PN-ABC-541

Commodity Research Programs from the Demand Side

John K. Lynam
Willem Janssen
Douglas Pachico

First Draft
May 1988

Paper submitted to the Agricultural Technology Management Workshop to be held on July 6-8, 1988 at Rutgers University, New Jersey.

FROM CIAT-CO 57-21-647243 5.27.1988 12:23 P. 2

Commodity Research Programs from the Demand Side

Crop research in developing countries, as normally practiced, involves improving the economic yield of essentially biological systems. The research is usually embodied in improved varieties or improved management practices, which then are distributed as new technologies. Adoption of these technologies by farmers, in turn, provides the acid test of the success of this research in increasing productivity. Such was the case with the rapid adoption of the dwarf wheat and rice varieties in Asia in the late 1960's and through the 1970's. This success, however, has not been repeated in other crops. Although discriminatory price policies have sometimes been invoked as the reason for this lack of diffusion, opinion has coalesced around the hypothesis that the technology itself is often inappropriate for the diversity of farming systems to which the technology is being targeted. To address this problem planning of crop research has been extended to incorporate interactions between the cropping system and other activities within the overall farming system. The commodity still remains the research focus but it is now evaluated at a higher systems level, that is within a farming systems research (FSR) framework.

The overall theme of this paper is a consideration of whether this extension is sufficient to guarantee more effective research planning and technology adoption or whether extensions to even higher systems levels are advisable. Two basic dimensions to this problem will be considered. First, farmers are not the only arbiters on whether or not a crop technology is appropriate, especially where new varieties are concerned. Consumers will weigh product characteristics in deciding whether a new

FROM CIAT-CO 57-22-642242 5.27.1988 12:24 P. 2

variety is acceptable and at what price. Middlemen must also weigh at which price differentially new varieties will move in the market. These quality constraints may be expressed in lack of farmer adoption but FSR is not sufficient to fully elucidate a solution.

Second, a singular focus on crop production technology assumes that production constraints, as distinct from marketing and utilization constraints, are more binding in retarding growth in production and utilization of the commodity, and therefore that research on new technologies in the production, as opposed to the post-harvest sphere, can have the larger impact. To even answer the question obviously implies an analytical extension outside of a pure focus on the production sphere to encompass marketing and demand research. Such an extension encompasses a higher systems level, what can be termed the commodity system -- often refered to as the sub-sector in the literature --, which entails a vertical integration of production, processing, marketing, and consumption activities and where the commodity market provides the integrating schema. Furthermore, a commodity system focus also extends crop technology development outside of the production sphere to include storage, processing, and utilization technologies.

These themes will be addressed by considering their incorporation in two crop research programs at CIAT, namely the cassava and bean programs. The focus will be methodological, in that the paper will review marketing and demand research that has supported technology development in these two programs. Moreover, although marketing and demand research is the topic of this paper, it should be kept in mind that they support and augment

production and supply research in these crop programs. Though achieving an appropriate balance between production and demand research in technology development programs is important, the topic is not considered in the paper, since there is an anterior objective of to motivating a role for demand side research in crop technology programs.

The Demand Side in Crop Technology Development

The starting point is a consideration of the role of agricultural technologies in the development process and by extension the objectives of crop research programs. The demand issue enters from the dismal side of the science and revolves around the impact that research on basic food crops has on producers and consumers in developing countries. It can be simply stated as follows: what is the effect of the technological treadmill in agricultural economies where rural-urban migration results in high social costs, where output diversification is constrained and where export is limited by the discriminatory price policies of developed countries? The issue explicitly introduces product demand as a major factor influencing the impact of production technologies and in turn the potential of crop research to meet many of the socio-economic goals that have been set for it, especially rural employment and rural equity objectives (Mellor, 1977). Moreover, the issue goes beyond the usual conception that producers lose and consumers gain under technical change to a consideration of social adjustment costs in calculating net social benefits to crop research and in turn how such costs might be minimized. Essentially the crop research program must assess whether product demand is

FROM CIAT-CO 57-23-647243 5.27.1988 12:25 P. 5

a given and develop its research strategy around it or whether research strategy can in fact be developed to "manage" product demand.

Research investment on basic food crops in the tropics is a post-war phenomenon (Evenson, 1984), and was intended to counterbalance the exclusive focus on tropical export crops. Demand was not a concern in production research on export crops and the same pattern was followed with the food crops. Yet, the work of Bennett (1954) on cross-country dietary differences in the early 1950's clearly showed an inverse relationship between per capita income and the percentage contribution of starchy staples to dietary calorie intake. It is only within the last few years that various agencies have begun to evaluate whether there is potential for more efficient production of staples in economies where land and labor are relatively abundant, i.e. Africa and Latin America, and where either staple markets are not well developed -- Africa -- or incomes have reached the point that income elasticities are low or negative -- Latin America. Not surprizingly new technologies for food crops were principally successful in Asia, and even here, where estimates had suggested significant income elasticity for rice, there has been a recent concern about how to diversify out of rice production (Schuh, 1987). Moreover, IFPRI has recently questioned research on sorghum and millet research in Africa due to the apparent preference for rice and maize, and the TAC has questioned the amount of resources that the CGIAR should devote to cassava research due to apparent declines in demand in developing countries (TAC, 1985) -- although interestingly the TAC supports more research on sweet potatoes, a commodity with even more severe demand problems.

FROM CIAT-CO 57-23-647247 5.27.1988 12:25 P. 6

These concerns are set within a dynamic situation, namely how agricultural research should be planned in relation to often rapidly changing food consumption patterns. The driving forces in this regard are (1) rising incomes, leading to diversification in the diet and increasing demand for income elastic foods, (2) urbanization, leading to increased demand for product convenience and increased consumption of embodied marketing services, and (3) commodity substitution, largely due to rapid technical change in food processing, as well as price policy interventions. Research planning is, thus, dependent on the current state of development of the economy and the projected structural change over time. As traditionally conceptualized, the decision problem then revolves around changing the relative allocation between commodities in relation to market growth prospects. Output diversification is thus promoted by linking farmers to growth markets, with technical change providing the potential for true dynamic growth, for example as has happened with poultry production in the tropics.

However, the more profound question is whether appropriate research could allow the basic food staples to take advantage of, rather than be penalized by, growth and structural change in the economy. Whereas research on food staples has traditionally stressed production linkages, such as employment linkages and backward linkage to input industries, little thought has been given to how research can promote consumption linkages, the term is used here in a narrower sense than usual (Hirschman, 1977), and refers to the potential for shifting demand for the commodity in question, rather than increasing demand for secondary commodities. Planning research to maximize such consumption linkages requires a

FROM CIAT-CO 57-22-647243 5.27.1988 12:26 P. 7

commodity system focus, namely extending the search for technological interventions from the production sphere to include as well processing, marketing and even consumption.

The types of research strategies that might be considered within a commodity system framework are briefly outlined in Figure 1. In assessing research priorities the benefits from shifts in the supply curve must be weighed against the potential benefits in shifting the demand curve. Such shifts in demand come by changing what in demand theory comes under the category of tastes. These may include enhanced quality, improved convenience -- i.e. decreased time for purchases, preparation or cooking -- or reduced losses between purchase and consumption. Such research may involve breeding, processing, or storage technologies.

Alternatively, research may increase demand by segmenting the market, an industrial strategy in, for example, pricing of airline tickets. In this case a range of quality characteristics, which result in a range of price differentials, are utilized to target particular market segments. Such a strategy is especailly useful in targeting low-income consumers, but the strategy depends on an inverse relationship between yields and quality, as, for example, happens in wheat and beans.

Finally, research may consider expanding demand by increasing the range of products and thereby diversifying end markets. End-market demand for many of these products may be strictly independant of each other, as for example is the case for maize used for high fructose syrup production and maize used in breakfast cereals. Maize and cassava are probably the

FROM CIAT-CO 57-23-647247 5.27.1988 12:27 P. 8

two best examples of crops with multiple market potential, although the oilseeds would probably came a close second. The significance of market diversification for the basic, carbohydrate staples is shown in the shift in grain use as per capita income changes (Figure 2). Overall demand for carbohydrates continues to increase with rising income, as use patterns shift from direct food consumption to indirect uses, especially as an animal feed.

Expanding the scope of research strategies to include demand-side interventions increases the flexibility for crop research programs to have an impact on the range of socio-economic goals. This is especially clear in the case of "demand-side" objectives, namely improvement in nutrition and welfare of low-income consumers. However, the greater flexibility probably comes in targeting "supply-side" objectives, especially improved equity in the rural sector. This improved flexibility comes in two principal areas. By simultaneously expanding demand -- by other means then just price declines -- when supply increases, due to adoption of new production technology, allows greater potential for achieving rural income objectives with new technology, especially when demand is inelastic. This is particularly critical for basic food staples, since these crops tend to form the major portion of incomes for poorer farmers in developing countries. Balancing demand expansion with production increases implies that a commodity system approach seeks an integration of the two activities, i.e. demand-side research is not an alternative to production-side research but rather the greater impact is achieved by integrating the two.

FROM CIAT-CC 57-22-642242 5.27.1988 12:22 P. 9

In the second place, demand-side research provides greater flexibility in targeting agricultural regions that lag in the growth process. These are usually regions that have an edaphic or climatic constraint that limits crop production, such as Northeast Brazil, Northeast Thailand, or northern Ivory Coast. Crops that dominate in such areas usually include sorghum, millet, cassava, or cowpeas, i.e. crops that apparently face relatively inelastic demand; moreover, alternative cropping activities tend to be limited. Markets for these crops tend to be regionally circumscribed and the urban areas in such regions tend to import commodities from other regions. Occasionally export may generate agricultural growth in the region but where this is not likely, balancing regional demand with regional production may be the only alternative. Such balancing requires significant substitution of commodities and therefore demand-side research on processing, quality, storage, and product characteristics.

Having justified a role for demand-side research in crop research programs, the question then becomes what type of economic analysis supports decision-making in this area? The question will be answered by examples from two CIAT crop programs. However, in order to set the discussion in context, broader determinents for the selection of methodology for demand analysis will be outlined. First, the type of demand analysis, and in turn the overall crop research strategy, follows in part from the inherent characteristics of the crop. In particular, the research program has to assess the range of variation in quality characteristics, the potential for multiple uses, constraints on consumer utilization or acceptance, and product characteristics that affect storage and marketing costs. These all follow from inherent physical characteristics such as perishability,

FROM CIAT-CO 57-22-647243 5.27.1988 12:28 P.10

bulkiness, protein content and quality, starch quality, the content of toxic elements, taste factors, and even grain color and size. The case studies of beans and cassava provide virtually polar examples of the extent to which these characteristics determine the range of demand-side interventions, with the potential in cassava being very wide and those in beans relatively narrow. The demand analysis, and the research strategy that follows from it, will very much depend on the potential interventions as defined by commodity characteristics.

Second, the demand methodology is very much dependent on the stage of development of the research program, i.e. extending from strategy definition to technology transfer. A few of these distinctions are outlined in Figure 3, which essentially makes the point that different questions are asked depending on the stage of technology development, which in turn entail different data needs and methodologies as input into the decision-making process. The level of detail in the demand analysis shifts as there is higher and higher resolution in research alternatives. This is an interactive process, since the demand analysis aids in that resolution which in turn results in the need for even more specific and more highly focused types of demand analysis.

Finally, the type of analysis will also depend on the stage in the commodity system that is being studied (Figure 4). There are two dimensions to the selection of methodology in this regard, namely the degree to which the methodology integrates the various stages and the level of aggregation, particularly whether at the individual or market level. This is applied economic research at its most demanding, since the analyst

ecom CIAT-CO 57-23-642242 5.27.1988 12:29 P.11

has to continually assess and rank research questions, define methodologies and data needs, and allocate his own scarce time accordingly. What follows is a discussion of how two crop programs have approached the issue.

Demand Issue within the CIAT Cassava Program

Research Program History:

The CIAT Cassava Program was initiated in 1972, following on the heels of the diffusion of the dwarf rice and wheat varieties in Asia. The research focus was in large part defined by this success of Green Revolution technologies, namely a focus on the development of high-yielding, widely-adapted varieties. The implicit assumption was that improved production technology was sufficient to have an impact on a range of socio-economic objectives, including increased food consumption and improved small farmer incomes. Nevertheless, a major donor did commission a study of cassava markets and demand. Since "the qualified findings of the study [were] that demand for cassava [would] grow in the 1970's (Phillips, 1973: p.vii)", the program appeared justified in its singular focus on production research.

Economics research in the program, as well, had an initial production focus. This consisted of an agro-economic survey of cassava production systems in 1975 (Diaz and Pinstrup-Andersen, 1977) and the initiation of an on-farm research activity in 1977 (Sanders and Lynam, 1982a). The research at this stage focused on prioritizing constraints on cassava productivity (Sanders and Lynam, 1982b). Nevertheless, the on-farm research very early on identified marketing and access to markets as a major determinant of

FROM CIAT-CO 57-21-647243 5.27.1988 12:30 P.12

farmer decision-making, and therefore a factor in technology design and a potential constraint in technology adoption (Lynam, 1982). This resulted in a complementary focus by the economics section on the analysis and resolution of marketing constraints.

This demand research led to the creation of a utilization research section in 1980. An integrated production and utilization research strategy was proposed in CIAT's long-range plan of 1981 (CIAT, 1981). Since then the CIAT cassava program has planned its research activities within a commodity system framework. As the above illustrates, the development of this framework has been evolutionary and dependent on the early linkage of the research program to field testing of its technology. Moreover, the above highlights the importance to a research program of continually assessing new information and making the necessary adjustments in program strategy. The following discussion thus incorporates a significant amount of hindsight in the evaluation of research planning in the cassava program.

Research Priority Assessment and Research Strategy:

Cassava is often described as a crop produced in poor areas, by poor farmers, for poor consumers. This generalization, although usually used in a disparaging context, nevertheless describes several salient features about the production and consumption of the crop in Latin America, which in turn lead to a definition of overall research objectives. First, because many traditional cassava products, such as farinha de mandioca in Brazil, are principally consumed by the poor, the benefits of technical change will be targeted to this group -- first, because their is still significant

FROM CIAT-CC 57-23-642243 5.22.1988 12:26 P.12

elasticity in demand for cassava among low income groups, and second, because the overall market demand is inelastic and price decline would be significant. On the other hand, cassava is generally a small-farmer crop in Latin America, grown in marginal environments where the production of other staple or cash crops is problematic. Cassava research had to focus on small farm systems and by implication the improvement of small-farm incomes, among a population otherwise difficult to target in Latin America. The overall objectives of the CIAT cassava program were therefore set by the structural features of cassava production and consumption, yet the strategy was faced with an obvious dilemma: inelastic market demand resulted in a major trade-off between improving small farmer income and increasing consumption by low income consumers. Moreover, extremely inelastic market demand potentially resulted in a lack of incentive for the adoption of new technology, and therefore an inability to meet either objective.

This dilemma, similar to Timmer, Falcon and Pearson's (1983) food price dilemma in food policy development, led to the search for a broader range of alternatives and the adoption of the commodity system as the basis for assessing technological interventions. Moreover, the strategy issue become one of linking interventions in the cassava commodity system to quite rapid structural change in Latin American economies. This entailed an identification of growth markets for cassava, the linkage of the small-scale cassava producer to these markets, the establishment of a price floor under traditional markets, and the eventual integration of cassava markets leading to adoption of production technology, stabilization of prices in food markets, and an equitable distribution of benefits between

FROM CIAT-CO 57-23-641243 5.27.1988 12:21 P.14

both low income consumers and small-scale farmers. Demand and market assessment thus were key to strategy definition.

Market Characterization in Strategy Development: Economists should not underestimate the insights to be learned from purely descriptive data, especially in a crop like cassava where reliable data are scarce. Table 1, which summarizes national food budget surveys, makes several important points about consumption patterns and the structure of cassava demand. First, cassava consumption is regionally circumscribed, which leads to a number of hypotheses about whether preferences, market structure or production factors are responsible. Second, fresh cassava consumption is concentrated in rural areas, with urban consumption being markedly lower. Farinha consumption, on the other hand, is a major urban staple, but only in the Northeast of Brazil. These consumption patterns in turn suggest hypotheses about how well cassava markets are integrated given the regional nature of consumption, how prices are formed in fragmented markets, and what the potential is for expanding cassava consumption.

Elasticity estimates provide the next level of market characterization. They summarize growth potential and consumption patterns, in the case of income elasticity, and price variability and market size, in the case of price elasticity. Often, as in a case like cassava where consumption data is scarce, the elasticity have been assumed from the characteristics of the crop. The conventional wisdom has suggested that food demand for cassava is income elastic or even that cassava is an inferior good. Actual estimation, however, suggests a more complex picture. First, elasticities vary significantly depending upon the

FROM CIAT-CO 57-23-647243 5.27.1988 12:32 P.15

cassava product. This has significant implications for a research strategy that includes utilization research, since that research is differentiated by product market. Moreover, this requires significant disaggregation in consumption data, i.e. almost exclusively cross-sectional, food budget surveys, and significant flexibility in the estimation methodology, i.e. estimation of elasticities by product and income strata usually requires estimates of individual, product-specific consumption functions (Timmer and Alderman, 1979) rather than complete, demand systems (eg. Strauss, 1982).

Second, the elasticities are conditioned on underlying structural factors and therefore are difficult to estimate and then interpret when the economy is undergoing rapid structural change. This is especially true for fresh cassava, where high marketing margins and risky product quality result in major differences between rural and urban consumption. Time series have suggested a negative income elasticity but only because income is correlated with overall structural change, especially urbanization. If the effect of urbanization is also included in the estimation, then income elasticities become in many cases positive, as the negative effect of urbanization is controlled for (Table 2). Further disaggregation reveals very significant market demand for fresh cassava, especially as economies shift away from consumption patterns which are subsistence based to those that are dependent are on market flows (Table 3). Thus, the question for research becomes not how to diversify out of fresh cassava because it is an inferior good but rather how to reduce costs of cassava destined for urban markets.

FROM CIAT-CO 57-22-647242 5.27.1988 12:33 P.16

Third, elasticity estimates by income strata suggest the potential for targeting low-income consumers, and where the data is very detailed, i.e. can be descriminated by quality parameters, they suggest the potential for market segmentation. Thus, in the rural northeast of Brazil, where it is estimated that up to 75 percent of the population suffers from calorie deficiencies, improved cassava technology resulting in cheaper farinha could supply as much as 20% of the average calorie shortfall for the region, a figure derived from estimates of price elasticities by income strata (Lynam and Pachico, 1982). Such estimates, however, do not usually consider substitution effects. Such cross-price considerations introduce price policy, as well as across-commodity research priorities, into the analysis and decision-making. An illustration of the effect price policy can have on research planning is illustrated in the case of the negative effect of the wheat subsidy in Brazil on farinha consumption (Table 4); in fact, by taking into account substitution effects, the effect of the wheat subsidy on the target population was in certain areas negative (Table 5). A subsidy on farinha, or even better, technical change in farinha production, could have had a more direct and positive impact on malnourished consumers.

The final level of characterization is at the market level and evaluates price formation. Price variability for farinha, on the order of that depicted in Figure 5, illustrates both the significant market risk attached to the adoption of improved production technologies, especially if there is a significant increase in cash costs, and the value of market diversification that could put a price floor under the farinha market. Such price variability may be attributed to the lack of significant

integration between markets, a feature of fresh cassava markets which storage or processing could overcome. Several methodologies are available to analyze spatial integration, most notably ARIMA methods, path analysis, and regression techniques. A path analysis for fresh cassava prices on the North Coast of Colombia (Table 6) shows a lack of arbitrage between major consumption centers and the dominate influence of one production center on each consumption center, i.e. the data suggests significant market fragmentation. Under such circumstances the adoption and impact of new production technology will be heavily influenced by local market conditions and will therefore be very fragmented as well. Searching for a mechanism that links such fragmented market into an integrated national market could aid in stabilizing price.

Market Priorities: Research strategy within the cassava commodity system in Latin America has as its principal operational objective market diversification. Priority definition thus starts with an evaluation and ranking of markets. A useful methodology for ranking market-specific research projects is benefit-cost analysis within an economic surplus framework. The methodology incorporates technical change at either the production or utilization stage, market size, and price change, and can incorporate market growth characteristics though demand shifts. Benefits can then be compared to research costs. This methodology was applied to the evaluation of technical change in the feed versus fresh market in Colombia (Pachico, Janssen, and Lynam, 1983) -- although the focus in this case was on market-specific, production technology. The analysis found that cassava technology development for the animal feed market could produce a rate of return of 16% per annum, compared to 10.2% in the fresh market.

FROM CIAT-CO 57-23-642243 5.27.1988 12:34 P.18

Pure efficiency criteria would thus suggest a relative shift in resources to the animal feed market.

Economic surplus methodologies to date have not taken into account cross-price elasticities for competing products, when evaluating alternative research investments. Moreover, the partial equilibrium framework provides very limited insights into cassava's ability to compete in alternative markets and the effect price policies would have on this relative competitive ability. Domestic resource cost evaluation, while not explicitly incorporating cross-price elasticities, nevertheless can explicitly consider cassava's ability to compete with alternative substitutes under a range of policy interventions. The analysis allows for significant disaggregation in production regions, market location, and alternative production and processing technologies and evaluates the private and social profits of cassava versus grain substitutes in alternative markets. An example of the detail that can be incorporated in this approach is the evaluation of the ability of dried cassava to compete with maize in the animal feed market in the Northeast of Brazil (Table 7). Since the major portion of surplus maize imported into the Northeast comes from the Center-West region, cassava would have a potential market, even at current yields.

<u>Target Area Stratification</u>: A principal issue in IARC's in developing a research strategy is how to deal with variation in such large target areas. This usually applies to variability in production constraints, but in the case of cassava as well entails a stratification by market potential. Since cassava competes with different substitutes in the animal

FROM CIAT-CO 57-23-647242 5.27.1988 12:35 P.19

feed, flour, starch and food markets, the potential to diversify end markets in particular region will depend on prices of substitutes -- and associated price policies -- cassava production and processing costs -- subject to technical change -- and transport costs. The process requires stratification of each country by consumption and production regions and then linking the region with the "comparative advantage" in cassava production -- which often includes equity weights -- with the most profitable market in the principal consumption centers. The process for the whole target area both defines relative market priorities and isolates production areas, which in turn can be characterized in terms of production constraints. In a very specific way market and production region stratification circumscribes the areas where research will have the highest probability of success, especially since production technology and market development are integrated. Private and social cost accounting within a DRC framework at a relevant level of disaggration provides a very practical methodology for such "low resolution" stratification.

Evaluation of Technological Alternatives (low resolution): The research strategy in the CIAT cassava program is based on an integration of both production and utilization research. Economic surplus methodologies have usually been applied when evaluating technological options, normally alternative production technologies within a single market. However, when research options are set within a complete commodity system and are therefore expanded to include utilization research, more flexibility is required of such methodologies. Two modifications are necessary. First, the supply curve needs to be divided into product stages, allowing shifts in the supply of processing or marketing services as well as shifts in the

FROM CIAT-CO 57-23-647243 5.27.1988 12:36 P.20

farm-level supply curve (see Freebairn, Davis and Edwards, 1982 for one solution to this problem in which the shift operates through a derived demand curve for the farm commodity). Second, research can modify the characteristics of the commodity for the consumer, either through quality enhancement or improved convenience, including reduced purchase and/or preparation costs. These types of technical change result in upward shifts in the demand curve.

These two types of shifts were employed to evaluate potential returns to research on cassava deterioration and control measures (Janssen and Wheatley, 1985). For Colombia alone such research could provide benefits on the order of US$19 to 28 million per year. These benefits could be compared to alternative interventions in the commodity system, either production technology or alternative post-harvest technologies. In this case the analysis justified a committment of resources to developing a storage technology for fresh cassava.

Ex-ante impact evaluation using economic surplus models have tended to focus only on efficiency criteria. Introducing equity considerations for both consumers and producers introduces further complexities. Such a methodology has been developed for supply shifts within a single market (Pachico, Lynam and Jones, 1987) and could easily be extended to include shifts in demand. However, evaluating the efficiency and equity impact of the simultaneous introduction of both production and post-harvest technologies within a multiple market context, such as is required in the cassava case, requires either a general equilibrium framework (Quison and Binswanger, 1983) -- the cost of which are usually not justified within a

crop research program unless such a model already exists -- or simulation. Such a simulation model was developed for ex-ante impact evaluation of technical change within production, fresh market storage, and development of the dried cassava for animal feed market (see Janssen and Lynam, 1988). In such cases the data requirements expand significantly and the model requires a detailed understanding of the region to be studied. Thus, the decision will have already been made that this particular region is a priority within the research program's target area.

Technology Design: Research strategy for cassava in Latin America thus focused on an integration of production and utilization research. Utilization research supported market diversification, which in turn created the effective demand for production technology. A principal objective was to maintain the comparative advantage of small-scale farmers in cassava production, and therefore a major design requirement for both processing and production technology was to effect a linkage between the small-scale, cassava producer and growth markets. The animal feed markets and the fresh food markets became the two priority markets, followed by cassava flours for human consumption and starch. Technology design therefore would have a very definite product or market focus. Technology design also would have to ensure compatability between producer, processor and consumer requirements. Finally, technology design should result in a bias in eventual benefits to the small-scale producer and the low-income consumer, that is reinforcing the traditional role of cassava in Latin American economies but within a rapidly changing economic climate.

Product Characteristics: Variation in product or commodity quality characteristics have not been overlooked but have probably not been

FROM CIAT-CO 57-21-642242 5.27.1988 12:12 P.22

systematically incorporated in crop research programs -- except in fruits and vegetables --, particularly where breeding for quality characteristics results in a trade-off with yield potential, eg. protein content in wheat or grain size in beans. Nevertheless, in a commodity purchase the consumer trades off price and quality (among other product characteristics) in the selection from a product range, while the farmer trades off yield and price (especially where there are large differentials for quality characteristics) in his choice of variety. Consumer preferences, the determinats of price differentials in product markets, and market segmentation on the basis of quality characteristics become key issues in technology design decisions. Moreover, product quality in a research program is not just managed at the level of variety development but can also include processing and storage technologies.

At the technology design stage analysis of consumer choice focuses on evaluating consumer preferances, i.e. the relative importance of different characteristics in consumer choice. In the testing stage, however, the consumer evaluation shifts more to acceptability trials, often through well structured consumer panels. Such studies can isolate issues requiring very detailed research. For example, certain environmental conditions, as yet not fully specified, result in fresh cassava turning hard and glassy, a characteristic that was found to be unacceptable to consumers. Research requirements are first to understand the biochemical changes leading to this condition, how these are determined by environmental factors, and then interventions which would retard the process.

The cassava program, to direct its research on fresh cassava had to sort out in more detail the underlying determinants of demand for the product. A major issue was the factors determining consumption levels of cassava versus other starchy staples in urban areas and whether these could in turn be modified. To do this the analysis had to go beyond the traditional price and income specification of demand or consumption functions. In general, consumption is a function of product price, product characteristics, and consumer characteristics, including income level. This specification is conceptually different from that in an hedonic price model (see the bean example in the next section). Price is not predetermined by product characteristics; rather, price is one among several other product characteristics that influences consumer choice, with that choice being constrainted by certain characteristics of the consumer; not just the budget constraint.

A study was designed to evaluate the determinants of starchy staple consumption (cassava, yam, plantain, potato and rice) in the Atlantic Coast of Colombia (Janssen, 1986). A stratified sample of consumers were asked to provide a positive or negative response for each commodity to a range of common descriptors (17 in this case) of the starchy staples. Consumers were stratified by income and residence. Product scores were then evaluated by factors analysis to isolate more global properties across starch staples. Four factors, in fact, explained 77% of the communality of the original matrix. These factors could be described as intrinsic quality, purchasing convenience, availability and price trends. The factor scores for the four characteristics were then calculated for each commodity and consumer stratum (Table 8). The dominant score in the case of cassava

FROM CIAT-CO 57-22-642243 5.27.1988 12:29 P.24

was the inconvenience attached to the purchase of cassava. Intrinsic taste factors were little different from other staples, apart from the apparent preference for plantain.

A global consumption function was estimated by incorporating factor scores, price per calorie of each staple, and income in a linear regression analysis (Table 9). The results indicate that in-shop availability had a very positive effect on staple consumption. More consistent availability of rice, which had the highest score on this factor, increased consumption by some 20% over the other staples. Buying inconvenience had a very marked negative effect on staple consumption, which declined in importance as the size of urban area declined, and had the largest effect in metropolitan areas. If cassava's score on purchase inconvenience were halved, per capita cassava consumption in metropolitan areas would increase by 16 kg over the present consumption level of 30.5 kg. There was no potential for pure price decreases to have such on impact. This thus focused research on improving convenience in this case, principally in the purchasing sphere, a finding recently suggested by Senauer, Sahn and Alderman (1986) when evaluating wheat versus rice in Sri Lanka.

Improving the convenience of purchase requires an inexpensive storage technology that improves shelf-life in both the marketing chain and in the home. Perishability results in "structural" constraints becoming very important in determining consumption levels. Understanding such structural determinants -- analogous to the consumer characteristics specified in the model above -- can aid in segmenting the market and/or insuring that benefits reach target, low income populations. A consumption function for

FROM CIAT-CO 57-23-647241 5.27.1988 12:40 P.25

fresh cassava was estimated which focused on particular consumer characteristics which influenced consumption levels (Table 10). The equation fleshes out in more detail the convenience factor. The housewife's time becomes a principal constraint, as reflected in whether she is employed outside the home and by the number of children (although this coefficient is also an adjustment for adult equivalency). Market access, in a sense the time and monetary cost to a retail outlet, had a significant impact on cassava consumption. Since market access was negatively related to income and since the women in many of the poorer households worked as domestic servants, storage technology would have an impact on these households if it reduced purchase frequency, on the one hand, and resulted in cassava moving into neighborhood, retail outlets, rather than just to larger market places, on the other hand. The income effect is only marginally negative -- an elasticity of about -0.1. Since many of the consumer characteristics are negatively associated with income in this case, this cross-sectional estimate would have produced a very negative income elasticity purely because of "structural" constraints and not due to a pure income response.

<u>Product/Market Development</u>: New product development is not commonly practiced within crop research programs. In general, the private, agro-processing sector is seen to have more of a comparative advantage in product development. However, in cassava, as compared to wheat or maize for example, there has been relatively little research in this area. In particular, it appears that very large market size is necessary to motivate investment by the private sector in such research, as can be seen by the fact that Brazil was virtually the only actor in this field until the very

FROM CIAT-CO 57-22-641243 5.27.1988 12:48 P.26

recent rise of the Thai cassava industry, and the agro-processing industry that has developed with it. Given the market oriented strategy of the cassava program and the lack of research in this area, new product development is a potential research focus.

A crop research team that is organized such that technological intervention can come at any stage in the commodity system has a particular flexibility in designing technologies leading to new product development. In particular, the research can focus on a least cost design to the whole system from cassava production to product consumption. Such a systems approach was used to design a composite flour system, where cassava flour would substitute for wheat in bread consumption. As seen in Figure 6 there is a significant interaction between the technical research and the economic research, a feature that arises as a result of clear specification of research problems at each stage of the product system. Moreover, the focus is on design of the overall system, especially ensuring the most appropriate linkages between each stage.

Composite flour programs have been advocated for tropical countries since at least the 1930's but only one or two cases have been successfully implemented, and then only for a short period of time. CIAT's research in this area focused on isolating the technical and economic factors that determined success in development of this market. Traditional composite flour schemes were based on relatively large factories, where conversion rates were low, drying costs were high, and root supply was usually inadequate or costly. Even in small-scale plants conversion rates remained low because of peeling of roots and inadequate particle size when put

FROM CIAT-CO 57-22-647243 5.27.1988 12:41 P.27

through a hammer mill. Also, how to organize the mixing and distribution of composite flour at the lowest cost was not clear; i.e. was the cassava flour to be mixed at the wheat mill, at an independent mixer, or at the bakery? Likewise, how were small-scale cassava producers to be integrated into the system?

The key to the system was the finding that unpeeled, dry chips of a "grit" size could be milled in a normal wheat mill -- i.e. a roller mill -- and peel and fiber could be separated from a flour of requisite particle size. Conversion rates and organization of mixing were solved. The parameters for village level drying were defined -- essentially washing and tray drying. Bakery evaluation found differences in bread quality depending on the cassva variety used, thus linking market development to production technology. A panel of bakers and consumers were drawn from a larger survey, and it was found that the bakers could make adjustments in their dough so that consumers found no differences between bread based on both pure wheat flour and a 15% cassava flour mixture. The research defined the requirements for the entire system from production to consumption.

Technology Transfer:

Technology design within a commodity system framework can be integrated by an appropriate discipline mix within the commodity research program. It is less clear how technology transfer is organized within a commodity system framework and in turn how demand and marketing analysis supports the transfer process. The CIAT cassava Program has approached the issue by organizing technology transfer in a project framework, what are

FROM CIAT-CC 57-22-647241 5.27.1988 12:42 P.28

termed integrated cassava development projects. The basic strategy is that the introduction of utilization technology will provide the incentive for the adoption of production technology. The process relies on the target area stratification started in the technology design stage, in which market potential is matched to regional comparative advantage in production. The vertical integration of the system, in which new processing technology is linked to both production systems and end markets, are developed within a pilot project, which them forms the basis for replication. The analysis that supports this process shifts from demand research to a focus on marketing research. The subject of technology transfer in a commodity framework is treated in detail in Janssen and Lynam (1988), but what can be said here is that there is little development in the literature of marketing and demand analysis that is designed to support agricultural technology transfer.

Demand and Marketing Issues in CIAT's Bean Program

The common bean, Phaseolus vulgaris, is an important, inexpensive protein source in Latin America and the highland regions of Africa. CIAT's research on beans started in the early 1970's and from the beginning had a very strong breeding focus. Diseases were diagnosed to be the principal constraint on productivity of the crop, which as well resulted in significant risk to intensifying bean systems. Breeding therefore concentrated principally on introducing resistance for a significant range of bean diseases into commercial grain types. In this regard the bean program chose to focus on the development of production technologies as a means of increasing production and utilization of the crop.

FROM CIAT-CO 57-23-642242 5.27.1988 12:43 P.29

This focus on production technology followed in part from bean's marketing characteristics. Marketing margins for dry beans are low. Breeding could lower production costs, which account for some 70 to 80% of the final consumer price. Lowering consumer prices was seen to be a means of increasing beans' role as a cheap protein source in the diets of low-income consumers in the two regions. In Africa the focus was more on subsistence consumption, while in Latin America the goal was improvement in the nutrition of the low-income urban consumer. In Latin America beans are also a principal source of income for small farmers in production areas, which created a potential trade-off in simultaneously meeting both objectives.

The Influence of Market and Demand Characteristics on Research Strategy Definition within the Bean Program:

Marketing and demand research has influenced the bean program's strategy in two ways. Firstly, marketing and demand characterization has defined the importance of quality characteristics as breeding objetives. Secondly, trend analysis of demand has helped to define regional resource allocation and to differentiate research strategies between the two continents.

In contrast to cassava, beans do not have wide versatibility in their end uses. Wherever beans are grown, they are grown for direct human consumption. In different countries of the developing world they might be consumed in various ways; in soups, as a stew, mashed or mixed with rice. Although some other bean products are consumed in the developing world (snap beans, green shelled beans, bean leaves), they were not considered to

be of sufficient importance to include them as target products. Also, given the nutritional importance of beans as a poor people's protein, a focus on enhancing this role was considered sufficient.

The principal feature of beans is the large variability in bean grain types. Black, white, yellow, red, cream and mottled beans of different grain sizes and forms exist, with different countries having different preferences for combinations of these characteristics. The major commercial grain types had therefore to be matched with the relevant disease complex. Each one of the three headquarters breeding programs is responsible for certain commercial grain types. Since these grain types have specific importance in some countries, breeding for quality characteristics also implies a geographical responsibility (Table 11).

Long-term trends in demand due to underlying population, income and urbanization trends, formed a second important input into CIAT bean program's activities. As can be seen in Table 12, present consumption in Latin America is considerably higher than in Africa. However, demand growth in the next two decade will occur primarily in Africa, where a burgeoning population and a low average income level highlight the need for rapid production development. Although Africa is rapidly urbanizing, a very substantial share of bean supply will still be consumed without being marketed. In Latin America, demand growth is not so spectacular, but the capacity of the bean sector to supply market demand has not been adequate and large imports have resulted (Table 12). Whereas bean production improvement in Latin America is directed towards the generation of highly

FROM CIAT-CO 57-22-647243 5.27.1988 12:44 P.31

marketable (commercial) varieties that necessarily contribute to improved farm income, the empahsis in Africa is towards yield expression.

Marketing and Demand Research for Technology Design:

The input of marketing and demand research in bean technology design has focused on four issues: firstly, defining commercial requirements of improved bean varieties; secondly, farmer target group selection on the basis of aggregate demand and demand for specific grain types; thirdly, target area selection on the basis of market integration studies; and finally post-harvest storage problems and their impact on bean consumption. The first two issues have received the most attention in the bean program and only methodological advances in these two areas will be discussed.

Preferences Studies among Consumers: With respect to the definition of commercial grain type requirements, it should be understood that productivity improvements as obtained through breeding are often related to major or minor changes in color, seed type or other characteristics. These characteristics potentially influence commercial acceptance. For example, a negative relation exists between yield potential and grain size. In turn, in many markets small grain types obtain inferior prices. It follows then that to define commercial characteristics of new varieties an understanding of consumer preferences is required.

The bean program has undertaken considerable research on the definition of these quality characteristics. The hypothesis is that long term acceptance of new varieties is defined by consumer preferences more than by requirements of the marketing channel. The marketing channel is

FROM CIAT-CO 57-23-642143 5.27.1988 12:45 P.32

expected to transfer these consumer preferences to the farm level. It is clear to the program that the marketing channel has an important role in the acceptance or non-acceptance of a new variety, but its long-term evaluation criteria are defined by consumers, while its short-term criteria should be incorporated in technology tranfer rather than in design.

To measure consumer preferences obviously first requires a clear specification of different product characteristics. Table 13 presents those characteristics identified for dry beans. It is clear that overall acceptability of a certain bean type is a complex function of a large number of characteristics. In the initial stages of consumer preference research, interviews have had a wide focus and were rather open ended. Demands on the interviewer and on the interviewed consumers were high at this stage. The structure of the interview and the elicitation of opinions in an objective way required well trained and informed interviewers. Moreover, these interviews, which dealt with a wide range of preference parameters, required the attention of the consumer for a considerable time (often more than an hour).

The application of sophisticated analytical methods to semi-open-ended, wide-ranging interviews was often constrained, especially by the difficulty in obtaining sufficient, complete observations. Consumer stratification, means and frequency analysis, factor analysis and correspondance analysis were useful analytical methods for these studies. Since the results of these studies were strongly country specific, they will not be discussed.

FROM CIAT-CO 57-23-64224 5.27.1988 12:46 P.33

Hedonic Princing: On the basis of the preference characterization, it is often possible to isolate a more specific preference problem. In such a case more sophisticated analytical methods can give valuable insights. Hedonic pricing is a powerful method in this respect. Prices of different varieties of the same crop are obtained through market information systems. When prices of non-traditional varieties are to be included, interviews with retailers and wholesalers can be executed. The average prices obtained through the market information system or the interviews are then regressed on specific consumption characteristics. The resulting coefficients express the value of a specific characteristic.

In the case of beans for Colombia, the following equation was estimated:

Price = f(grain size, grain form, color) (1)

Thirty varieties were included of which five were commercially available at the time of study. Grain size was measured as a continuous variable (weight per 100 grams), while grain form and color were measured as dummy variables. The equation was able to explain 61% of the variability in bean prices. Grain size had a very significant effect on the price. In fact, large grain types can be expected to receive a 30% price premium. Grain form was not significant. With respect to color, red or red-cream mottled beans received price premiums on the order of 10%.

The implications for research design were very clear. In order to obtain good market access, varietal development for Colombia should be concentrated in the larger, red or red-cream mottled grain types. If bean

breeding focuses on small grain types, because these have higher yield potential and can be supplied to the poor consumer at a lower price, these grain types should out yield large grain types by more than 30% in order to be attractive to the farmer. Although such conditions increase selection parameters in the breeding program, they in turn increase the final probability of success and expected pay-off.

Another method which might help to define quality characteristics in research programs is conjoint analysis. In comparison with hedonic pricing, conjoint analysis puts less demand on the interview and more demand on the design of the study. Conjoint analysis only requires rank orders, but greatly increases its efficiency if specific combinations of the quality characteristics in question can be included in the interview. For more information see Steenkamp (1987).

Farmer and Consumer Target Group Selection: Equity considerations stimulate many research programs to design technologies that benefit small over large farmers and CIAT's bean program is no exception. In subsistence situations such a choice is rather straight forward, but in market-oriented economies a trade-off between consumer and producer welfare might be expected. In Latin America over 70% of the population lives in urban areas. Research to decrease food acquisition costs to the poor, urban dweller is highly justified, but not necessarily compatible with the objective of improving small farm income. To evaluate such trade-offs involves detailed knowledge of consumer demand.

Within a number of countries in Latin America, bean markets are highly stratified, with some expensive (often large) and some cheap (often small)

FROM CIAT-CO 57-23-647243 5.27.1988 12:47 P.15

grain types. Since these grain types often originate in different regions of the country, poor consumers can be targeted by concentrating research on bean production in a specific region. In the case of beans in Brazil, the question was asked whether production technology should be biased towards small farmers or not. Small farmers can be targeted by semi-climbing or climbing materials and varieties adapted to associated cropping. Large farmers can be targeted by breeding erect, mechanizable beans. Small farm and large farm bean supply functions were estimated along with consumer demand functions by income strata and then were integrated in a partial-equilibrium model benefits; to the different groups were then assessed (Pachico, Lynam and Jones, 1987).

Table 14 shows the results of this exercise. Production technology biased towards small farmers would bring them considerable annual benefits. In this situation large farmers would actually be net losers while consumers would obtain access to slightly cheaper beans. In case production technology would be biased towards large farmers, the small farmers would lose considerably. On the other hand, consumers, and especially the poorest among them would obtain access to considerably cheaper beans. The dilemma is clear: either small farmers or poor consumers can be the target group of new technology, but it is impossible to benefit one group without a reduction of benefits to the other. The solution to this dilemma is outside the domain of economic analysis. Rather economic analysis offers policy makers a clear and objective view of the consequences of alternative choices.

Marketing and Demand Studies for Technology Transfer:

Technology transfer for the bean program focuses on new varieties.

FROM CIAT-CO 57-22-647242 5.27.1988 12:48 P.26

The introduction of a new variety in a certain country shows remarkable similarities with new product release strategies as designed and reported in the marketing literature (Kotler, 1976). The product (seed) should be widely available and in sufficient quantities; the users of the new product (farmers) should have appropriate information on what to expect; the price at the moment of release should allow its diffusion.

Research with respect to varietal release strategies is in its initial stages within the bean program. For a number of countries in Central America, varietal release strategies have been compared and evaluated, in order to improve their effectiveness. For Colombia, the effect of import policies on bean price and on the subsequent chances of successful release of a new variety has been studied. Seed production schemes are being tested; the effect of risk aversion and volume limitations on the behavior of market agents with respect to new varieties is being researched. With respect to technology tranfer the importance of marketing and demand studies for effective transfer strategies will probably surpass its role in strategy or design definition.

Conclusions

Demand and marketing analysis is not often systematically utilized in research planning of commodity programs. The reason is partly organizational. Biological research tends to be production focused and is usually separated from "food technology" research, which focuses on utilization. Moreover, economics research tends to be separated from both other areas. Because demand and marketing analysis is very dependent on

FROM CIAT-CO 57-22-642243 5.27.1988 12:49 P.37

problem definition to be effective, this separation usually precludes even any consideration of a demand-side problem.

The other reason is the general lack of an integrating framework for such research, which has precluded problem identification from leading to problem resolution. For example, the market demand faced by a commodity is usually taken as unalterable in agricultural research rather than an indication for demand-side research. The commodity system provides such an integrative framework for linking production analysis to demand and marketing analysis, and in turn for linking research on production technology with that on post-harvest technology. Demand and marketing analysis thus completes the picture in a commodity system but in the process expands the scope of commodity research programs.

The cases of the CIAT cassava and bean programs were utilized to illustrate the diversity in the methodologies utilized and how methodology and data collection methods need to be selected on the basis of the research question being asked. This "problem identification" in turn depends on the state of development of the research program, the type of crop, and the state of development of agricultural markets. Thus, in the bean program demand and marketing analysis supported the development of production technologies, while in the cassava program such analysis led the research very heavily into the post-harvest area.

John Mellor (1977) has also pointed to the need for methodological flexibility in planning economic analysis for agricultural research programs. His advice is applicable to the selection of demand or marketing

FROM CIAT-CO 57-13-647243 5.27.1988 12:49 P.38

methodology and is worth repeating: "(Social scientists) must recognize the impracticality of a general equilibrium approach in this extraordinarily complex area and settle for numerous partial approaches .... They must immerse themselves in the operational context of the real world so that they many choose economically among the many possible "partial" problems in allocating their own potentially valuable resources." Unfortunately, this is advice which now runs counter to the mainstream of the agricultural economics profession.

FROM CIAT-CO ST-II-647243 5.27.1998 12:50 P.13

Bibliography

1. CIAT, "CIAT in the 1980s: A Long-Range Plan for the Centro Internacional de Agricultura Tropical", Cali, Colombia: CIAT, 1981.

2. De Haan, C., "Buying Behaviour and Changing Cassava Consumption Habits in Bucaramanga," mimeo, Agricultural University of Wageningen, Wageningen, 1986.

3. Díaz, R.O. and P. Pinstrup-Andersen, "Descripción Agro-económica del Proceso de Producción de Yuca en Colombia," Cali, Colombia: CIAT, 1977.

4. Evenson, R.E., "Benefits and Obstacles in Developing Appropriate Agricultural Technology," in C.K. Eicher and J.M. Staatz (eds), Agricultural Development in the Third World, Baltimore: John Hopkins University Press, 1984.

5. Freebairn, J.W., J.S. Davis, and G.W. Edwards, "Distribution of Research Gains in Multistage Production Systems," American Journal of Agricultural Economics, 64(1982):39-46.

6. Hirschman, A.O., "A Generalized Linkage Approach to Development, with Special Reference to Staples," Economic Development and Cultural Change, 25(1977):67-98.

7. Janssen, W., "Market Impact on Cassava's Development Potential in the Atlantic Coast Region of Colombia," Cali, Colombia: CIAT, 1986.

8. Janssen, W. and J.K. Lynam, "Integrated Ex-Ante and Ex-Post Impact Assessment in Agricultural Technology Generation: Cassava in the Atlantic Coast of Colombia," mimeo, Cali, Colombia: CIAT, 1988.

9. Janssen, W. and C. Wheatley, "Urban Cassava Markets: The Impact of Fresh Root Storage," Food Policy, 10(1985):265-277.

10. Kotler, P., Marketing Management: Analysis, Planning and Control, London; Prentice-Hall International, 1976.

11. Lynam, J.K., "On-Farm Evaluation of Improved Cassava Technology," in Fifth Internactional Symposium on Tropical Root and Tuber Crops, Los Baños, Philippines: PCARRD, 1982.

12. Lynam, J.K., L. Sanint, C. Ibañez-Meier, and R. Saez, "The Cassava Economy of Latin America: A Food Staple in Transition," Cali, Colombia: CIAT, 1987.

13. Lynam, J.K. and D. Pachico, "Cassava In Latin America: Current Status and Future Prospects," mimeo, Cali, Colombia: CIAT, 1983.

FROM CIAT-CO 57-23-647243 5.27.1988 12:51 P.40

14. Mellor, J.W., "Relating Research Resource Allocation to Multiple Goals," in T.M. Arndt, D.G. Dalrymple, and V.W. Ruttan, Resource Allocation and Productivity in National and International Agricultural Research, Minneapolis: University of Minnesota Press, 1974.

15. Monke, E.A., "International Grain Trade, 1950-80," Technical Bulletin 247, College of Agriculture, University of Arizona, 1983.

16. Pachico, D., W. Janssen; and J.K. Lynam, "Ex-Ante Analysis of New Technology: A Comparison of Cassava for the Feed and Fresh Markets in Colombia," Agricultural Systems, 11(1983):131-142.

17. Pachico, D., J.K. Lynam; P.G. Jones, "The Distribution of Benefits from Technical Change Among Classes of Consumers and Producers: An Ex-Ante Analysis of Beans in Brazil," Research Policy, 16(1987):279-285.

18. Phillips, T.L., "Cassava Utilization and Potential Markets," IDRC-020e, Ottawa: IDRC, 1973.

19. Quizon, J.B. and H.P. Binswanger, "Income Distribution in Agriculture: A Unified Approach, "American Journal of Agricultural Economics, 65(1983):526-538.

20. Sanders, J.H. and J.K. Lynam, "Evaluation of New Technology On Farms: Methodology and Some Results from Two Crop Programmes at CIAT," Agricultural Systems, 9(1982):97-112.

21. Sanders, J.H. and J.K. Lynam, "Definition of the Relevant Constraints for Research Resource Allocation in Crop Breeding Programmes," Agricultural Administration, 9(1982):273-284.

22. Schuh, G.E., "Meeting the Challenge of Diversification out of Rice Production in Asia: Towards a Research Agenda," paper presented at CGIAR Group Meeting, Montpellier, France, 1987.

23. Senaur, B., D. Sahn, and H. Alderman, "The Effect of Value of Time on Food Consumption Patterns in Developing Countries: Evidence from Sri Lanka," American Journal of Agricultural Economics, 68(1986):920-927.

24. Steenkamp, J.F.M., "Conjoint Measurement in Ham Quality Evaluation," Journal of Agricultural Economics, 38(1987):473-480.

25. Technical Advisory Committee, "TAC Review of CGIAR Priorities and Future Strategies," Rome; FAO, 1985.

26. Timmer, C.P., W.P. Falcon, and S.R. Pearson, Food Policy Analysis, Baltimore: John Hopkins University Press, 1983.

27. Timmer, C.P. and H. Alderman, "Estimating Consumption Parameters for Food Policy Analysis," American Journal of Agricultural Economics, 61(1979):982-987.

Table 1. Latin America: Annual Per Capita Consumption of Cassava by Region and Rural-Urban Status.

Country and Region	Rural (kg)	Urban: Town (kg)	Urban: City (kg)	Avaraga (kg)
Colombia (1981)				
Atlantic Coast	72.7		42.3	54
Eastern Region	39.0		23.5	31
Bogota	-		7.2	7
Central Region	35.4		12.5	20
Pacific	17.3		8.3	12
Peru (1971-72)				
North Coast	11.0	10.6	9.7	11
North Sierra	18.0	7.5	-	17
Central Coast	n.a.	n.a.	n.a.	4
Central Sierra	n.a.	n.a.	n.a.	2
South Coast	n.a.	n.a.	n.a.	5
South Sierra	n.a.	n.a.	n.a.	1
High Jungle	82.2	14.2	-	71
Low Jungle	101.8	78.6	15.5	65
Metro Lima	-	-	4	4
Brazil (1975)				
Fresh Cassava				
North	n.a.	1.8	0.4	2
Northeast	5.2	3.4	1.9	4
Southeast	4.7	2.8	1.7	3
South	23.2	7.0	5.7	16
Center-West	n.a.	8.2	2.6	16
Farinha				
North	n.a	49.0	45.5	54
Northeast	55.0	31.9	21.4	44
Southeast	10.5	3.3	2.2	5
South	4.4	3.2	0.5	4
Center-West	n.a.	3.7	2.2	4

Source: Lynam, et.al, 1987.

FROM CIAT-CO 57-23-647243 5.27.1988 12:52 P.42

Table 2. Latin America: Time Series Estimates of Demand Elasticities for Fresh Cassava in the Period 1965-84.

	Colombia	Ecuador	Paraguay	Peru
Own Price	- 0.30	- 2.08	- 0.10	- 0.20
Income	1.60	1.38	- 0.13	0.03
Urbanization	- 0.16	- 0.99	- 0.13	- 1.03
Wheat Price	n.s.	0.45	0.07	0.11
Rice Price	n.s.	2.42	-	0.64

Source: Lynam, et.al., 1987.

FROM CIAT-CO 57-23-642242 5.27.1988 12:57 P.42

Table 3. Colombia: Disaggregation of Demand Parameters for Fresh Cassava in Rural and Urban Areas, 1981.

Parameters	Rural	Urban
Population Growth	- 0.1	3.7
Income Elasticity	0.28	0.38
Per Capita Income Growth	2.5	1.4
Demand Growth	0.6	4.2
Weighted Average [1]	0.51 (0.6) +	.49 (4.2) = 2.4

[1] Weights are distribution of total consumption between rural and urban areas in 1981.

Source: Lynam, et.al., 1987.

FROM CIAT-CO 57-23-647243 5.27.1988 12:52 P.44

Table 4. Brazil: Relationship between farinha de mandioca and wheat flour prices and consumption, 1960-80.

	1960	1970	1980
Farinha Consumption (kg/capita)	26.3	23.5	12.0
Wheat Consumption (kg/capita)	26.2	25.2	45.2
Farinha/Wheat Consumption	1.0	0.93	0.26
Farinha/Wheat Prices	0.61	0.64	2.95

Source: Lynam, et.al., 1987

FROM CIAT-CO 57-22-642243 5.27.1988 12:54 P.45

Table 5. Brazil: Effects of Wheat Subsidy on Daily Calories Consumed.

Commodity and Income Strata	South		Southeast		Northeast	
	Urban	Rural	Urban	Rural	Urban	Rural
Rice						
1 min salary	-18	-52	-49	-8	-33	-47
2 min salary	-33	-115	-21	51	-14	-45
5 min salary	-52	-195	15	127	11	-43
8 min salary	-60	-231	32	162	23	-42
Wheat						
1 min salary	85	97	27	5	77	15
2 min salary	75	89	34	2	89	18
5 min salary	61	77	41	0	106	22
8 min salary	53	70	45	0	113	24
Cassava flour						
1 min salary	-7	-30	-8	-30	-5	23
2 min salary	-3	-14	-5	-14	-41	-44
5 min salary	3	6	-1	6	-90	-133
8 min salary	6	17	1	17	-113	-177
Total						
1 min salary	60	14	-30	-33	39	-9
2 min salary	40	-41	7	39	34	-71
5 min salary	13	-112	55	133	27	-154
8 min salary	-1	-145	77	178	23	-195

Source: Lynam, et.al., 1987

FROM CIAT-CO 57-23-642143 5.27.1988 12:54 P.46

Table 6. Colombia: Path Coefficients between Cassava Retail Price Series in Five Different Towns in the Atlantic Coast Region, 1970-1984. 3/

Consumption Areas	Production Areas			
	Barranquilla	Sincelejo	Monteria	Santa Marta
Barranquilla		0.51	0.02	0.40
Cartagena	-0.26 1/	0.84 1/	-0.05 1/	0.42 1/
	- 2/	0.71 2/	-0.06 2/	0.32 2/

1/ Values assume the Cartagena price is dependent on the Barranquilla price.

2/ Values assume the Cartagena price is not dependent on the Barranquilla price.

3/ Sincelejo prices from 1979-1984.

Source: Janssen, 1986.

FROM CIAT-CC 57-23-642243 5.27.1988 12:55 P.47

Table 7. Brazil: Private and Social Costs of Supplying Maize and Dried Cassava in the Northeast, 1986.

Item	Private costs		Social costs	
	Absolute (Cr$t)	Cassava/maize (%)	Absolute (Cr$/t)	Cassava/maize (%)
Locally produced maize	1517	86	1405	88
Maize from south	1616	81	1468	84
Maize from central west	2494	52	2130	58
Imported maize	1705	77	1675	73
Locally produced cassava	1306		1231	
Maize price	1690	77	1690	73

Source: Lynam, et.al., 1987.

ESOM CIAT-CO 57-12-642243 5.27.1988 12:55 P.48

Table 8. Atlantic Coast, Colombia: Factor Scores per Crop, Average Values of Total Sample.

Crop	Factor 1 "buying inconvenience"	Factor 2 "intrinsic value"	Factor 3 "in shop availability"	Factor 4 "short-term price trends"
Rice	-0.77	-1.00	0.85	-0.64
Potatoes	-0.35	0.08	0.00	1.20
Cassava	1.75	-0.18	0.05	0.42
Plantain	-0.69	1.42	-0.26	-0.75
Yam	0.06	-0.32	-0.89	0.64

Source: Janssen, 1986.

FROM CIAT-CO 57-23-6472243 5.27.1988 12:56 P.49

Table 9. Results of a Hedonic-Demand Model to Explain Cassava and Other Starchy Staple Consumption in the Atlantic Coast Region of Colombia.

	Effect of buying convenience (cal/year)	Effect of in-shop availability (cal/year)	Effect of price trends (cal/year)	Income elasticity	Price elasticity	Shifts 1/ in cassava consumption (kg)	Price change to obtain similar shift
Total sample		38912 (4.1)	-26710 (-3.28)				
- Large towns	26544 (2.50)			0.04 (0.27)	-0.69 (-1.54)	15.6	-46%
- Intermediate towns	26937 (2.28)			-0.17 (1.03)	-0.66 (2.21)	10.9	-28%
- Large villages	19556 (1.54)			-0.17 (1.00)	-0.62 (-1.92)	8.8	-17%
- Small villages	-8701 (-0.59)			-0.13 (0.67)	-0.70 (-2.21)	-4.4	N.R. 2/

1/ The reported shift is the product of the expected change in cassava convenience per urbanization stratum times the effect of buying convenience on consumption.

2/ N.R. = not relevant.

Source: Janssen, 1986.

FROM CIAT-CO 57-23-647242 5.27.1988 12:56 P.50

Table 10. Bucaramanga, Colombia: A Model of Fresh Cassava Consumption in Urban Areas

Factor	Coefficient
Intercept: per capita annual consumption	75.7 *
Income: change per 100 pesos of monthly family income	-.14 *
Number of children in family	-22.6 *
Housewife is employed	-6.9 *
Family has a refrigerator	7.8 *
Barrio with poor market access	-18.2 *
Barrio with reasonable market access	-10.2 *
Barrio with good market access	-5.8

* Coefficient significant at the probability level of 5%.

Source: De Haan, 1986.

FROM CIAT-CC 57-17-647243 5.27.1988 12:56 P.51

Table 11. Main Groups of Commercial Grain Types in the Developing World, CIAT's Bean Program Breeding Responsibilities.

Grain Type	Main Production Region	Estimated Production (tons)	Breeding Program Responsible
Medium Reds	Africa, L.A. Andes	1,600,000	II
Blacks	Brazil, Mexico, Central America	1,200,000	I
Small Creams	Brazil	1,000,000	II
Large Creams, Pintos	Mexico	850,000	II
Whites	Northern Africa, West Asia, Argentina	650,000	II
Small Reds, Pintos	Brazil, Central America	600,000	I
Yellows	Mexico, Africa	300,000	I

Source: Bean Program, internal information.

FROM CIAT-CC SF-12-64204 5.27.1988 12:57 P.02

Table 12. Trends in Bean Consumption in Africa and Latin America

	Consumption 1985 (000 tons)	Projected Consumption 2005 (000 tons)	% Urban Population 1985	Imports (1982-1984) (000 tons)	Demand Growth (000 tons)	Bean Program % Budget Allocation
African bean producing countries	2419	5414	25	17	2995	55%
Latin America	4137	6152	69	244	2022	45%

Source: FAO, Production and Trade figures, various years
World Bank: World Development report 1987
Bean Program, internal data.

FROM CIAT-CO 57-23-647243 5.27.1988 12:57 P.53

Table 13. A Framework for the Study of Consumer Preferences with Respect to Dry Beans.

I Visual characteristics of the dry beans

- size
- color
- shape
- brilliance
- appearance after storage

II Cooking characteristics of beans

- hard seed phenomenon
- cooking time
- storage possibility after cooking
- broth color and thickness
- water absorption
- stable or unstable seed coat

III Eating characteristics of beans

- toughness of the seed coat
- texture
- flavor
- digestibility
- gas production
- sliminess

FROM CIAT-CO 57-21-647243 5.27.1988 12:58 P.54

Table 14. Brazil: Distribution of Estimated Annual Benefits of Alternative Bean Technologies (000 US-dollars, 1982).

Technology Bias	Benefits Small Farms	Large Farms	Consumers	Poorest 25% Consumers	Total Benefits	Expected Rate of Return to Investment
Small farm	85,556	-6,434	13,259	3,844	92.381	41%
Large farm	-46,900	83,561	92,362	26,962	129.023	53%

Source: Pachico, Lynam, Jones, 1987.

FROM CIAT-CO 57-23-6472/3 5.27.1988 12:58 P.55

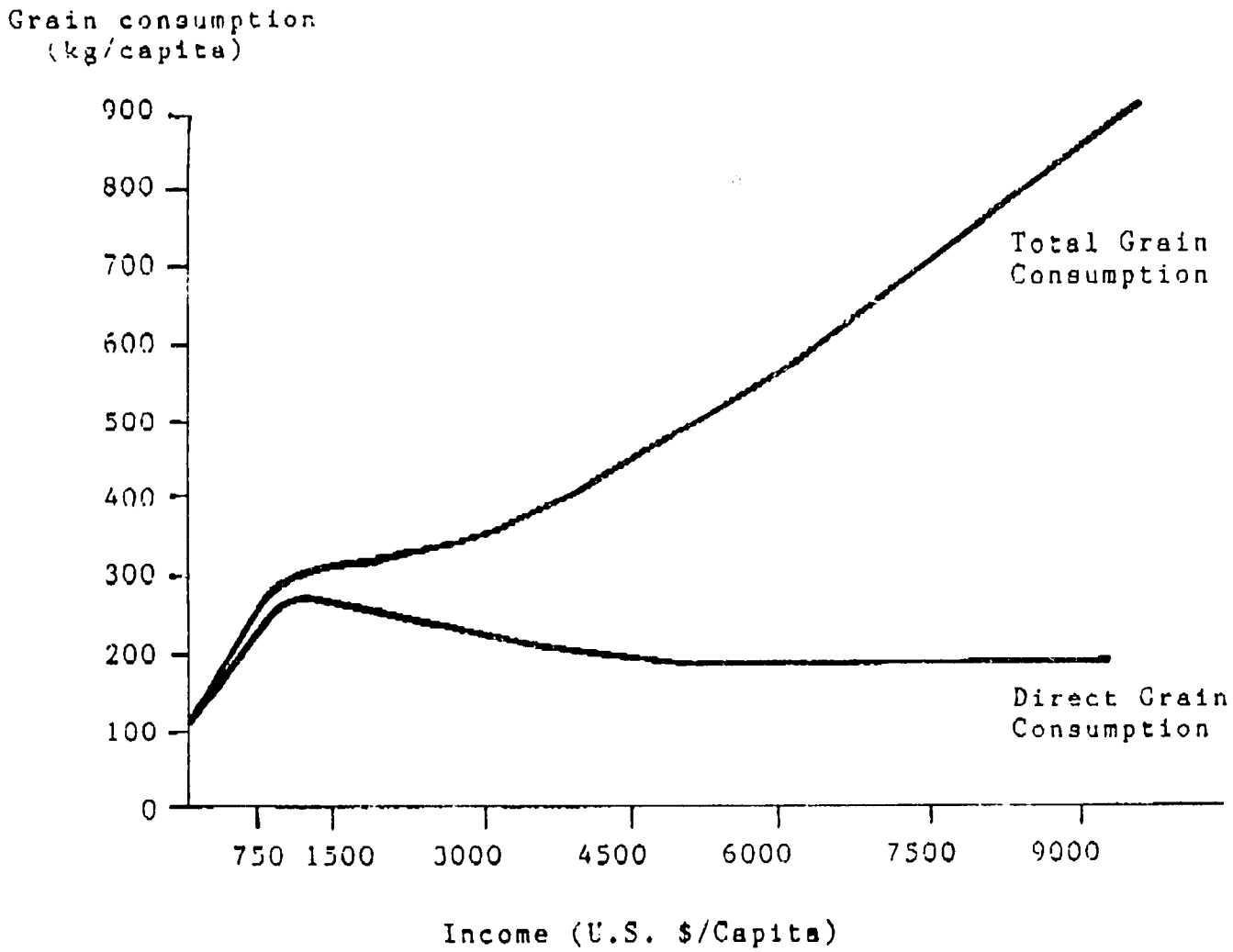
Figure 1. Alternative Research Strategies within a Commodity System Focus

Demand Side		Supply Side	
Demand expansion:	market diversification product development market segmentation quality enhacement	Production expansion:	area yield constraint alleviation
Cost reduction :	marketing margins processing costs	Cost reduction:	input costs labor costs
Price stability/ Market integration		Yield stability/ System sustainability	

FROM CIAT-CO 57-22-642243 5.27.1988 12:59 P.56

55A

Figure 2. Income and Grain Consumption, 1978



Source: Monke, 1983

Figure 3. A Conceptual Scheme for Demand Studies in Agricultural Research.

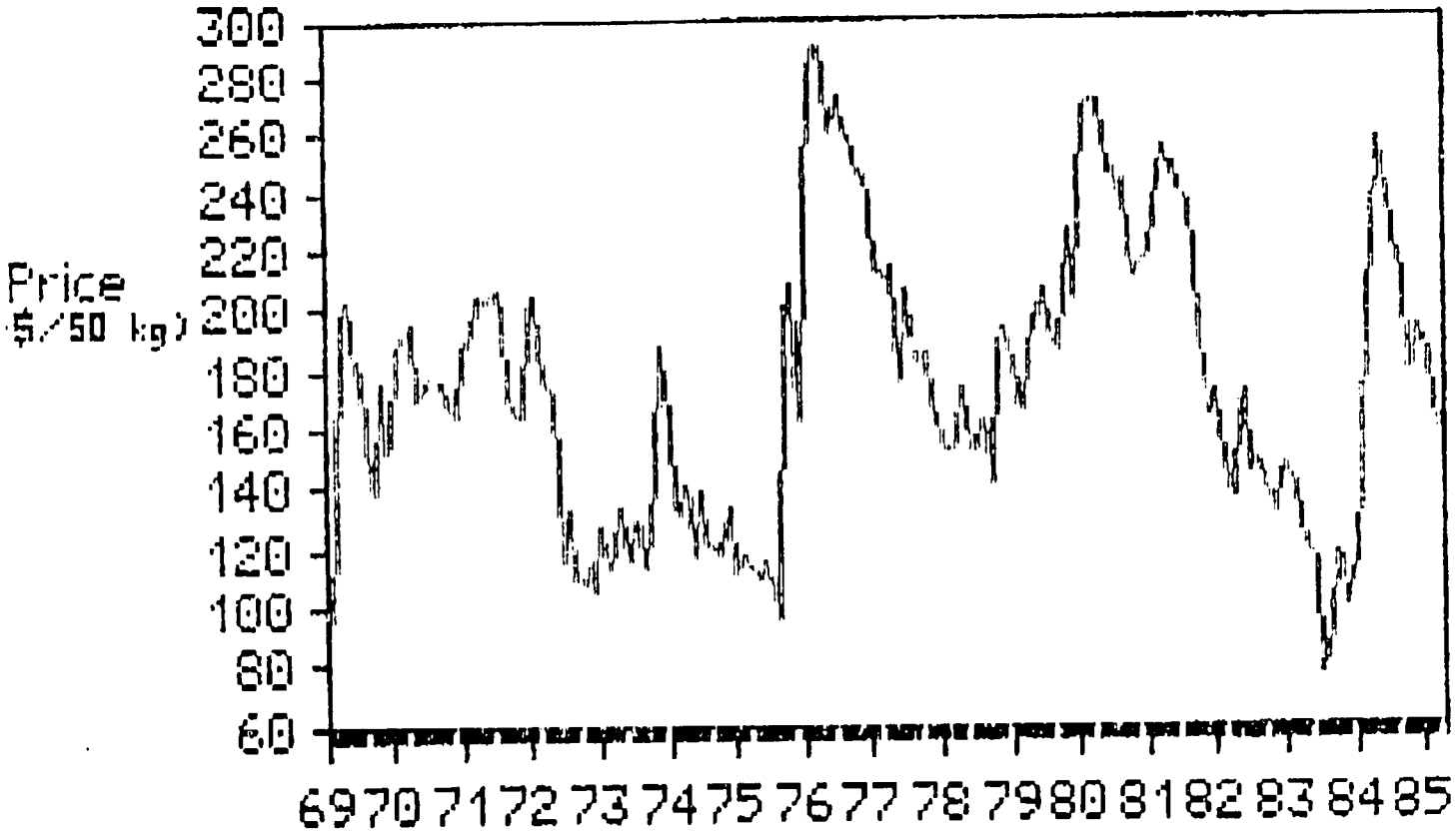
Time Frame	Management Focus	Operational Goals	Methodologies	Data Sources	Research Parameters
Long term	Research Priorities and Strategies	Resource allocation	-Trend analysis and projections -Food budget survey analysis -Simultaneous system	-National and international statistics -National food budget surveys -Price series	-Elasticities -Consumption patterns -Budget shares
Intermediate term	Technology Design and Testing	Efficient use of allocated resources	-Quality-price research -Product characterization -Consumer characterization -Hedonic pricing	-Consumer questionnaires -Panels -Market studies -Regional statistics	-Long-term price differentials -Demand shifts -Market segments -Price projections
Short term	Technology Tranfer	effectiveness of prototype solutions	-Test marketing -Market share studies -Marketing mix studies -Adoption studies	-Monitoring -Consumer questionnaires	-Short-term price differentials -Promotion and distribution parameters

FROM CIAT-CO 57-22-647243 5.27.1988 12:59 P.56

56A

FIGURE 5

Bahia, Brazil: Variation in the Wholesale Price of Farinha (at Constant 1977 Prices).



FROM CIAT-CO 57-23-642243 5.27.1988 13:00 P.59

FROM CIAT-CO 57-23-647243 5.27.1988 13:01 P.60

Figure 4. Technology Evaluation within a Commodity System Focus

Stage in the Commodity System	Individual Agent: Evaluation of Technology Traits	Market: Determinants of Impact
Consumer	Quality: variety, processing Convenience: processing, storage Price differentials	Market segmentation: quality, access
Assembly-Wholesale-Retail	Quality: minimum standards Risk: in case of perishables Storage properties Margin (cost) components	Structure, conduct, performance Market integration
Processing	Quality: variety, technique Processing yield Scale Cost components	New market development
Producer	Cost components Risk: production, market	Price determination Risk: price, market access