions than they had answered and had often faced unforeseen problems. But this was to be expected. We were inevitably at an early learning stage. The following seemed to be two of the most important lessons emerging from this experience:

(a) There was a need to develop accepted analytical tools comparable to the well established economic analysis for project lending. In particular, establishment of a "without intervention" scenario was particularly difficult. How would one dissociate other unrelated developments that would have happened without the intervention?

(b) There was a need for a monitoring and evaluation methodology.

After Mr. Dubey's presentation the Chairman introduced the panelists and referred one key question to each panelist in turn. Responses to the questions posed are outlined in the following paragraphs.

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On the question of the need for an analytical framework which was raised in Mr. Dubey's paper, Mr. Burcroft offered experience from the Turkey Agriculture Sector Policy Loan (see paper number 13). In this case the sector loan flowed from the prior experience of five Structural Adjustment Loans (SAL's). Mid-way through this series of SAL's an agriculture sector survey was commissioned, mainly to understand the trade-offs relevant within an export-oriented growth strategy. Assisted by CPD, a general equilibrium model and agriculture sector model were developed so that by the fourth SAL knowledge had evolved to a stage at which specific agricultural issues could be addressed within a generally understood framework. The analysis could then focus on agricultural policy questions such as farmgate prices, sectoral budgetary allocation, agricultural interest rates, as well as the more macro-issues of trade liberalization and exchange rates. By this time, and with the help of the analyses that had been completed, the policy dialogue had intensified. At the final stages in putting together the sector loan, with much of the dialogue on macro-issues behind them, the team focused on a series of very practical, project-type analyses using many technically oriented, rather than policy oriented, staff.

Mr. Shivakumar, on the same question, commented that while the need for an analytical framework was sound in theory and should also cover institutional and technical issues arising out of project experiences, in practice, in a crisis, time was of the essence and in order to respond quickly one might have to proceed with approximate solutions rather than await the "perfect" solution. In Sudan, there were obvious things on policy that could be recommended without a major series of studies (e.g., cotton pricing) and Government were quite convinced on reforms even without more analysis to make a case. It was possible to put together a sensible policy package in this case without an immaculate analytical framework.

On the next question related to problems of Government receptivity and aid coordination, Mr. Blanchi (paper Number 12) said the Senegal SAL came at a time of crisis. By 1983, Government had realized that major policy changes could not be avoided, and, following an initiative of both the Club du Sahel and the Government, a conference was called during which there was a general convergence of donors' views. A document, a sort of ultimatum, signed by five major donors, outlining needs for essential changes was presented to the Government. The recommendations included:

- redefining and reducing the role of parastatals in agriculture;
- adjustment of the price of imported rice to permit local cereals to compete with imports;
- ensuring an adequate input delivery system; and
- adjustment of producer prices to allow cost recovery and thus elimination of subsidies in the irrigation subsector.
The President was in favor of the drastic policy reforms recommended, otherwise it was probable that the civil servants would have blocked them. Nevertheless, progress was slow. Government then prepared their own agricultural policy proposals developed in close contact with the Bank and other donors. Government's receptivity seemed to have been increased by the Bank's earlier toughness with respect to cancelling the second tranche of the SAL. But even with the "progress" made on Government receptivity by early 1985 not much of practical significance had actually happened. The higher rice price remains only a promise.

On the question of how one determines the size, timing and sequencing of action, Mr. Macgregor discussed the experience with the Philippines Agriculture Sector Loan (paper Number 11). The loan size for the Philippines was initially set arbitrarily at one-third of the cost of agriculture imports for the previous year. The size remained at that level during the preparation process because of the predominance of the balance-of-payments motivation behind the operation. The policy package, in this case, did not guide the size of the loan which Mr. Macgregor felt was a mistake. It would have been better to use a project-style efficiency criterion of maximizing policy leverage per dollar lent. This would have implied loan size flexibility. Balance of payments support should, he felt, derive secondarily from the policy support and leverage objectives, not be a primary purpose. The Bank could satisfy both the BOP support motivation and the efficiency criterion by linking policy reforms with specific related projects or, where reforms transcend project bounds, with a range of ongoing projects with Structural Adjustment Program-style increases in disbursement percentages to speed project completion and cut total cost. In this way, even if policy changes do not stick, there is at least something positive on the ground to show for the investment.

With respect to receptivity, Government in the Philippines was receptive to good ideas, even in a non-crisis situation. There was a better chance of reforms being maintained if Government were persuaded rather than forced. The best way to achieve this was to fully involve Government staff at an early stage in studying the issues and options.

On the question of the linkage between traditional lending and policy-based lending, Mr. Yoon discussed the experience with Pakistan Agriculture Sector Conditionality. Policy-based lending could only, and should only, be separated from other Bank work for lending classification purposes. With respect to overall strategy, all operations in Pakistan were part of a continuum of Bank support at many levels. Both the Fertilizer Import Credit and the SAL I had been in support of the Pakistan National Agricultural Policy and the Revised Action Plan, developed with intellectual input from the Bank. There had, over recent years, been an evolving consensus between Government and donors. Under SAL I there were a number of agriculture sector related and time bound covenants that formalized this consensus into a concrete action plan. These covered:

- fertilizer subsidy elimination by 1985;
- increasing operation and maintenance (O&M) expenditure on irrigation;
- reducing O&M subsidies (i.e. raising water charges); and
- institutional reforms related to the Agriculture Prices Commission.

In Pakistan, following up policy change needs continuing policy-related and project-related lending and studies since the target is continually moving.

On the question of processing problems within the Bank, Mr. Shivakumar outlined three questions that were important:

(a) the role of the respective Programs and Project staff in the Bank;
(b) the role of the borrower; and
(c) the question of what we should finance.

Problems arose in the Sudan operation due to the Bank's structure. Programs and Projects staff disagreed on some issues and these had to be escalated to the VP level for resolution because managers below this level did not have authority to overrule one or the other of these departments. For example, a November 1983 Project Brief containing the disputed issues took until June 1984 to resolve. The difference of view was partly because Projects staff were taking a longer-term view with technical and institutional concerns in mind and Programs staff were taking a shorter-term view with political and macro-economic concerns in mind. The Projects/Programs organizational dichotomy was seen in this case as a handicap for policy related lending. It also contributed to giving conflicting signals to other donors and the country. Perhaps the Bank needed some "structural adjustment" itself?

On sector work related to policy-based lending, Mr. Shivakumar outlined experience with three approaches:

(a) Using consultants (ineffective, the reports simply gathered dust).
(b) Government alone (ideal if the issue did not require some outside pushing).
(c) Bank/Government (worked well in Sudan, it gradually built up a consensus).

On the issue of what the Bank should finance, Mr. Shivakumar mentioned that in the Sudan case, spare parts, equipment, and recurrent inputs relating to the agriculture sector were financed since the items were (a) quick disbursing, (b) supported directly by the economic recovery program, (c) encouraged other donors to fund such inputs, and (d) provided an opportunity for the Bank to improve cost effectiveness of input usage. The drawback in this was that if policy dialogue had become stalled, input
financing (e.g., pesticides) would have been disrupted with damaging effects on ongoing IDA projects and the country's recovery effort. On balance, targeting agriculture sector inputs was a good idea provided emphasis was given to inputs for which timeliness of arrival was not too critical (e.g., equipment or spare parts instead of pesticides or fertilizers).

Following this discussion of questions posed directly to panel members, questions/comments were requested from the floor.

The first question from the floor related to the Bank's role in supporting policy changes. How did we judge policy performance and if the policies fail who pays? Mr. Dubey answered that it was clear who paid, but that obviously failing policies should be changed. Therefore monitoring was important. In situations of limited knowledge we should generally start with issues like gross price distortions where the need and the direction of change needed may be clear with minimal analysis.

The second question related to the resolution within the Bank of the appropriate policy advice to a country. The speaker had been involved in studies that indicated to him that recommendations being made by the Bank, in some cases, would have a negative effect on the country. He was dissatisfied with the Bank's internal mechanisms for resolving differences of view on such matters. Mr. Dubey responded that the regional front office should have the final say but they should obviously offer reasons for judgments made in refereeing significant conflicting views. He stressed that having an analytical framework does not automatically lead to the correct recommendations, although it should help.

Mr. Blanchi, in response to the same question, stressed that in the case being referred to the range of considerations we had to take into account in arriving at our policy recommendations was much broader than what was captured by the analytical model. The model results suggested a position which would present a number of problems including a possible open conflict with the IMF and an implied conclusion that local food production was impossible to develop in Senegal. The fixed exchange rate in this case had been a major constraint to flexibility of action.

The third question related to the question of the choice between project and policy-based loans. Mr. Dubey said he was advocating both types of operation. Projects have advantages but get delayed and the benefits eroded by policy problems, therefore there was a need for a better integration, a balance in the lending program, between project-based and policy-based loans. For example, in Jamaica, projects had pointed to the policy issues that needed to be addressed through the SAL, the SAL, in turn, had pointed to areas where project lending was needed.

The fourth question/comment had two parts:

a) The need for agriculture technicians (mentioned by the panel) was welcomed, but whereas the types of technicians needed in policy-based sector lending were similar to those needed for traditional project operations, the types of economists needed may be different.
b) We generally don't know enough about country political power bases and how decisions are made. Also, the Bank needed staff with more experience of working within our borrowers' bureaucracies; a minimum of five years was suggested. Without this understanding we could not do well with policy-based lending. Perhaps we needed more staff in the field?

Mr. Shivakumar felt a Resident Representative was very useful provided that disagreements between Programs and Projects was not at a level that would prevent resolution of issues in the field. Other panelists supported the need for good resident representation and generally supported points made under the fourth question.

The fifth question related to the extent to which one should support specific project type funding as opposed to less specific balance of payments support. The speaker took the view that sector operations should largely be a "sweetener" for policy discussion, and that disbursing against ongoing projects would endanger our lending program if Government failed to honor its reform pledges.

Mr. Macgregor responded that the Bank should not be asking for reforms which it did not expect could be maintained. In addition, the incentive to uphold reforms is greater and lasts longer if implementation of a project portfolio is at stake. As for selection of reforms for Bank support, he said that where there was strong opposition to a proposed reform, attempted use of leverage with any kind of loan, sectoral or project, would probably not succeed for long. Policy changes that Government widely and strongly favored would probably happen anyway. Therefore, the Bank should focus on policy changes that were "on the fence" and needed a firm nudge to fall on the right side, particularly changes which would generate enough domestic support to be self-sustaining.

Mr. Shivakumar, in relation to the same question, noted that where policy was involved there was always difficulty getting agreement and processing problems inevitably arose, therefore for these operations one should be particularly wary about financing essential inputs (e.g., cotton pesticides) where delay could be disastrous. If such considerations reduced the available project-type investments too much, then less defined balance of payments support was the next choice.

Mr. Harris commented that there was a danger of generalization here and that the specific situation should be borne in mind. The delay in funding issue was serious in the Sudan case but not, for example, in the Philippines case.

The sixth question asked what inputs were made by the Bank in the operations under discussion and what alternative or additional inputs might have improved this?

Mr. Macgregor said that in the case of the Philippines the Division had thought initially that they had a strong sector study background to ride on, but once down the track it became apparent that many of
the practical aspects of the necessary reforms had not been considered (particularly the question of how to get there from here). This issue was still being addressed in the Philippines operation. Six studies by Government with the help of consultants were to be done under the project.

On the same question, Mr. Burcroff said about 200 staff-weeks had been used in Turkey since the start of the process. Six core policy areas had been studied. SAL supporting sector work had started the study process but thereafter much more sector specific institutional and technical studies had been necessary. A further problem was how to monitor progress. The operation had been very staff intensive.

The Seventh question related to how one should carry out policy related lending which was not essentially a bribe but was complementary to, and partly compensated borrowers for, the transition costs of difficult actions taken.

Mr. Blanchi said that initially, in Senegal, the irrigation agency had got just such rewards for doing absolutely nothing. This delayed the crisis and therefore the solution. Now the approach was to try to do exactly what was suggested in the question. The loan would cover the cost of adjustment. Mr. Blanchi felt that generally in his experience there had not been success with bribes, particularly where this approach was linked to quick disbursement. If quick disbursement operations were intended then such operations should be a result of reforms made.

The eighth question/comment pointed to:

(a) the need to tie ourselves down a bit more than suggested in Mr. Dubey's paper (on page 6), by deciding in advance how long we should wait for the performance of policy change to be judged;

(b) the problem that using a project stream as a vehicle for policy study and policy change, although more attractive than policy-based loans, was undermined by the fact that the CPP was used simply as part of a numbers game. In many countries in the past we have already had leverage in situations where there have been plenty of policy changes needed but instead of proceeding with projects circumspectly, with appropriate conditionality, we have simply proceeded with rapid disbursement lending programs to meet the pre-set targets.

(c) Economic and sector work has, in the past, been two-thirds macro-economy oriented and one-third sector oriented, this should be reversed. Our work so far has not been operational enough. Turkey might be the exception to this.

The ninth question/comment was made by a speaker who said that he had become an advocate of the policy-change vehicle best described as "non-lending." In Senegal this vehicle seemed to have brought about a consensus. What might have happened in Sudan and Philippines?
Mr. Shivakumar responded that in Sudan the irrigation sub-sector was now doing quite well and that without the lending operation the borrower might have abandoned part of that sub-sector. On the other hand, the country as a whole was not doing well.

Mr. Macgregor felt the Philippines loan had not contributed very much in terms of investment impact. Input demand estimates had, in the event, been too high due to rising prices. However, managing without these vital inputs would have been national suicide, so that clearly Government would have found the funding from somewhere else. Thus the Bank loan, due to fungibility was in this case supporting some unidentified lower priority activity elsewhere in the economy. In terms of sector work on policy, the contribution of the operation was better. Some policy improvement may result; e.g., on the use of the private sector for the import of feed grains. Some useful studies had also been completed under the operation.

Mr. Blanchi said that a fundamental problem in much of our work was that the Bank's way of operating implied uncertainty about whether the objective was the transfer of money or the support of sound investments.

Mr. Harris summed up the session by outlining some common threads:

(a) In a sense, all good agricultural project operations were policy-based; the appropriate policies and institutions needed to be in place, or put in place, to create an environment within which projects could succeed.

(b) Policy-based lending per se tended to be complementary, not competitive, with more traditional project and sector work. While in the short run (one year's lending program), there may be competition for staff time, Board slots and funds, over the longer run the existence of a policy-based agricultural lending dialogue should lead to more, and better projects, not fewer. There was a need to integrate the total lending program and portfolio management in support of policy based lending: not just isolated operations.

(c) A sector analytical framework was required to pursue agricultural policy-based lending. This was the interface between macro policy analysis, traditionally carried out by Programs, and micro level project work with policy/institutional analysis traditionally carried out by Projects. While a start could be made within a rudimentary analytical framework, since we could not afford to wait until a fully articulated system was available (if it ever would be), an objective of policy-based lending ought, at least, to be to refine and develop the analytical framework as time goes on. This would require increasingly close cooperation between Projects/Programs (and IMF) and Bank/Borrowers.
(d) Policy-based lending should be a series of operations and a continuous learning process. Also, each operation itself was a continuous process involving mid-term reviews, tranching, etc. to be followed up in turn by further sector policy-based and project lending.

(e) For receptivity we should build as much as possible on Government initiatives (Senegal/Pakistan/Turkey). Policy and institutional changes needed to be supported at the highest levels of government and the core ministries (Finance, Planning, etc.). But line Ministries also would have to have some direct incentive to carry out these reforms. SAL's provided benefits and required actions by core ministries. Sector Policy Lending provided macro benefits to core ministries but actions in many cases had to be taken by line ministries. What would be in it for them? All actors needed to be brought in from the beginning.

(f) There had been mixed and sometimes conflicting motivations for policy-based lending - balance of payments support, policy and institutional reform, short-term stabilization vs. longer term development objectives. Based on a wide range of diverse country situations, policy based lending operations needed to be tailor-made to suit specific needs and circumstances; it was difficult and dangerous to generalize.

(g) Finally, experience with policy-based lending in agriculture to date had clearly demonstrated the large and important role of agricultural technical staff in the identification, preparation, appraisal and monitoring of policy and especially institutional aspects of policy-based lending. There was no substitution for the Bank's traditional strong suit--high quality, professional project work.
CLOSING REMARKS:

THOUGHTS ON THE FUTURE PRODUCT OF THE BANK

by

S. Shahid Husain*

I hear that you have had very good discussions, particularly on the so-called policy-based lending in the Bank. I always say to my colleagues that this is a very poor term, in the sense that all of our lending is policy based and therefore we shouldn't be talking about policy based lending as a special category. The issue is what sort of policies are attached to what sort of operations.

Let me try and do some thinking aloud -- which a number of us have done in the last year about the outlook for the Bank's operations. What are the issues that affect these operations? How do the events in the recent past, and our perceptions, affect these operations?

As far as the Bank is concerned, and as far as development economists are concerned, we basically rationalize times and experience. There are no eternal truths in economics and therefore the Bank's own operational approaches are nothing but an extension of perceptions about the current processes and issues of the time. Since issues have kept changing, and will keep changing, our approaches will change.

Let me try to recapitulate how these approaches have been affected by the times, and by our own economic experience. If you look at the Bank's early operations, in the first twenty years or so of its experience, there was tremendous emphasis on capital formation, on installation of physical assets and physical infrastructure. The whole concept of "project" was elaborated in that period and it became sacrosanct in what Ibrahim Shihata calls "the engineering concept of the project." We are concerned that the Bank's lending, which obviously creates debt service obligations, should be associated with the creation of productive facilities or assets which would lead to the flow of income and production over a period of time. We did, of course, early in our experience, realize that physical assets need an institutional framework and hence the substantial emphasis on building suitable institutions, on insuring their financial integrity, and on improving the quality of management.

For a long time people didn't even recognize that lending for agriculture, except possibly for some plantation agriculture, could really be a very productive thing to do. You may remember, those of you who were here about twenty years ago, the resistance to any significant work on agriculture, particularly with small farmers. Much of our early agriculture work was plantation agriculture, some irrigation, some livestock.

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*Vice President, Operations Policy, World Bank.
But as we went along, clearly we understood a few things. We understood the importance of agriculture in the production and development process; we understood the importance of human infrastructure in the development process; and clearly our approaches became more elastic.

Perhaps the '70s were crucial in several ways. They were crucial because of the recognition during this decade by the economists and by most of us in the Bank that growth is translated into development only when participation in the process of growth is fairly broad. This means that we have to be concerned, not simply about aggregates, but also about the distribution of benefits within the aggregates and how the welfare of the population shifts in this process. Our concern now is with the whole approach to development -- with the beneficiaries of growth, the target groups, the poorest section of the population, and so on. Of course, all of you have witnessed the emphasis on rural development, which came to be synonymous, in our vocabulary, with reaching the poorest sections of the agricultural population of the rural areas.

Then came the petroleum crisis, the tremendous squeeze on resources in developing countries, and the worsening of terms of trade in oil importing countries, followed, of course, by the massive debt crisis, the stagnation of Africa, and the decline of per capita food production in Africa. The realization came that, yes, capital accumulation is important, institutions are important, but no less crucial is the overall policy environment in which development takes place. We began to see the difference between inadequate and adequate policy environments, whether the macro-economic policy environment, the sectoral policy environment, or the project environment. These often make the fundamental difference between the success and failure of the process of economic growth.

We have seen country after country, where if you look at raw statistics you will find investment percentage rates in the low 20% of GNP, on a sustained basis, and yet the benefits in terms of production, in terms of income, have not been commensurate with this effort. Africa is littered with countries where the investment rates have been in the 20% -- Ivory Coast, Nigeria, Kenya, Tanzania, Zambia -- and yet these are countries which are facing massive crises.

Some of the country experiences are very interesting. Consider Nigeria, for example, during the ten years of the oil boom, say from 1973 until perhaps 1981-1982. It had one of the highest rates of investment in any country: investments perhaps in the upper 20% of the GNP on a sustained basis. It had massive expenditure on imports, capital imports, massive construction programs, and so on. What would you guess has been the increase in per capita GNP of Nigeria over this ten year period? Very little. This tells us something about the importance of the institutional environment, the importance of the policy framework.
Also, we should look at agricultural production; look at agricultural exports in Nigeria over this ten-year period. Nigeria used to be one of the major exporters of agricultural products, and now it is a major importer. Nigeria used to be one of the major exporters of palm oil and now imports vegetable oil. Cocoa production has declined very substantially, and the question that we would ask is "Why has this come about?"

Take another country -- another OPEC country -- Indonesia, in similar resource circumstances. Both countries were exporting similar quantities of oil. Both had similar per capita GNPs at the beginning of the process. Both countries had pretty poor institutional environments. But there is a tremendous contrast in the performance of the two economies. Over the ten-year period of the oil boom, Indonesia's GNP has increased by 7-8% on a sustained basis. Per capita GNP has increased by about 4-5% per annum; per capita income may have increased much more because of the terms of trade effect. Agricultural production has increased at about 4% per annum. The overall rate of agricultural production and exports have been maintained; palm oil, rubber, other things.

What is the difference in the policy environment in the two countries? Both are oil economies; both were low income economies at the beginning of the process; and both had similar population size. The fundamental difference has been in three or four key policy areas. First, throughout the oil boom Indonesia has channeled a very substantial part of the oil income into rural areas, to the improvement of rural infrastructure through a rural development program, agricultural credit, irrigation networks, research, and extension. No less important has been the maintenance of fairly high domestic agricultural prices. In rice production, where Indonesia has done particularly well, the domestic price for rice has been kept close to that of international markets. Indonesia also has accomplished periodic devaluations -- not just because it was facing a balance of payments crisis (for part of this period it had a balance of payments surplus) but fundamentally to maintain the competitiveness of domestic production.

Nigeria, on the other hand, spent massive amounts on capital goods, on construction, but it had no coherent agricultural policy, no coherent rural policy, and tremendous suppression of agricultural prices by maintenance of an over-valued currency over most of this period. Consequently, we have seen substantial disincentives for agriculture production and massive migration into the cities. Market agriculture has been weakened through massive imports of food and sale of subsidized imported food.

In this period the Bank has financed agricultural projects both in Nigeria and Indonesia. There have been problem projects in both countries; but partly because of the contrasting policy approaches our agricultural projects in Indonesia have by and large done well. Some Indonesian projects have been delayed; they have had problems; but, they have met our expectations. By and large, our agricultural projects in Nigeria, however, have not done well, even though the physical concept of these projects may have been right, and even though the institutional framework may have been right. The overall policy environment militated against an economic use of resources, and hence the results were as noted.
Given these sort of circumstances, what do we do? What should our approaches be? Clearly, the Bank's contribution to the development process has many facets. We are carriers of technology. In fact, my view is that we don't do enough of that. We are also carriers of capital investments, and should be carriers of capital investments, whatever emphasis we place on institutional or policy improvement. Fundamentally, the importance of capital accumulation in the process of development remains. And therefore our lending has to be associated with investments; it has to contribute to capital formation. But what we can no longer afford, and what countries can no longer afford, is to ignore the overall policy environment in which this investment is going to take place. I don't think we can distinguish anymore between macro-economic policies, sector policies and project policies. We have only to ask, basically, what are the sort of polices that contribute to the mobilization of domestic resources and to improving the efficiency of resource use and how can they be implemented. What are the policies that are counterproductive?

A second point about this is that we can be at two extremes of a spectrum and make mistakes regarding both. We have to guard against that. One extreme is to say that policy is for economists and we operations people only have to worry about the details of the so-called projects. That's one extreme, and I don't think anyone practices that extreme anymore. Anyone who is working on operations also has to be working on and be interested in the policy environment. But the other extreme is to think as some do, that there are only two positions -- the optimum and the sub-optimum -- and that the movement from the sub-optimum to the optimum is either instantaneous or costless. In point of fact, it is neither. This means that we have to be not only economists, but we have to be political economists. We have not only to understand policies -- policies that work, policies that don't work, policies that are desirable, policies that are not desirable, but we also have to ask "What is the adjustment process?" What is the adjustment process in terms of institutional frictions, in terms of elasticities, in terms of costs to decision makers, and in terms of costs and benefits to the interested groups who inevitably have influence in policies. Therefore, we not only have to ask what is the most desirable, but we also have to ask whether the most desirable is attainable. And if the most desirable is not attainable, then what is the second best, or third best, or the fourth best. And this is the difficult part, and nobody can possibly have ready prescriptions for it.

We will have to make judgements on the goals of insuring efficiency in the use of resources, mobilization of savings, and so on. On the other hand, we will have to ask how to get to where we want to be, and whether we can get there in one big jump or whether several steps are needed.

Policy prescriptions have to be combined with an assessment of the costs of adjustments, of the responses to adjustments and the time it takes for changes to bear fruit in terms of employment, and production increases. Unrealistic plans and poor implementation may discredit an entire process of reform. These are very important questions that should be on our minds.
A word about the design of lending. Distinctions between various types of lending are improved in so far as they guide us in response to particular types of situations. We have to have great flexibility in doing what needs to be done. Therefore, we have to ask, in each case, what combination of investments, policy changes, and institutional improvements is needed. Should we approach the problems by financing well-defined discrete investments? Could we best approach them by attaching our funds to greater policy and institutional improvements. Because these decisions have to be country specific, the fewer generalizations we make about them, the better.

We have learned from the development process that the developing countries are diverse. The diversity has been increasing, not simply in terms of per capita GNP, but also in institutional capacity, openness to the world market, domestic production base, natural resources, human resource development, and elasticities of supply. When we talk of institutional base, we are talking about the capability and responsiveness of the policy making apparatus.

We have, of course, highly sophisticated countries like Korea, on one side, where we can fundamentally assume that the capacity of the economy, and the capacity of institutions to respond to changing environments, is very great. And we have, of course, the economies of Sub-Saharan Africa, Bangladesh, Laos, and other countries, on the other hand, where superimposed on very severe natural environment and population pressures, is a whole institutional apparatus which inhibits rapid change and rapid movement. Therefore, it is absolutely essential that we adapt our operations and our approaches to this variety of circumstances, and to this variety of environments. Our operations -- our approaches -- have to be increasingly country specific. What will work in Korea certainly will not work in Nigeria. We have to start with that assumption, and we have to ask how some general issues, some general principles, if you will, have to be adapted to the varying circumstances in different parts of the world.

So let me summarize. What I have been trying to say is that development is a dynamic process, and that our perceptions about developmental questions and developmental priorities will keep on changing with the times because nobody has perfect foresight. Nobody foresaw the oil crisis; nobody foresaw the tremendous explosion of commercial bank lending; nobody foresaw the debt crisis that has come; nobody really foresaw the African agricultural crisis the way it has unfolded. While we try to develop a vision, we are led substantially by our experience. Then we come to a point at which we find that yesterday's crises are not tomorrow's crises and we have to adapt and change.

The crises that we foresee today are very diverse. All of us probably think that the hard core of the developmental problem is Africa, because Africa combines every single issue of development that you can think of. There we have a fragile natural environment. We have a population explosion whose parallel we have not seen; we are told that fertility
declines when there is rapid growth in per capita income, and high literacy. In Kenya, for example, this has not been so, and we have a 4% population growth rate; we have a fertility rate of 8. Therefore, in Africa we have not only a fragile ecology, a fragile natural environment, but a rate of growth of population which is untenable.

Also, in Africa we have a proliferation of the apparatus of the State, which makes the job of management particularly difficult. We have in many countries a policy environment which has been hostile to agricultural development. The policy and institutional environment includes parastatals and marketing boards which have been siphoning resources from the rural sector. We have had massive growth in urban populations which ultimately have become tremendous pressure groups for the maintenance of cheap food and for the import of cheap food which, again, inhibits policy change.

Therefore, what I am saying is that we have to find ways, not simply of asking what is the right policy for a particular country and what are the right approaches, but to approach our work with a certain amount of humility. We have to ask about the frictions in the process and about the costs of adjustment. These will have to be dealt with, not simply in the abstract, but specifically as to the costs of adjustments to interested groups, the pressure groups who make decisions, and ask how the policy-adjustment can be rendered more smoothly and at less cost.

What it also means is that, since there are no ready answers, the intellectual processes that will lie behind our analyses and our prescriptions are extremely important. We cannot afford arrogance in this process -- arrogance that might come from ignorance. The more we dig into issues, the more we find how little we know. Therefore, we will have to keep on with the trend that we have had in the last few years of emphasis on the importance of economic and sector work and the link between economic and sector work and our operations.

Lastly, I would like to repeat, that the flexibility in our lending instruments, in our approaches, has increased beyond recognition. The staff of yesterday would not even recognize the Bank operations today. The purpose of all of this is not to give greater weight to one part of the Bank or the other part of the Bank, but to give us the instruments to adjust to the issues that we face -- issues of policy, institutions and productivity.

The Bank cannot afford to remain obsessed with creation of new assets; we have to look at the economic development process as an integrated process. Therefore, the productivity of existing assets is crucial. We cannot build new roads while old roads are going out of service. We cannot go ahead and build new canals while the entire irrigation system in a country is decaying because of the lack of operations and maintenance. We have to look at the project, not as an isolated entity. We have to look at sectors and the economic development process as a whole. The management of the Bank and the Board of the Bank not only are tolerant of diversity, but we urge you to be diverse, we urge you to be innovative.
I am very concerned about two issues which I want to mention to you. First the issue of technology. I spent about a week at the International Institute of Tropical Agriculture about two weeks ago. I'm not an agriculturalist, nor am I a researcher. But I do think alot of valuable work is going on in some of these International Agricultural Research Centers. I looked at the visitors' book in IITA, and I looked for the names of Bank people who had visited there, and I didn't come across many. In a lot of projects, in a lot of work, we assume that technology will come or it will be looked after. But I urge you to ask this question explicitly. What are the issues of technology that we face in our operations and where will they come from? What is the capacity of national agricultural research institutes and the extension systems to convey that technology?

The second issue I want to mention to you, of which obviously you are fully aware, is that of sustainability. This is an issue which OED highlighted in its last report. It's not sufficient for us that we create organizations, bring in expatriates, think in terms of seven to eight years, by which time the disbursements should be completed and we shall be gone. We should ask how these organisms that we create are supposed to be absorbed into the local framework. Ask that if expenditures are to be made for capital accumulation, what will happen to maintenance? Ask what will happen to the farmers in terms of access to credit and other institutional support after the project is finished? We must ask also whether these innovations have a reasonable chance -- not certainty -- have a reasonable chance, of leading to a sustainable framework.

Thank you very much and I'll be very glad to answer any questions.
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