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RESEARCH NOTES ON AGRICULTURAL CAPITAL FORMATION
AND TECHNOLOGICAL CHANGE

The Ohio State University

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These notes report on preliminary findings of a continuing research project. The data and conclusions are tentative and formal reference to them should be cleared with the authors.

I - Objectives

In 1969 the Ohio State University/USAID Capital Formation Project initiated farm level research in Brazil in conjunction with several Brazil institutions. The focus of this research has been on rural credit and technological innovations as factors in stimulating farm modernization and capital formation. Most of the research has been concentrated in southern Brazil, but some of the general ideas and preliminary results have been discussed with knowledgeable persons in the NE.

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The results of this and other research suggest some important conclusions with serious implications for future agricultural growth in Brazil. Although some of these results are still in preliminary form and require additional testing before solid conclusions can be made, we have decided to call attention to them now with the hope they will be of immediate value to policy makers, and perhaps other researchers will be encouraged to test these ideas in their own research programs. Additional research results from the Capital Formation Project, either supporting or refuting these conclusions, will be distributed as they become available.

II - Economic Justification for Credit and Price Programs

Before delving into the specifics of the Brazilian case it is useful to recall the economic justification given for adopting credit and price programs favorable to agriculture. Within the context of agricultural growth, government intervention in agricultural credit policies, and factor and product pricing mechanism is undertaken for two basic reasons:

- a) To induce farmers to employ new technology, and
- b) To reduce economic and social inequities that arise from existing market mechanisms.

In the first case, favorable credit and/or price policies are instituted to induce farmers to initiate or accelerate the adoption of improved technology. The objective is to temporarily increase the profitability or reduce the economic risk associated with adoption, as well as provide the financial means for acquisition of the required inputs. Policy instruments commonly used include subsidized factor and product prices, guaranteed minimum product prices, expansion of total credit available to agriculture, and improvement in loan terms including subsidized interest rates.

The economic rationale for these policies is that the evolutionary adoption process will operate too slowly to take maximum advantage of technological innova-

tions, or that some groups of farmers will be systematically excluded, as is the case when low income farmers are faced with techniques requiring high initial investment costs. A fundamental assumption is that unused output increasing technology actually exists, or will soon become available, and is economically preferable to traditional production methods. After the technology has been adopted, no economic rationale exists for continued favorable policies. Indeed it would be expected that some factor and product prices would eventually fall below previous equilibrium levels. A continuation of market disequilibrium through intervention will eventually lead to overcapitalization in agriculture and misallocation of productive resources.

Substantial growth in agriculture can be achieved by the judicious and selective application of credit and price stimulus. There are real social and economic costs, however, to following policies that induce farmers to invest in temporarily profitable alternatives which in the long run, at equilibrium prices, are economically unviable. First, the total cost of inducement will be high. Secondly, pressure for continued intervention will be great and economic and social adjustment painful when support is withdrawn. Therefore, policies interfering with normal market mechanisms should be undertaken only for short periods of time with specific well-defined objectives, when it is reasonably certain that an inefficient agriculture will not be fostered or perpetuated.

In the second case, government intervention is intended to reduce economic and social inequities in existing market mechanisms. Problems to be redressed include, among others, unequal distribution of scarce resources among different groups of farmers (i.e. credit for small farmers), large seasonal fluctuations in product prices, and undue market concentration by a few input and product firms. Each is unique to a particular situation and requires a specific problem-oriented solution. Solutions may be short- or long-run in nature.

Other reasons put forth as justification for government intervention include fostering domestic production of strategic products and maintaining agriculture incomes. These are largely political issues, and intervention encourages the same misallocation of resources and/or perpetuation of inefficient agricultural organization mentioned above. Agricultural policies used for these objectives must be justified on other than economic grounds.

III - Brazil's Agricultural Development Strategy

During the past ten years, the Brazilian government has selectively employed credit and price policies to accelerate agricultural growth. The most important of these has been a substantial increase in institutional credit made available to the agricultural sector. As a result, the ratio of credit to gross agricultural product increased from .18 to .34 during the period 1960-1969. From 1965 to 1968, the real value of agricultural credit almost doubled.⁽¹⁾ Since interest rates on most institutional credit ranged from 9 to 18 percent per year while inflation varied from 25 to 85 per cent, real interest rates were substantially negative.

Minimum prices have been employed for some agricultural commodities. This program has often not been effective because the rate of inflation has been so great that established prices have been less than those received in the market at harvest time. Wheat, however, is an important exception.

These policies have stimulated the use of modern inputs. Fertilizer use increased from 237 thousand metric tons of NPK equivalents in 1962 to 630 thousand metric tons in 1969. In Rio Grande do Sul and Santa Catarina, fertilizer use increased from 34 thousand tons to 151 thousand tons during the same period.⁽³⁾ Consumption of improved seeds has also risen, and agricultural mechanization has rapidly expanded.

The agricultural growth rate has risen from an annual rate of 3 to 4 per cent per year in the early 1960's to 6 to 8 per cent in the late 1960's. Expansion of wheat, corn, and soybean production has been particularly noteworthy. During the 1962/63 to 1970/71 period, wheat production quadrupled from 400 thousand to 1600 thousand metric tons and brought Brazil to 50 per cent of self-sufficiency with prospects for even greater future production. Rural communities have benefited through increased activity in local factor and product markets. (18)

These policies have contributed to an increase in farm income, and some increase in agricultural productivity. However, a major portion of growth seems to have originated with an expansion in area rather than per unit output increases, even in areas of fairly intensive agriculture. Furthermore, the major impact has been largely restricted to Southern Brazil.

IV - Impact of the Agricultural Development Policies in Southern Brazil

Considerable research has been and is being conducted in Southern Brazil on the farm level impact of these development policies, with special attention directed to the use of modern inputs. The lessons to be learned from the research have important implications for policy makers in Southern Brazil and elsewhere.

While the important growth stimulus of these policies cannot be denied, several important limitations are now evident. The general conclusions are that these policies have been selective in favoring large farmers, have distorted the allocation of both variable and fixed capital investments, and have in large measure already exhausted the possibilities for additional productivity gains using known production technology on affected farms.*

* For a more detailed discussion of each conclusion that follows, the reader is referred to the appropriate reference.

1) Agricultural Credit is necessary for stimulating input use

The use of agricultural credit is closely related to the increased use of modern purchased inputs. On farms where substantial amounts of these inputs are used, new credit (*) is equal to 50 to 75 per cent or more of annual operating expenses. (20,21) Increases in fertilizer use at the national level are closely correlated with increases in agricultural credit. (19)

2) Over Capitalization in Agriculture is occurring

Agricultural policies including subsidized interest rates (in most cases negative real rates of interest), have stimulated the use of modern inputs, especially fertilizer, up to and even beyond the point of optimum economic utilization. (19, 20)

Abnormally high product prices (wheat) have been associated with intense capitalization of agriculture (principally mechanization). Simulated farm models using lower levels of price subsidies generated optimum solutions with more diversified enterprise combinations requiring more intensive use of less machinery. (10)

3) Low levels of Productivity are apparent

The optimum economic level of fertilizer use in some crops is reached at input and yield levels substantially below those observed in other major producing countries with similar factor-product price relations. For example typical average yields for fertilized crops are: corn, 15-20 bushels per acre and soybeans and wheat, 10-15 bushels per acre. Water availability and reliability does not appear to be a significant factor in explaining these low levels. Rather, it appears that major breakthroughs in production technology are

* Total new loan obligations incurred during the year.

prerequisite to additional productivity gains. Research is needed in soil fertility and management, and development of new varieties capable of effectively utilizing heavy applications of chemical fertilizers. (15,19)

4) Policies are more favorable to large farmers

It is apparent that the impact of these general policy instruments has been selective in favor of medium and large farmers. Probably the original conception of the policies did not explicitly consider the size issue, but in implementation conditions are more favorable to larger farms. Actually, in the case of credit, attempts are made to favor small farms (a notable exception would be credit for mechanization which in practice is most applicable to large farms).

Small farmers generally use considerably less modern inputs, have a smaller ratio of credit to operating expenses, yet demonstrate higher marginal returns to the use of additional inputs than do larger farms. However, the experience of larger farms would indicate that the magnitude of productivity gains is limited for small farmers as well. Some readjustment in policy and implementation should, however, result in modest productivity and income improvements for the smaller farms. (20,4)

5) Economic opportunities exist on small farms

Special development programs (pilot areas) which have included a package of inputs plus credit and limited technical assistance have prompted significant increases in credit and modern input use in small farm regions. (11)

6) Administrative policies lead to inequitable distribution of Credit

Credit policies and procedures may be largely responsible for the lack of credit use (and consequently modern input use) by small farmers. High marginal returns suggest sufficient demand to use credit if it was functionally available. Therefore it is probable that a supply allocation problem exists. Given the great demand by large farms for subsidized credit, increasing supplies

of institutional credit may never reach small farms because they represent higher risks and administrative costs for profit oriented credit institutions. (10)

These several research findings indicate that credit policies and price subsidies have been instrumental in some areas of Southern Brazil in stimulating the use of new production inputs and accelerating the growth of output. The overall results, however, have been less than spectacular. Furthermore, it appears that those farmers most affected by the policies have already exhausted known opportunities for productivity increases through easily adoptable technology. Massive programs to further stimulate input use are not warranted until production technology is improved. Thus the relatively easy increases in output obtainable by manipulating market mechanisms have been exploited in Southern Brazil, and the complex long-term task of basic research must be confronted.

V. Contrasting Results in the Northeast

Ever since the disastrous drought of 1877, Northeast Brazil has been an area of special concern. Considerable public and private funds have been channeled into hydraulic investments, industrial development, and agricultural modernization. During recent years, credit has been subsidized and broadly distributed; some product prices have been subsidized and stabilized; marketing and transport systems have been studied and some recommended improvements adopted; research and extension have been stimulated through increased funding and a proliferation of organizations. Yet the results have fallen far short of those desired, and the same or similar policies have produced proportionately less development and growth in the Northeast than experienced in the South. This section of the research note reports on a preliminary attempt to explain why.

Farm level, economic research similar to that undertaken in Southern Brazil has not been conducted in the Northeast. Correct information concerning credit, input use and production response at the farm level therefore, are not available. As well, hard data on the probable physical response of widespread adoption of modern inputs for the varied soil, water, and climatic conditions of the Northeast do not exist. Those experiments which have been conducted and are documented often show conflicting results. Therefore it is impossible to accurately calculate optimum allocation of productive resources. Likewise, data on credit utilization and distribution are extremely sketchy. To study the impact of agricultural policies in light of such data limitations, the authors first discussed development issues with technicians of various state, regional, and federal agencies in Recife and Brasilia. The impressions obtained were subsequently tested by interviewing local bankers, agronomists and farmers in the Northeast. In view of this data limitation, and lack of published material to support the conclusion drawn, considerable more detail is presented in this section of the report.

When analyzing agricultural development problems, one must be cognizant of the substantial regional differences in present and potential agricultural organization and output within the Northeast. Moisture availability and distribution, for example, are the principal limiting factors in the Sertao and Agreste. Sufficient rainfall is available for many forms of agricultural production in the Zona da Mata, but a semi-feudalistic system of sugar cane production on large farms under an umbrella of quotas and price supports has effectively dampened the appearance of, or experimentation with, other systems of agricultural production in that region. The potential impact of credit and price policies also reflects these differences. Therefore, the following discussion treats the Sertao and Agreste together, and a subsequent section deals with the Zona da Mata.

Sertao and Agreste

During the interviews, five questions were asked and the results are reported below. Although conditions vary widely between and within the two regions, the responses were surprisingly uniform. However, if solutions to the problems identified are to be effective, they will have to be area specific in design and implementation.

1) Does a modern profitable technology exist?

In general, existing research results do not show positive economic returns from using purchased inputs. Certain exceptions, tomatoes for example, are apparent. Farmers generally support the experimental findings by not using modern inputs.

The reasons for the unprofitability of "high return inputs" are numerous. Extreme variability in soils, climate, and water availability increases the risk associated with adoption. Farmers are reluctant to incur additional operating expenses when many production factors are largely beyond their control. Furthermore, current varieties do not respond well to chemical fertilizers under limited water availability in certain soils. In most cases, the natural soil fertility is sufficient to meet plant nutrient demands with normal rainfall. Wide year to year variability in yields, partly due to variation in rainfall, masks the possible modest response that may be attributable to fertilization. One would conclude that gains from new technology must be substantial and highly visible to foster acceptance by the farmer. In the few isolated instances where this has occurred, adoption has been fairly rapid.

Irrigation is a logical answer to inadequate and unpredictable rainfall. However, experience has shown that the salt content of water and soil within the region is often sufficiently high to cause serious salinity problems after just a few years of irrigation. Furthermore, high development costs of practically all irrigation projects to date impose severe economic limitations even when technical problems are minimal. (12)

2) Is there sufficient institutional credit available to meet current farmer demands?

The answer to this question is a definite yes; in fact evidence suggests that much of the current credit is actually being used for relatively non-productive purposes. Except in special cases, farmers generally do not use nor consider profitable modern inputs such as improved seed and fertilizer. Therefore credit obtained for operating expenses is applied to hired labor, minor investments, livestock purchase, and perhaps most importantly, family consumption expenditures. Most bankers interviewed felt that a major portion is used for consumption. On small farms this credit is applied to family living expenses during low income periods; on larger farms some of it finances the necessities of laborers and sharecroppers. Both cases represent a relatively unproductive use of subsidized credit intended to stimulate use of improved technology.

This conclusion was supported by bankers' unanimous response that there is no credit constraint in meeting farmer demand. In fact, sharp competition has developed between the federal banks currently authorized to loan at rates of 7 to 10% per year, while the state and private banks must follow a 13-17% interest schedule. While the federal banks have no trouble meeting the demand for agricultural credit, other banks are faced with insufficient demand to exhaust available supplies at negative real interest rates.

A further indication of an adequate or super adequate supply of credit is the relative position of the Northeast in terms of credit used per unit of gross output. Northeast Brazil uses approximately the same percentage of credit to output as the rest of the country (22) yet considerably less modern inputs. Labor and land are still the principal factors of production. This implies a correspondingly lower cost to output ratio, indicating less need for operating credit. The fact that credit use is still high supports the bankers'

view of substantial diversion of credit resources to non-productive use.

3) Are there significant inequities in the distribution of credit use among farmer groups?

As a general rule, larger farmers are obtaining more institutional credit than small farmers and sharecroppers. To the extent that credit use is oriented more to the larger farmer, inequities exist. However, a concomitant "inequity" in the use of production inputs is not readily apparent. That is, with or without credit, little modern technology is employed by either large or small farmers. Thus, an economic rationale for readjustment of credit services to serve a broader clientele is not clearly indicated. Social considerations, however, may dictate such changes.

Once again considerable variability exists within these broad generalizations. Credit restrictions for small farmers are more an administrative than a policy problem, and as such conditions vary considerably from one credit agency to another, and between branches of the same agency. For example, Bank of Brazil regulations reduce the interest rate and other requirements for small farmer loans. However, some branches establish informal minimum loan limits that effectively exclude many small borrowers. Others apply rather crude subjective criteria for determining credit worthiness. In some cases land ownership is almost a prerequisite for eligibility to receive credit. Other bank managers recognize the small borrowers' inability to effectively articulate a need for credit and demonstrate credit worthiness. They believe that small farmers strongly desire to repay borrowed funds so they actually "bend" existing regulations to accommodate them.

The end result is that some areas have a considerably wider distribution of credit use among farmer groups than others. It is not clear the extent to which this situation is economically detrimental to the growth of output in the Northeast. In situations where credit would be used largely for consumptive purposes, the output effect is minimal. In cases where new technology may be

unattainable by present credit allocation, growth in agricultural output and income is retarded.

It would seem that a more energetic application of existing regulations, and perhaps some additional liberalization of banking procedures affecting small farmers is called for, even though they will not always have more profitable uses for it than larger farmers.

4) Does a lack of technical assistance hinder the adoption of improved technology and use of credit?

Two problems are evident regarding technical assistance in the Sertao and Agreste. The first and most important is the dearth of technology to extend to farmers. Research results on new varieties or fertilizer response show only modest productivity gains over indigenous varieties and current farming practices. Furthermore, the results are not area specific; thus applicability to a given farming situation is often questionable. In many cases farmers prefer the rustic characteristics of indigenous varieties. This may demonstrate a lack of sensitivity by researchers to adequately design research and development programs to meet farmer needs. In this way the extension agent begins work in the disadvantageous position of having little to offer farmers.

The second problem is the duplication of effort in some areas by several separate extension agencies. The state extension services, the secretary of agriculture, and special development agencies such as SUDENE or GERAN all have separate extension programs with approximately the same objectives. A tremendous duplication of time and effort and a resultant waste of scarce resources and personnel occurs.

These factors severely limit the potential impact of technical assistance. With the lack of concrete new technology to extend, however, it is unlikely that additional extension services would lead to increased use of improved technology and credit. The weakest link in the chain of adoption is that

first link of solid basic research.

5) Are minimum price supports an effective counter measure to seasonal fluctuations in farmer prices?

There exists fragmentary and conflicting evidence on this point. Monthly farmer price quotations of the Bank of the Northeast for major agricultural products do not demonstrate dramatic seasonal price fluctuations. Professionals in the producing areas feel that seasonal price variations are not the real problem. The major price changes result from abundant or scarce production; year to year price changes that reflect uncertain production levels are greater than seasonal fluctuations.

Bankers who administer the minimum price program report that few farmers use it. Several reasons are suggested. First, in many cases the prevailing market price is substantially above the minimum price. Secondly, they feel that some farmers escape payment of the ICM tax when selling farm commodities. In this case the price paid through the minimum price program would have to be 15-20% above "market price" to cover taxes and other costs incurred by farmers in using it. Thirdly, some feel that farmers lack initiative to make adequate use of the program. Lastly, others indicate that facilities for preparing and storing commodities are not readily available.

In summary, credit and price policy instruments in the Sertao and Agreste have had little impact on input use and growth in output. Significant diversion of production credit to consumption and non-productive uses has probably occurred. Research results in most cases do not indicate significant economic returns from the use of new inputs. Continued expansion of credit supply is not warranted, but some adjustments in lending procedures would be desirable so more small and tenant farmers would gain access to credit.

Zona Da Mata

Although some of the agricultural problems of the Zona da Mata are similar to those of the Agreste and Sertao, the causes and possibilities for solution are quite different. The history of sugar production explains part of the present problem in the sugar cane zone, and ironically governmental sugar policies in recent years have created rather than eliminated a development bottleneck. An inefficient sugar industry has been propped up, serious economic and social problems have been created, and strong vested interests have developed which inhibit rational decision-making and problem-solving. Only a basic change in policies and substantial investments in research to develop viable production alternatives can correct the problem. Before anticipating how these changes would affect the future of agriculture in the Northeast, it is necessary to briefly describe the present situation.

Present Situation

The Zona da Mata offers the best long-run development prospects for the NE because of its superior natural resource endowment. Water, the key limiting factor for the Agreste and Sertao, is in fairly dependable supply, both in quantity and seasonal distribution. In some seasons, rainfall may actually be excessive for optimum yields of temperate zone crops like corn and beans. Soils in the traditional cane growing area are somewhat infertile but respond to chemical fertilization. A major restriction on land use is topography, but some areas are no more hilly than the Agreste or Sertao. A massive shift from cane to annual crops could pose the threat of severe erosion.

The major economic and social problems of the region are generally believed to exist in the northern part where cane growing on large farms predominates. Livestock is the second most important activity, and a few farmers are experimenting with non-traditional crops but none has yet reached major propor-

tions. In the Northern drier part of Pernambuco, a few farmers are producing oranges and pineapples. Corn, beans, manioc, and rice are grown by sugar workers for subsistence, but there is limited commercial production. Farmers desiring to diversify find a dearth of data and recommendations on alternatives and preferred cultural practices. Their own trial-and-error experiments have not yet established production potential, and no one interviewed was yet ready to suggest that any non-traditional crop will become a feasible widespread alternative to cane in the near future.

It is estimated that almost 90 per cent of the fertilizer consumed in the NE is applied to cane. The limited use on other crops reflects the lack of significant response, and its high cost. Cane growers keep the cost down through direct importation. Almost all credit consumed by cane producers is used for paying fertilizer and labor costs, and buying livestock. Increases in demand for credit for other purposes will occur only when profitable production alternatives are discovered.

In spite of this consumption of fertilizer and credit, cane production is neither modern nor efficient compared to the sugar cane regions of Southern Brazil. Traditional wisdom recommended that hilltops be retained in natural vegetation to assure adequate rainfall. Therefore most of the cane is currently grown on hillsides while much of the top land with favorable topography is uncultivated forest or pasture. At present more than one third of the cane acreage is on slopes greater than 20% where mechanization is impossible. Harvested cane is transported down the steepest slopes by animal power and is handled several times before arriving at the refinery. Most of the large amount of labor required for cultivation is provided by a resident labor force, but workers from the Agreste migrate in during the peak harvest season.

Thus, a strange paradox exists in the sugar zone: underutilized land co-exists with surplus labor. Traditional labor-intensive cane growing is practiced on the hillsides while large amounts of land remain uncultivated, some with topography superior to that cultivated. Labor is underutilized during a portion of the year, and the general lack of employment forces people to the cities.

This apparent irrational use of resources can be explained by the unique interaction of sugar policies and the organizational structure of agriculture. First, land has a low opportunity cost. It is held in large tracts, but the present owners are prevented by the sugar quotas from expanding cane production on their underutilized land. Current agronomic and economic information does not clearly indicate how land could be profitably used in other enterprises. As elsewhere in Brazil, land taxes are relatively low so it is inexpensive to hold land from which little income is generated. Finally, demand for purchasing land is limited because of a lack of alternative uses, and an inability of non-owners to finance acquisitions which could be used for subsistence food production. This combination of factors reduces the economic motivation for present landowners to adopt land saving technology.

The labor market in the NE is characterized by excess supply, and the slow growth of demand in the industrial and service sectors diminishes their labor absorptive capacity. Furthermore, the systematic frustration in the creation of effective rural labor unions prevents raising wage rates much above equilibrium levels. Those minimum wage and social welfare regulations which do exist are regularly circumvented so the sugar growers keep total wage costs low in spite of inefficient usage. Therefore, they find it preferable to continue producing labor-intensive cane on the hillsides rather than incur

the high cost of land clearing required to shift to mechanized operations. If labor costs were increased, or the high investment in land clearing reduced, labor saving technology would become more attractive.

To summarize, high sugar prices in the face of low opportunity cost for underutilized land and low wage costs are disincentives to modernization. The farmer is rational in employing land and labor extensive methods while excess labor is denied access to land uneconomic for cane. As long as cane producers receive high product prices and control the allocation of factors of production, this is a logical outcome.

It is clear that this combination of policies has served to support a non-modernizing production system rather than encourage modernization. While these policies are in effect, other direct modernization programs are unsuccessful. For example, the recently discontinued GERAN* program implemented only one modernization project after several years of operation. A number of changes are now being discussed for the Northeast, including alterations in sugar policies and PROTERRA. On the one hand, the resources spent on the present subsidy program could be effectively employed more efficiently in other ways. On the other hand, some production could surely be obtained from presently underutilized land and labor. Increased access to land at least would give non-owners greater potential participation in the entire economic-socio-political system, and could lead to a more equitable distribution of income. Therefore for reasons of both economic efficiency and social justice, these changes are long overdue.

Policy Alternatives

The main problem in attempting to develop a better set of policies and production systems is that Brazil has never really determined which enterprise

* GERAN was a federal agency to assist in the rational development of the Northeast sugar cane industry.

has the long-run comparative advantage within the sugar zone. Sugar is produced more economically in the South than in the NE. Does that necessarily mean that sugar still does not have a comparative advantage within the NE? Do the results of the limited experiments with food crops in the Zona da Mata imply that cane is really most profitable? If so, would it be without present subsidies? Is it likely that food crops can be grown with less expense in the Agreste? Where are future technological advances in agriculture likely to have the biggest effect? In the Zona da Mata? In the Agreste or in the South?

Few insights into these questions can be gained from present research in the NE. This may be due to the difficulty of finding easy solutions to basically tough problems, or inadequate research efforts to date, or both. Yet, development of a rational set of policies requires knowledge about production possibilities.

Let us consider the various alternatives for the sugar zone. A basic policy tenet is that no useful economic or social criteria are served by indefinite continuation of high sugar price supports. Then let us first assume that sugar has the best long-run prospects for the zone. Brazil's objective then should be to make production more efficient. This could be accomplished by lowering the present high price and using the resources consumed by the subsidy to stimulate the use of specific inputs. If mechanized cane growing is the basic objective then machinery purchases and clearing of flatter land should be stimulated through input and credit subsidies. This strategy forces farmers to use specific inputs if they are to receive the subsidy. Inefficient producers who cannot mechanize because of topography would be forced to discontinue cane growing or set up operations on flatter land. Production quotas might be eliminated, or at least adjusted so farmers with good land could expand beyond present limits.

Infertile and hilly land would go out of cane and become available for alternative uses including distribution to laborers displaced by mechanization. A special credit source for land purchase could facilitate land transactions. Introduction of new activities presents the greatest development challenge because of incomplete knowledge about production alternatives and their labor absorbing capacity. It is possible that the complexities and costs of developing economic alternatives would be so great as to warrant conversion of the entire sector to a peasant cane system. Furthermore, profitability of other activities may never reach levels comparable to cane or to crops and livestock in the Agreste and Sertao, thereby creating permanent economic and social inequities. Only substantial amounts of additional research will provide insights into these issues.

As a second possibility, let us now assume that crops and livestock rather than cane offer the best long-run potential. The recommended policies are the same as the previous case: massive short- and long-term investments in research followed by incentive policies to stimulate adoption of specific recommended inputs and practices. First, it must be determined which enterprises have the best prospects given reasonable expectations of future agronomic research results, projected domestic and foreign demand, and labor absorption possibilities in those enterprises and the non-agricultural sector. This implies an initial stage of adaptive research drawing heavily on experience already obtained in the Northeast and the South. Longer term research must be simultaneously initiated to develop those varieties, practices, and techniques specifically suited to the sugar zone which will assure the future competitiveness of the area, recognizing that Southern Brazil and other countries will continue their drive for productivity increases in some of the same commodities.

The transition from cane to new enterprises is likely to be even more difficult than to modernize cane. Much of the agricultural capital invested in

sugar production will have little use. Widespread abandonment of agriculture by cane growers would leave the sector in the hands of workers with little previous entrepreneurial experience precisely when profound transformation in inputs and products is required. Lack of information about sound alternatives would make it difficult for even well intending extension personnel to make recommendations.

It is probable that agricultural development in the sugar zone will actually follow some middle path between these two assumed alternatives. But by choosing these extreme cases, the policy considerations are placed in sharp relief. The basic policy requirements are the same in both cases. Central to both is a reduction in sugar price subsidy and adjustments in the quota system. A research program must accompany these changes to identify and develop viable alternative cropping systems for land and labor released from cane production. The larger the amounts released, the greater must be the research effort. Credit and price policies and sound extension services can undoubtedly play an important role in accelerating and facilitating changes suggested by the research. They cannot play a significant role in accelerating agricultural development, however, in the absence of additional knowledge about profitable farm level enterprise changes and technological innovations.

VI - Conclusions

Research on recent Brazil agricultural development, although far from exhaustive, demonstrates the validity and limitations of governmental intervention in factor and product markets as a means of accelerating agricultural growth. In Southern Brazil where underutilized improved production technology existed, manipulation of credit and agricultural price policies during the past few years fostered a rapid expansion in the use of purchased inputs, especially chemical fertilizers and mechanization, and increased the growth rate of output in some products. However, the gains in productivity have been fairly limited,

and more importantly, it appears that these policies fairly quickly exploited known production alternatives. Further gains in productivity seem to be limited by a lack of technical knowledge about improved production systems.

Agricultural development in the Northeast has been even more limited. Little improved technology existed when some of these same agricultural policies were implemented so their impact on use of inputs or growth of output has been considerably less. In the sugar zone, the policies have propped up inefficient agriculture rather than stimulate modernization.

It appears that Brazilian agricultural growth in the near future will depend largely on expanding area rather than increasing productivity. Demand for modern inputs is likely to depend primarily on adoption by non-users while intensification by present users will be modest. Agricultural policies should be modified, therefore, to increase their range of applicability to various farmer groups rather than encourage increased impact on those already affected. Agronomic and economic research must be greatly expanded and intensified to create those varieties, techniques, and conditions necessary for agricultural modernization. Once they become available, some of the policies effective in the recent past can be applied once again to stimulate farmer adoption and broaden the distribution of benefits. Brazil has exploited the relatively rapid means to increase productivity, but now faces the relatively tough job of basic research. However, evidence already obtained for some commodities in Brazil and elsewhere demonstrates a very high rate of return from investment in research.

The lesson for agricultural development is that intervention in markets can be an important short-run stimulus for growth. It cannot stimulate agricultural modernization and intensification in the absence of sound information on profitable farm-level alternatives. A once-and-for-all effect can be achieved by introducing farmers to a new production function, but modern

agriculture requires a research system capable of providing a constant flow of information in response to new and different problems. The basic production function itself must be continually improved if the agriculture sector is to successfully fulfill its function in a modernizing society.

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