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Socioeconomic Constraints to Agricultural Development in the Semi-Arid Tropics and ICRISAT's Approach

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Abstract

This paper discusses how socioeconomic constraints to agricultural development are evaluated at ICRISAT in order to better formulate research priorities in an ex ante sense as well as to improve the efficiency with which new technologies, once they are developed, are "marketed" to farmers. The constraints discussed include variations in population densities, the heterogeneity of the resource endowments in the SAT, the role of risk in farmers' decision making, marketing institutions, human institutional requirements, and, finally, efficiency and equity concerns in research resource allocation

One of the important mandates of ICRISAT is to help identify socioeconomic and other constraints to agricultural development in the SAT, and to evaluate alternative technological and institutional means of alleviating them. This is a recognition that agricultural research must be designed and implemented keeping the socioeconomic environment of target and client groups clearly in view; agricultural research investments that consider only the potentialities and constraints of the agrobiological environment do not lead to the highest possible returns. Viewing agricultural research as a multidisciplinary exercise can enhance the returns, not only in terms of efficiency but also in terms of human welfare and equity.

The importance of carefully targeting research allocations cannot be overstressed in view of the extremely limited amount of research expenditures in the SAT. They amount to only 0.008 U.S. cents per hectare of geographic area and only 0.14 cents per hectare of the five ICRISAT crops — sorghum, pearl millet, pigeonpea, chickpea, and groundnut. Total research expenditure in the SAT amounts to $14 million, of which over 50% is ICRISAT's. The low level of national research expenditures for SAT agriculture is in itself an important socioeconomic constraint that needs to be emphasized at the outset of this paper.

Socioeconomic Constraints

Population Densities

The 48 less developed countries with semi-arid tropical climates had an estimated population of around 600 million in 1975. These are supported on a SAT geographical land area of approximately 17.6 million km² representing a population density of 0.34 people/ha.[1] Or, to put it another way, there are about 3 ha of geographic land available per person in the SAT to provide food, clothing, shelter, and the wherewithal to invest for the future, as well as to augment the necessities of life at the present population level. In some SAT countries, the population/land equation is far in excess of the 0.34 average. For example, in India the density is almost five times the SAT average, while in Nigeria it is twice. This means in SAT India there is only 0.6 ha of land for each person, while in Nigeria there is 1.5 ha. Since not all this land is arable, the picture is even more serious than these figures indicate.

It is the generally high population/land pressure in the SAT — along with the primary dependence on uncertain rainfall and nutrient-deficient and often eroded soils — that poses the most significant physical constraint to de-

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1. Land areas are on a geographical basis. The source for most of these data are Ryan (1974, 1978), with appropriate updating.

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velopment. When this is combined with the high population growth rates, the problems for agricultural research become urgent. These population growth rates are as follows:

SAT region	*Population growth*[2] (% p.a.)
Asia	2.45
Africa south of Sahara	2.50
South and Central America	2.70
Near East and North West Africa	2.90
Total SAT	2.50

More than 75% of the population of these countries depend on agriculture for their livelihood, particularly the people who reside in the SAT regions.

These statistics reveal to some a gloomy prospect for the SAT. However, at the same time there are some hopeful signs. First, more recent population growth rate calculations suggest that in many of the less developed SAT countries the rates of increase have begun to slow down (World Bank 1974). The reasons seem to be that the rapid increases in life expectancies since World War II — resulting from substantial public health programs aimed at controlling malaria, tuberculosis, smallpox, cholera, etc. — have begun to taper off. Also, birth rates have been declining as people incorporate this information about increased life expectancies into their decisions on family size. To have one's children alive when one reaches old age is now much more probable than it was 25 years ago. Since 1950, the life expectancy at birth in many low-income countries has increased 40% or more (Ram and Schultz 1977). For India, male life expectancy at birth between 1951 and 1971 rose from 32.4 to 47.1 years, an increase of 45%; for females, the increase was 44% — from 31.7 to 45.6 years. To the extent that part of the demand for children in less developed countries is to provide social security for old age (Mamdani 1972), these increased life expectancies must further reduce the demand for children.

These are simple averages of individual country growth rates as reported in Ryan (1974). Data cover the period prior to 1971.

The increase in life expectancy, resulting primarily from improved health and/or nutrition, also implies an increase in the quality of labor — or enhanced *human capital*. These improvements have positive impacts on production (Ram and Schultz 1977). Increased investments in schooling, which are also occurring in low-income countries, further augment their stocks of human capital. Preston (1976) suggests that the decline in mortality leads to increased incentives for people to invest in schooling.

Hence, while demographic events in less developed countries on the surface have resulted in what many would call physical constraints on development, a more informed view suggests that these same events have also led to an increased investment in humans; this, in turn, is expected to lead to a greater potential for populations to deal with the economic disequilibria that characterize economic modernization (Schultz 1975).[3] Viewed in this perspective, the high population/land ratios of much of the SAT need not be a negative factor in the prospects for growth of food production and enhanced development in these countries.

The predominance of subsistence-oriented farming in SAT countries is a current fact; ICRISAT is designing its technologies to explicitly recognize this, especially in the short run. However, we are not restricting ourselves to this concept in the long run. There is evidence (Doherty 1978) that in commercialized agriculture, where reliance on unskilled and family labor is less than in subsistence-oriented agricultural sectors, birth rates are also considerably less. Planning agricultural technology that allows or even encourages commercialization itself can have a restraining influence on population growth.

Heterogeneity of Resource Endowments

The heterogeneity of the SAT is a factor which makes technology design a difficult exercise for an international center. This is why we have

3. We do not have precise information on health and schooling in countries other than India at this time. However, similar trends in life expectancies and fertility are occurring in many developing countries (World Bank 1974).

devoted considerable effort to characterizing the SAT, to ensure that our research is focused on the priority problems and regions. In India the SAT population/land ratio is about 1.7 persons/ha, while in SAT Africa it averages only 0.14; this means that technology design in these two regions must embody different characteristics.[4] In SAT India, with its abundance of animal draft power, ICRISAT has opted for technologies that use labor and animals but save scarce land. On the other hand, in SAT Africa the emphasis may be more toward labor-saving and land-using technologies, with the possibility of mechanical innovations also (Ryan 1974, Subrahmanyam and Ryan 1975). In SAT India, it seems from the work of Binswanger (1978a) that, except in special circumstances, tractors may not be a desirable component of new technologies. Therefore, our primary focus at ICRISAT — particularly in farming systems research for India — has been on developing improved soil, water, and cropping systems that can be implemented with animal-powered implements supported by human labor, resources that are relatively abundant.

The heterogeneity in the resource endowments of the SAT regions of the world has led ICRISAT to use the concepts of induced innovation espoused by Hayami and Ruttan (1971) in their now-famous book *Agricultural Development: An International Perspective*, and subsequently elaborated by Boyce and Evenson (1975) and Binswanger et al. (1979). This has helped guide research resource allocation decisions and the search for new techniques of production. Although this has often been more at the macro end of the spectrum (Ryan 1974, 1978, Doherty 1978), these concepts are increasingly being applied at the micro or farm level (Binswanger et al. 1976, Binswanger and Ryan 1977, Ryan and Rathore 1978, Jodha 1978, Doherty 1979).

Infrastructure

There are substantial differences in the infrastructural support systems in the 48 less developed SAT countries. India has a well-developed marketing system for crops (von Oppen 1978a); a widespread road, rail, electricity, and communications network; rural credit facilities that are improving each year; large-scale fertilizer and pesticide manufacturing and distribution facilities; and a sophisticated agricultural research and training network. Other SAT countries such as Brazil, Mexico, Thailand, Nigeria, Senegal, Rhodesia, and Argentina are also relatively well-endowed with infrastructural facilities of this type. Even in these countries, however, there is an imbalance in the regional distribution of facilities, with the urban areas and the non-SAT agricultural regions with higher and more assured rainfall generally receiving a disproportionate share of infrastructural investments. Nevertheless, these countries are in a far better position than such SAT countries as Mali, Chad, Sudan, Ethiopia, Niger, and Upper Volta.

In the short run, infrastructural constraints will mean that all SAT farmers will not be able to fully adopt technologies that offer high payoffs to investments in purchased inputs such as fertilizers, pesticides, and improved implements; rather, adoption will be a sequential process. ICRISAT must therefore evolve technological options that will fit the varying infrastructural support systems prevailing in different SAT countries. At the same time, it should be recognized that a prerequisite for infrastructure improvement in these countries is a demand for improvements such as fertilizers, credit, roads, markets, and communications, resulting from development of technologies that make profitable use of these inputs. We believe this demand must be there in order to convince governments and international donor and aid agencies of the need to supply improved infrastructural facilities. These are the precursors of development and growth. Research in the Economics Program by von Oppen and his colleagues (1979) has demonstrated the gains in productivity that can be achieved from investments in establishing markets, in improving roads and communications, and in enhancing interregional trade opportunities. Gains from improvements in interregional trade flows were shown to be substantially greater under circumstances where technological change is occurring differentially in the regions concerned.

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4 The differences are even more extreme between countries: the lowest ratio is in Botswana, with 0.02 people/ha, or 1% that of India.

International and national agricultural research institutions must not focus solely on input and management-intensive technology; other technological options, which make better use of the extremely limited infrastructural facilities found at present in many SAT countries, must also be a part of the portfolio.[5] As Ryan and Subrahmanyam (1975) have shown, there seems to be a real scope for development of technological options that offer substantial payoffs to farmers with limited access to infrastructural facilities while at the same time allowing those with better access to reap additional benefits. There need be no trade-off made here in designing technologies that offer improved productivity and income to farmers regardless of where they are located on the infrastructural spectrum; a single package-of-practices approach will not be the correct philosophy in this context.

At ICRISAT we have adopted an approach to research that embraces the concept of technological options. In the Farming Systems Research Program, for example, a series of experiments has been under way for several years to evaluate the individual and complementary effects on yields and yield stability of various levels of fertilization, soil and water management, and crop varieties. These are termed "steps in improved technology" experiments.

The watershed-based research of the FSRP has aimed at development of soil- and water-management technologies that make use of the natural drainage unit. In this, we have examined the differential effects of various sized watersheds, with particular emphasis on the scope for group action among farmers (Doherty and Jodha 1977). Are there benefits to be gained by individual farmers from adoption of parts of the complete watershed-management technology, such as the broadbed-and-furrow method of cultivation? Or will several farmers with contiguous land parcels on a watershed have to agree to manage their parcels jointly in order to reap significant gains?[6] In addition to being examined on research stations at ICRISAT and in cooperating national programs, these issues are being taken to carefully selected villages in the SAT. It is only at the village and farm levels that such questions can be satisfactorily answered, through cooperative experiments with farmers, national program scientists, and ICRISAT scientists working together to identify the viable elements of prospective technologies and to learn from each other. (See Binswanger and Ryan, this symposium.)

In the crop improvement program of ICRISAT, the advanced cultivars and lines are being selected under high and low levels of fertility and management. Before elite lines are released to national programs, they are tested to ensure that they are not only superior to existing cultivars at the higher fertility management levels, but also that they are clearly superior at very low levels.

Risk

The SAT environment is a risky one. The risks derive from various sources. Weather is often thought of as the most significant factor influencing the riskiness of farming in the SAT; however, weed, pest, and disease incidence — along with fluctuations in market prices — are among some of the other major contributors. Studies conducted by Barah at ICRISAT and reported in Binswanger et al (1979) have shown that in the regions of SAT India where there is little irrigation and low average rainfall, the largest component of overall risk is crop-yield variability rather than price variability.[7] In the higher rainfall regions and or those with a substantial proportion of irrigated land, the contribution of price risk is higher than that of yield risk.

Ryan (1974) calculated the coefficient of variation (CV) of yield for the two major SAT

5. There is increasing evidence that the national and international community is recognizing the key role of agriculture and its associated infrastructure in the economic growth of less developed countries. For example, after the Sahelian drought of the early 1970s, substantial funds were made available to the Sahelian countries to develop their agricultural sectors.

6. In India there are almost five parcels of spatially separated land comprising the average holding (Ryan 1974).

7. Risk was measured as the variance of gross returns over time from the cropping patterns of the districts comprising each region.

cereals as follows:

SAT region	Coefficient of variation of yields (%)	
	Sorghum	Millets
India	9.4	22.2
Other Asia	9.8	14.1
Africa south of Sahara	11.5	14.9
South and Central America	17.0	12.4
Near East and North west Africa	2.3	11.6
Average SAT	11.7	14.4

Generally the CV of annual rainfall in the SAT regions rises as the average annual rainfall decreases; that is, those regions where rainfall is generally lowest are also those where fluctuations in annual rainfall are larger. This is reflected in the above table, where the variabilities in millet yields are greater than those in sorghum. Millets are primarily grown in the regions where rainfall is lower and more highly variable. In eastern Rajasthan, India, for example, where millets are mainly grown, the probability of a drought of moderate or worse severity is almost one in three. In the sorghum-growing areas such as Andhra Pradesh, Madhya Pradesh, Karnataka, and Maharashtra, the probabilities are less than one in four (Ryan 1974).

Research at ICRISAT explicitly recognizes the nature and significance of risk facing farmers of the SAT. In the Farming Systems Research Program, much of the research is predicated on the notion that water is the most limiting natural factor in SAT crop production. Research in soil and water management, agroclimatology, environmental physics, and cropping systems is aimed at making more effective and economic use of rainfall, soil moisture, runoff, and groundwater for increasing and stabilizing crop production. In crop improvement, entomologists, pathologists, physiologists, and microbiologists are working with plant breeders to develop cultivars resistant or tolerant to such "yield reducers" as insects, pests, pathogens, drought, and soil nutrient deficiencies. Success in these programs would mean less risk of crop failures.

The field-scale research in development of improved soil, water, crop, and implement management technologies at ICRISAT is carefully monitored by the agronomists, engineers, economists, and anthropologists in a multidisciplinary team approach extending beyond the research station into the villages. Not only is the technical, economic, and social viability of prospective technologies analyzed, but their effects on risk are also gauged. For example, such analyses have confirmed that intercropping is not only more profitable than double cropping but also less risky (Ryan et al. 1979).

Economists have researched the extent and determinants of risk in the SAT and of the attitudes of farmers to these risks. In a study of 330 ruralists in Andhra Pradesh and Maharashtra, Binswanger (1978) found all farmers moderately risk averse when faced with choices of varying profits and risks. If this reflects risk attitudes of SAT farmers in general, it suggests that separate technologies with different risk characteristics for small and large farmers are not required. Farmers will invest in technologies that have some risk, provided the profits are attractive. The fact that small farmers often may not have participated as much as large farmers in previous technological innovations may have been due more to unequal access to infrastructural support facilities than to any great aversion to taking risks. This research therefore suggests that institutional policies are required to give small farmers equal access with large farmers to credit and modern inputs.

Market Parameters and Preferences

The two cereals of ICRISAT's mandate, sorghum and pearl millet, and to a lesser extent the two pulses, chickpea and pigeonpea, are what may be termed staple food in the SAT. As such we *expect* them to be faced with relatively small price and income elasticities of demand. That is to say, if their prices fall by 10%, we expect consumer demand to increase far less than that. If income increases by 10%, we expect consumption of these staples to increase only marginally and possibly even to decrease.

Very little precise information is available on demand elasticities. What is available is at an

aggregative level, often not suitable for the type of policy analyses to be undertaken.

The picture with respect to market information on groundnut is similar to that of the four foodgrain staples, except that this is a commodity that enters commercial market channels to a much greater extent. Raju (1976) estimated that in India around 60% of total groundnut production reaches markets. The figure for sorghum and millets is 15 to 20%; for chickpea and pigeonpea, 35 to 40%. With groundnuts, where national and international trade occurs in three components — hps (hand-picked selection) kernels, oil, and oilcake — the parameters of demand for the various countries are much more complex, but still are as necessary to know as are the parameters of staple foodgrain demand.

If staple foodgrain demand is as inelastic as expected, then technological change that shifts supply functions will generate substantial price declines. Hence, the market demand for them could place constraints on sustained increases in foodgrain supplies, as farmers subsequently react to their depressed relative prices. By how much will farmers' supply respond to changes in these prices? Again, we know very little about farmers' supply response to market price changes and to other variables for these four foodgrain staples and for groundnuts. ICRISAT has been undertaking research into these questions to help fill the void (Bapna 1976, von Oppen et al. 1979). With the aid of these market parameters, price and trade policy questions can be more adequately addressed by policymakers in SAT countries, especially those where supplies of these commodities become more abundant following technological advances. Policies designed to enhance technology adoption and increase welfare can also be formulated with these more precisely estimated parameters.

Consumer preferences for evident and cryptic quality characteristics in foodgrains are often well defined and are reflected in differential prices in the market (von Oppen 1978b, 1978c). Failure of researchers to develop new cultivars with characteristics acceptable to consumers can adversely affect adoption and relative prices. Past experience with some of the new wheat and rice cultivars testifies to this. In SAT India, for sorghum and pearl millet, we need to consider factors such as seed size, color mix, swelling capacity in water, cooking time, chapati-making quality, and protein and calorie content. For the pulses, instead of chapati quality, we need to consider dhal-making qualities. In the African SAT, other preparations such as cous-cous, beer, and gruel are considered for the two cereals.

ICRISAT breeders, biochemists, and economists are working together to determine more precisely what characteristics consumers prefer, by how much, and whether there is genetic scope for breeders to manipulate these various attributes into viable grain types that lose none of the other important characteristics we are breeding for, such as high and stable yields (von Oppen and Jambunathan 1978)

Human Nutrition

One might say that the problems of inelastic demands and consumer preferences for the staple foodgrain crops of the SAT are concerns for ICRISAT in the short to medium term only. To an extent, this is true, as in the longer run population and income growth are projected by many agencies to place excessive strains on food supplies, particularly in SAT countries. In the less developed countries, demand for coarse grains is expected to triple by the year 2000. Some 60% will be for human consumption and the rest for animals (Kanwar and Ryan 1976). Demand for coarse grains in all less developed countries is estimated to grow by 3.23% per year in the future. In the decade from 1964 to 1974, the SAT production of sorghum and millets together rose at a compound rate of only 2.11% per year, made up of 2.81% for sorghum and 1.24% for millets (Table 1). If this continues into the future, serious imbalances in supply and demand will occur in the less developed countries of the SAT. Studies reviewed by Ryan (1978) suggest these cereal deficits could be between 17 and 37% by 2000 A.D. If not corrected by trade flows from developed countries, which are projected to have a demand growth of only 2.14% per year with recent production trends of 3.48%, the nutritional welfare of some of the poorest people in the world — those of the SAT — will be severely reduced. This will be especially true in Africa, where cereal deficits are expected to be worse than in Asia.

A more adverse long-run supply/demand

Table 1. Annual compound growth rates of five major crops in the less developed countries of the SAT during 1964–74.

Crop	Area (%)	Yield (%)	Production (%)
Sorghum	0.71	2.08	2.81
Millets [a]	0.04	1.20	1.24
Chickpea	−1.29	1.46	0.15
Pigeonpea	−0.08	0.83	0.75
Groundnut	−0.40	0.02	−0.38

a. Includes pearl millet (*Pennisetum americanum*), as well as the minor millets such as *Setaries*, *Panicums*, and *Eleusines*.
Source: Ryan (1978).

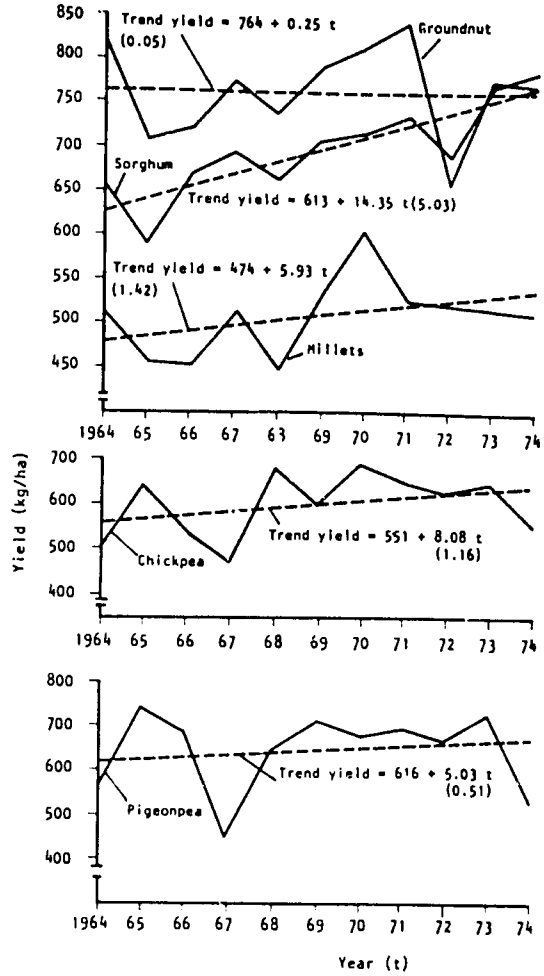

Figure 1. Yield of five crops grown in less developed countries of the SAT from 1964 to 1974. (Figures in parentheses are t-values.)

balance is projected for the pulses than for the cereals. Here the deficit in the less developed countries is estimated to be around 50%. For oilseeds, it will be closer to 40%. India and Africa are likely to have equally large deficits of pulses and oilseeds.

The long-run answer to alleviating these projected food deficits is increased crop yields. As Table 1 and Figure 1 indicate, yields have been virtually stagnant for groundnuts and pigeonpeas in less developed countries of the SAT. They have been moderately better for chickpea, millets, and sorghum. In view of the increasing pressure on arable land, particularly in SAT Asia, the long-run need is for land-augmenting and capital-saving technological change that will have the effect of increasing yields per unit of land and capital. In SAT Africa and South America, where land constraints are not as immediately binding, emphasis should also be given to labor-augmenting technological innovations.

Emphasis on technologies that increase food production per unit of the scarcest resources will also directly contribute to the alleviation of the major nutritional constraint in the SAT — energy. Studies by Ryan, Yadav, and Sheldrake (reported in Ryan 1977) showed that calories, vitamin A, vitamin B complex, and selected minerals were the primary nutritional deficiencies in diets of the people in the SAT, even those with low incomes (proteins and amino acids were not found to be as deficient as was earlier believed). Breeding strategies that emphasize yield and yield stability offer the best prospects for improving the nutritional well-being of the least nutritionally and economically affluent groups in the SAT. This is the primary strategy of ICRISAT, and it finds more support from an analysis of the net nutritional impact of the new dwarf cultivars of wheat introduced into India in the mid-1960s. Ryan and Asokan (1977) found that, even allowing for the reductions in pulse production to which the new wheats contributed, the net production of energy, proteins, and amino acids was substantially higher with

the new wheats than it would have been without them.

Increased yields and production of foodgrains have a direct impact on prices and real incomes of the least affluent groups, who spend a large amount of their incomes on these foodgrains. Increased real income will enable them to purchase additional foodgrains and improve their nutrition. If yield potentials of cereals, pulses, and oilseeds could all be increased, nutritional improvements would follow, as these crops have complementary nutritional compositions. ICRISAT will continue to search for cultivars with better nutrient compositions also, as long as this does not unacceptably affect the attainment of increased yield and yield stability.

Efficiency and Equity Concerns

As a whole, the SAT region is probably the poorest in the world, with an average gross domestic product of about $160/yr per capita (Ryan 1974). The fact that ICRISAT was established to undertake research for the benefit of the SAT signifies that any productivity gains that might result from its efforts will directly benefit the poorest sector of humanity. The initial choice of the SAT region and its staple foodgrain and oilseed crops as the mandates of ICRISAT ensures that efficiency and equity considerations at the macro-level are not in conflict. However, there are potential conflicts between efficiency and equity concerns as we move to the regional, village, and farm levels within the SAT.

The first of these relates to the allocation of research resources amongst regions and countries within the SAT, and also among the various research programs. Research resources should be allocated to achieve maximum productivity gains consistent with interests of the various potential beneficiaries. This is not an easy task in an ex ante framework (Binswanger and Ryan 1977). It is one where techniques such as Boyce and Evenson's (1975) congruence technique can be helpful, as indeed it has been at ICRISAT (Ryan 1978).

A second concern is the effect of the unequal distribution of land on the allocation of research resources. Biological innovations are usually divisible and hence scale-neutral. Scale economies generally arise with mechanical innovations. A strategy favoring small farmers should thus discourage research resource allocation to techniques requiring large-scale or expensive machines. In this context, little conflict between efficiency and equity should arise, since most mechanical innovations are labor-saving and unlikely to result in large efficiency gains in low-wage countries. This has guided ICRISAT in its strategies regarding tractors, as mentioned earlier.

There is evidence that large and small farmers in SAT India do not fit uniformly into two distinct factor endowment ratio groups. Although Ryan and Rathore (1978) found significant differences in mean levels of factor *endowment* ratios, these differences were reduced when factor *use* ratios were considered. The operation of factor markets in the villages was such as to tend to equalize factor *use* ratios although not completely. Even more relevant was the fact that variability of factor ratios within farm size groups was so large that it was impossible to delineate small from large farms. It would seem from this that at the micro-level the type of technology relevant for large farmers will not be basically different from that for small farmers in factor saving using characteristics. There need not necessarily be a search for substantially different technologies for small and large farmers. Improving factor market access and providing for technology options should be all that is required, as was mentioned earlier in this paper.

There may be research activities that might favor particular socioeconomic groups and that can be identified after careful study of farming systems at the village level. For example, Jodha (1977) found from ICRISAT's Village-Level Studies that the practices of intercropping and rainy-season fallowing postrainy-season cropping of deeper Vertisols were more prevalent on the smaller farms in SAT peninsular India. This suggests that successful research on new intercropping technologies and on technologies that allow a rainy season crop to be grown on deeper Vertisols will not only have large productivity effects but will also be of relatively large benefit to smaller farmers. These two problems are receiving major attention in ICRISAT's Farming Systems Research Program.

In the Asian SAT, there is a large population of landless agricultural laborers. There are signs

in some of the more densely populated African SAT countries, such as Nigeria, of an emerging landless labor class. In designing agricultural technology, the interests of this group must not be forgotten. Labor-using technology will always be in the interests of landless labor; labor-saving technology will not, as Binswanger and Shetty (1977) point out is the case with herbicide technology.[8]

Hired females are a major source of labor in SAT agriculture, especially in India. They are generally the most disadvantaged in terms of wage rates and employment probabilities. This seems especially true for those from the landless households (Ryan and Ghodake 1979). For this reason, and because of the negative effect of work participation on female fertility, their role must be explicitly considered in the design of new technology. ICRISAT has recognized this from the outset.

Conclusions

The SAT being the poorest region in the world, ICRISAT is committed to strategies that will help alleviate constraints on its food production and development. Indeed, it seems clear that the major factor involved in enhancing SAT development is improving the productivity and stability of food production, thereby allowing the release of necessary resources for other developmental activities. The source of much of these gains will be agricultural research, to which national and international programs in the SAT and other countries are contributing, frequently in cooperation.

In attempting to make these contributions, it is our contention that socioeconomic factors or constraints must be explicitly considered. This is true both in the ex ante framework of research resource allocation questions and when technology is being "marketed." This is a continuing process requiring close collaboration among scientists of many disciplines. New socioeconomic constraints arise almost weekly; research institutions must be able to evaluate the likely effect of these on agriculture and design appropriate strategic responses.

A good example of this was the substantial oil and fertilizer price rise in the early 1970s. Many inferred that the oil price rise caused the fertilizer price rise; therefore, as oil prices were likely to rise further in future, new cultivars that could yield well with zero fertilizers should be the major focus of plant breeders. The answer was not as simple as that. Fertilizer prices are indeed affected by oil prices, but not proportionately; oil is a small component of fertilizer costs. Fertilizer prices are now almost at their lowest ebb (in real terms), whereas oil prices are at their highest — a complete reversal of the implied relationship after the early 1970s oil crisis! Other factors, such as fertilizer plant capacity, growth, and demand, are more important in determining fertilizer prices. The problem of how to respond to the likely future fertilizer situation still confronts research institutes such as ICRISAT. It involves questions such as the likelihood of future relative price changes, the scope for developing fertilizer-saving technologies, and their gestation periods. Scientists of many disciplines are required to sit down and assess these types of issues together. The stakes are high.

The SAT farmers may be poor in resources but are certainly economically rational agents willing to take some risk on attractive rewards.

Given appropriate incentives from superior technologies and appropriate economic policies, farmers can be expected to innovate in their production and marketing practices. If we better understand their aspirations and the constraints under which they operate, technology design and economic policies are more likely to fit their needs.

8. As the landless also are at the low end of the income spectrum, ICRISAT's research on the staple foodgrains will further benefit the landless via reduced relative prices of these major items in their consumer budgets.

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