



DISSERTATION ABSTRACTS
Relating to
**INTERNATIONAL AGRICULTURAL
AND RURAL DEVELOPMENT**

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International Agricultural and
Rural Development

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Compiled by Donald Henry

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SOME ENDOSPERM CHARACTERISTICS OF A HIGH-LYSINE MAIZE (ZEA MAYS L.) COMPOSITE

A high-lysine composite was made by crossing eighteen inbred lines homozygous for o_2 with 74 normal inbreds, selfing these, growing the opaque seed, and interpollinating. The resulting population showed unexpected segregation ratios for endosperm appearance. Three methods were applied to determine the cause of these unexpected ratios.

First, a number of plants from the population were selfed and test-crossed to homozygous o_2 lines. The kernels from resulting ears were separated into classes and counted. Second, the lysine content of kernels from several of the selfed ears was measured, using 2,4,6-trinitrobenzenesulfonic acid (TNBS) as a colorimetric reagent. Third, protein bodies in thin sections of mature kernels from selfed ears were examined using transmission electron microscopy and compared to known sources with o_2 , $f1_2$, and their normal alleles.

The clear segregation ratios on the selfed and test-crossed ears suggested that a single major gene in addition to o_2 was involved. A model using o_2 and $f1_2$ adequately accounted for the observed ratios and estimated the frequencies of these two genes in the population. Lysine analyses supported the model as well. Examination with a transmission electron microscope, which can distinguish between protein bodies of normal, o_2 , and $f1_2$, also showed that $f1_2$ was present. Furthermore, the work indicated that the TNBS assay for lysine is too complex and that its results are too variable for routine use.

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INTERSPECIFIC TRANSFER OF POWDERY MILDEW RESISTANCE IN THE GENUS CUCURBITA

Most cultivated squash varieties grown in the U.S. belong to Cucurbita pepo, C. moschata and C. maxima, and all C. pepo and C. moschata varieties grown are susceptible to powdery mildew. Most C. maxima varieties appear to

have useful levels of resistance. Some control of powdery mildew can be achieved with fungicides, but resistant varieties would be a better alternative. C. martinezii probably has the highest level of resistance in wild species crossable with cultivated Cucurbitas. The main objectives of this study have been to transfer resistance from C. martinezii into C. moschata 'Butternut' and various C. pepo cultivars, to determine the inheritance of resistance, and to compare this source of resistance to others already reported.

Plants were evaluated in both greenhouse and field tests. In the greenhouse tests, inoculation was done by breath-blowing spores onto the plants, and resistance was evaluated in 3-4 week-old plants. In the field tests, seedlings were inoculated in the greenhouse, transplanted to the field in June and evaluated for resistance in August. Susceptible cultivars showed abundant sporulation, whereas resistant species suppressed sporulation partially or totally. Thus, resistance in this study was expressed as the ability of plants to suppress sporulation. Lack of sporulation on hypocotyls, stems and petioles of seedlings identified those plants with the greatest likelihood of being resistant at later stages. At maturity, suppression of leaf sporulation was more diagnostic of resistance. Leaf retention was positively correlated with suppression of leaf sporulation ($r = 0.22-0.60$), but other factors in addition to sporulation appeared to have an effect on leaf retention.

Resistance in C. moschata x C. martinezii and [(C. pepo x C. moschata) x C. pepo] x (C. moschata x C. martinezii) crosses was largely determined by a major dominant gene. Dominance was complete at the seedling stage and incomplete at later stages. Heterozygous resistant mature plants from BC1 through BC3 generations were as resistant as the original F1, but the C. martinezii level of resistance was not recovered upon selfing them. In addition, resistance levels between Butternut and the F1 (Butternut x C. martinezii) were identified. All of this suggests that the phenotypic expression of resistance at maturity was influenced by modifier genes.

The major gene for resistance from C. martinezii appeared to be identical to the reported gene from C. lundelliana. However, it is not known if original levels of resistance can be maintained in advanced generations of crosses with C. lundelliana.

F1 plants of C. moschata x C. maxima were susceptible, male-sterile and highly cross-incompatible. The expression of the resistance gene from C. martinezii

was modified in (C. moschata x C. martinezii) x C. maxima crosses. This suggests the presence of different genes for resistance in C. maxima.

Additional evaluations were made with other sources of resistance. Resistance from a C. moschata selection from the Dominican Republic was expressed only at maturity when crossed to Butternut, and was due to more than one gene. Crosses with C. okeechobeensis were not made, but its similarity to C. martinezii in mildew resistance and in its morphological features suggests that it has the same gene for resistance. PI 201254 resembled C. mixta in appearance and C. maxima in resistance. Crosses with Butternut or the F1 (Butternut x C. martinezii) failed to produce seeds.

None of the sources of resistance evaluated in this study appeared to be superior to C. martinezii or to offer different major genes which could be identified in segregating progenies to produce higher levels of resistance.

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Delgado, Christopher Linn

Economics

LIVESTOCK VERSUS FOOD GRAIN PRODUCTION IN SOUTHEASTERN UPPER VOLTA: A RESOURCE ALLOCATION ANALYSIS

Policy makers concerned with the West African Savannah have emphasized the value of integrating cattle-raising into smallholder agriculture. Particular interest in this respect has been expressed in village livestock development in Southeastern Upper Volta. The small-scale cattle enterprise is extolled as providing the participating sedentary farmer with milk proteins, cash income from the sale of animals fattened on farm by-products, and crop yield increases from usufruct of the manure. Furthermore, farm cattle can be used for ploughing. However, the peasant households that own cattle in this area typically choose to forego these benefits by entrusting the animals to semi-sedentary Fulani herdsmen who live outside the village.

The principal hypothesis is that the high opportunity cost of seasonal labor in terms of food grains, the desire for self-sufficiency in millet, and

the high seasonal labor requirement for grazing and supervising animals offer an economic explanation of why farmers prefer to entrust animals to the Fulani, rather than to look after them themselves. This hypothesis is tested using input-output data on actual farm practices during the 1976-77 agricultural year. A thirteen month farm management survey of forty-one Mossi and Bisa households from two villages in the Tenkodogo area provided detailed information on labor flows, land use patterns, and outputs, using semi-weekly interviews. A concomitant five month survey of twenty Fulani families provided information on cattle labor requirements and ownership patterns.

A linear programming model incorporating eleven crop and two small stock activities is constructed from the data. An hypothetical cattle enterprise is also included, based upon the results of the herder survey. The income from this activity represents the extra returns to keeping the animals on the farm as opposed to entrusting them to the Fulani. The model is used to identify optimal production strategies and resource constraints under different assumptions concerning farmers' desires for self-sufficiency in food grains.

The basic model is modified to incorporate the crop yield increases and seedbed preparation decreases projected by research station personnel for animal traction. The new model farmer is also obliged to keep two steers on the farm. The weeding and harvesting labor requirements for crops are increased in accordance with the research station predictions. These changes permit testing the effect of animal traction on farm income in the event that it has the effects predicted by its principal proponents.

The basic model shows that a revenue-maximizing farmer will entrust his cattle to the Fulani, rather than keep them himself, regardless of the assumptions concerning food grain production. Furthermore, a rise in the minimum area of farmland put under food grains increases the opportunity cost of harvest labor resources in mid-November. Starting from grain production consistent with the lowest amount of millet cultivated by any sample member in 1976, the opportunity cost of the labor required to maintain two steers on the farm is estimated at 1.2 hectares of grain. The introduction of animal traction adds very little to the maximum attainable farm income, even when the cost of the equipment is ignored. Farm income actually decreases if farmers desire to product food grains; it falls most when they use traction on the millet fields as well as on the cash crops.

In view of these considerations, efforts to increase livestock production in the research area should be directed to supporting the traditional cattle entrusting system. In the absence of this option, attention should be directed to peak labor-saving innovations in food grain output. This would then be the best means of introducing cattle into the farming system.

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Garcia, Philip

Agricultural Economics

MARKET LINKAGES OF SMALL FARMS: A STUDY OF THE MAIZE MARKET IN NORTHERN
VERA CRUZ, MEXICO

Despite its potential importance, there has been little systematic economic research in the developing world on small farm marketing behavior and the interactions of the small farmer and the marketing system. The purpose of this study is to explore the interrelationships of the small farmer in low-income, tropical regions with the grain marketing system that most directly services him.

Understanding the environment within which the small farmer and the marketing system function is of particular importance in Mexico. Maize production, which primarily comes from small, non-irrigated, low income farms has lagged behind national consumption since the late 1960's. Government officials speculate that the middleman's ability to maintain producer prices at artificially low levels is a major obstacle to increased production.

This study is divided into three sections: (1) a description of the rural grain marketing system for maize, including an evaluation of pricing efficiency; (2) a description of government marketing programs and an assessment of farmer participation in them; and (3) an assessment of the price responsiveness of marketed surplus. Primary data were collected from maize farmers, local maize buyers, and officials involved in government marketing programs in three municipalities of Northern Vera Cruz, Mexico for the two harvest periods, Winter 1975/76 and Spring/Summer 1976.

The findings of the study indicate that the local rural maize marketing system is operating reasonable well even though a level of monopsonistic practice exists. Comparison of the results from an econometric analysis of the relation in producer prices with marketing costs showed that prices vary rather

systematically with differences in processing costs and levels of maize moisture content. Price differentials slightly greater than transportation costs were encountered as the distance from the central market increased. The results of the marketing margin analysis suggest that large monopsonistic profits are not characteristic of the local maize markets. This absence of large profits is consistent with the market conditions analyzed within the market structure and conduct paradigm.

Increased marketing efficiencies may be achieved by augmenting the flow of price information, by improving on-farm storage facilities and by encouraging the marketing of larger volume units.

Producer participation in government marketing programs is extremely limited. Sensitivity analysis with the probit results reveals that a comprehensive program designed to simultaneously increase accessibility to modes of transportation, production credit, information on the quality of services at the local warehouses and raise the guaranteed price of maize would have the largest impact on increasing direct farmer participation in government marketing programs.

Analysis of the price elasticity of marketed surplus shows that the allocation of maize between domestic consumption and market sale, for a given level of production, is not sensitive to changes in relative prices. Alternative structures (disappearance equations) and estimating techniques (the Tobit) do not change this conclusion. The most important variables in explaining the level of marketed surplus are the quantity of maize produced and family size, income, and household production activities.

In terms of increasing maize production and marketed surplus through government channels by producers in Mexico, the evidence indicates that the rural marketing system in the study area neither significantly depresses producer prices nor impedes the government price policy of stimulating production. Producer participation in government marketing programs probably will not increase appreciably unless specific changes are made (e.g., increasing accessibility to modes of transportation, raising the guaranteed price). Increases in marketed surplus most likely will be achieved through the long run effects of price and credit programs designed to foster improved maize technology and increased production.

Gillette, Cynthia

Anthropology

A TEST OF THE CONCEPT OF BACKWARDNESS: A CASE STUDY OF DIGO SOCIETY IN KENYA

The concept of backwardness is explored in both its theoretical dimensions and its empirical application to Digo society in Kenya. As an idea, backwardness is shown to be associated with the historical development of Western notions of progress and change which have produced a dichotomy between tradition and modernity. As a condition, backwardness is identified in a number of theoretical models which variously locate the sources of backwardness in history, natural laws, and tradition. It is shown that there is a predominant tendency to link tradition and backwardness with resistance to change in these models.

In separate chapters, the role of history and tradition are explored as potential explanations for the image of Digo backwardness followed by an analysis of the Digo economy and a discussion of Kenya's rural development policies as expressed in the Swynnerton Plan and the Special Rural Development Program. It is argued that the role of history lies in the structure and quality of inter-group relations as much as in culture contact, diffusion and external events. The role of tradition, discussed in terms of Digo cultural values and attitudes as well as structural features that channel access to resources, is seen as ambiguous with respect to development. It is also argued that tradition is not simply homogeneous, consistent and changeless.

Analysis of the economy shows that subsistence agriculture is only a limited segment of economic activity and that the Digo economy is already quite commercialized. A comparison of Digo and Kamba investments in farming indicates that reputedly more progressive Kamba settlers are converging toward Digo patterns of production, which would seem to show that Digo patterns are constrained by local conditions rather than backwardness per se.

In analyzing the "modern sector," the Swynnerton Plan is viewed as a program of the colonial government designed to introduce European farming practices by instituting structural changes in man-land relationships. After independence the Special Rural Development Program was devised in an attempt to achieve an innovative approach to rural development. However, it is argued that the SRDP has remained consistent with the Swynnerton Plan in many important

respects. Rigidities and obstacles to development are thus seen as being located in the "modern" as well as the "traditional" sector.

The principal conclusions of the study are that the idea of backwardness has become encrusted with Western ethnocentrism, with stereotypic and inaccurate images of traditional societies, and with an obstacle approach to tradition which automatically links backwardness with resistance to change. It is argued that such encrustations prevent sound conceptualizations of small-scale societies, obscuring the real issues involved in modernization.

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Goel, Vinod Kumar

Food Science and Technology

ENERGY USE AND CONSERVATION IN THE FOOD INDUSTRY: UNITED STATES AND INDIA

An energy study was conducted to estimate the energy consumption and losses in food processing, and to outline the techniques for conservation. Seven different dairy plants in New York State - fluid milk, surplus milk, cheese, cultured product, and ice-cream - were included in the study. The Indian dairy industry was represented by 6 different plants - fluid milk, surplus milk, and baby food. The operations of a meat product canning plant were also studied on request from the plant management.

Extensive field survey was undertaken to collect data on energy consumption, production, processing methods and equipment, buildings, packaging, and transportation. A computer model 'ENGPROF' was outlined to analyze the energy use profile in dairy plants. This model was used to estimate direct energy (natural gas, fuel oil, coal, diesel, gasoline, electricity, water, and L.P. gas) and indirect energy (packaging and transportation) consumption in the plants.

Major sources of energy loss were identified and the magnitude of heat losses from different sources was estimated. Energy conservation strategies were investigated. A computer model 'PSTCSN' was presented to evaluate the energy savings from the upgrading of pasteurization equipment. A mathematical

model 'PRODMIX' was proposed to formulate an energy efficient product mix. The model 'TRPCNS' outlines a procedure to work out an energy efficient transportation network. The economics of energy conservation measures were studied with the aid of two economic models. Financial analysis of process equipment replacement in a meat plant was performed using the 'EQPREP' computer model. Another economic model 'ENGECON' was proposed to analyse the economic feasibility of capital investments in energy conservation projects. These economic models consider salvage value, economic life, depreciation, cost of the projects and price changes. Economic analysis was conducted using net present value approach on an after-tax basis.

Energy consumption in dairy plants was influenced by plant design, location, milk collection and product distribution constituencies, volumes processed, seasonal variations, condition of process equipment and buildings, product manufactured, type of packaging, mode of transportation, and operational efficiency. Large sized plants were found to consume less energy on a per capita production basis. Packaging was found to be energy intensive - even more than direct energy usage in some cases.

Process energy expenditures in U.S. dairy plants varied from a low of 1,105 BTU per pound of milk for a milk powder plant to a high of 22,666 BTU/pound of milk for an ice-cream plant.

Major sources of energy losses were found to be buildings, vapours, hot water, and boiler condensate. The losses varied from 10 to 46 percent in U.S. plants. The heat losses in Indian dairy plants were between 9.2 and 13.5 percent.

Energy conservation techniques were discussed. These included recycling of condensate and hot water; heat recovery from hot water, flue gases, exhaust air and refrigeration systems; upgrading the efficiency of process equipment; insulation of buildings, steam pipes, and process equipment; better process control; change in packaging and transportation practices.

Energy consumption can be reduced by increasing the regeneration efficiency of H.T.S.T. units, adding more effects in evaporators, installing vapour re-compression system on evaporators, using double stage drying system, using agitated retorts for sterilization of food products.

Use of bigger sized packages and replacement of steel cans by pouches would reduce energy expenditures in packaging. Transportation of products by train

was found to be energy economical.

Non-commercial energy sources (solar and bio-gas) were being used by dairy plants in India.

Finally, a comprehensive list of energy conservation techniques and procedures for the food industry is presented.

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Haji-Omar, Afifuddin Bin

Development Sociology

PEASANTS, INSTITUTIONS, AND DEVELOPMENT IN MALAYSIA: THE POLITICAL ECONOMY OF DEVELOPMENT IN THE MUDA REGION

A major issue in rural development is that of popular participation in government-sponsored programs. Balanced exchanges of resources, power, and esteem between the peasantry and the state determines the economic and political stability of the regime. In the Muda Region of Malaysia, economic and political power have historically been the monopoly of the elite and the better endowed merchant class. In order to arrive at a more balanced exchange system, adequate trade-offs have to be made by all sides. Lacking from the elite to the peasantry has been the sharing of power. The latter have always been represented in the legislative structures by elites.

Peasant participation is indeed a critical parameter missing in most government-led development programs. Programs and projects have been planned in administrative centers with the peasantry at best passively adopting innovations extended by the government agencies. As a result, most of the gains accrued to the peasantry are not sustained once the active role of the government officials is withdrawn.

This diachronic study of Muda River peasant interaction with the state shows that in many exchanges, it has been the elite and the merchant class who could afford to make full use of the facilities provided by the state. The economic and political domination by the elite and merchant class over the peasantry has been the major reason for the disproportionate gains of the former.

Deliberate efforts through institutional manipulation arrangements have been used to prevent the peasantry from breaking away from their subsistence-oriented culture.

Elite awareness of this imbalance emerged when threats against the legitimacy of the regime they supported came from both internal and external sources. The militant communist movement and the ethnic feelings of deprivation prompted the government to adopt development plans which would strengthen the integration of the peasantry and the state.

A concerted effort by the government to develop the Muda peasantry began with the provision of a massive irrigation infrastructure to enable greater productivity through organized agriculture. Based upon the increased productivity in agriculture, it was assumed that other patterns of growth and development could be induced.

The Muda Agricultural Development Authority, MADA, managed through organizational innovations first to attain a holistic framework of growth and development and second to enable active participation of the peasantry in its development activities. The innovator-clientele structure has been substituted by participatory structures, thus blurring the boundaries which so long have separated government agencies from the peasantry. Within these participatory structures conflicts are resolved in the spirit of collective responsibility.

After seven years of organized agriculture under the supervision of MADA, productivity has increased significantly. However, the old pattern of unequal sharing of benefits persists. Peasant awareness of this situation begins to emerge through constant interaction with MADA personnel within the participatory framework. As a result their leaders began to agitate for stronger programs and regulation by government to close the economic and political power gaps. Higher levels of price support for rice and capital assistance in Farmers Association projects have been the two main requests made to the government.

Responses by the government have been largely positive. Peasant leaders perceive these as a recognition of their emerging economic and political power. Hence they begin to make efforts toward consolidating peasant forces within a collective bargaining system, i.e., the Farmers Association movement.

The emergence of this new power structure within the political-economic system is a generating force for further development of the Muda Region. It has resulted in greater integration of the peasant society with the state, thus

increasing popular support and the legitimacy of the regime.

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Hart, Gillian Patricia

Agricultural Economics

LABOR ALLOCATION STRATEGIES IN RURAL JAVANESE HOUSEHOLDS

The manner in which men, women and children allocate their time among various activities is a reflection of the household's strategy for survival and welfare. Analysis of the determinants of household allocational behavior is, therefore, fundamental to identifying the constraints under which households operate. Further, an understanding of decision-making processes is essential for assessing the way in which households are likely to respond to changes in the constraints confronting them. On the basis of these considerations, this study examines allocational behavior in large-landowning, small-landowning and landless households over the course of a year in a rice-cultivating village on the north coast of Central Java.

The basic contention of the study is that, within existing structures, the distinguishing feature of poverty in the study village is lack of control over assets rather than inadequate employment per se. The "employment problem" involves men, women and children from landless households having to work long hours at extremely low wage rates in order to meet bare subsistence needs. In contrast, the wealthiest households are able to devote substantial amounts of time to activities which yield direct welfare and which reinforce the household's relative position in the village power structure. While small-landowning households are actively involved in wage labor, their off-farm labor supply behavior differs from that of the landless in two respects. The security provided by being able to meet a large proportion of their rice needs facilitates withdrawal from the labor force in slack seasons when wage rates decline. Moreover, in periods when jobs within the village are limited, small-landowning households tend to have preferential access to them.

Assets play a dual role in the domestic economy of the peasant household. First, they determine both the household's security and the way in which it values increments to income. Second, the household's asset status is a major factor mediating its relationship with the outside world, and hence its access to income earning opportunities. Neoclassical economic analyses of household behavior tend to neglect the second facet, or to treat it inadequately. Chapter II argues that an understanding of the system of production and exchange relationships should precede analysis of decision-making in individual households, and that the operation of land and labor markets can only be understood in historical perspective.

Contrary to Geertz's widely held stereotype of agricultural involution and shared poverty, Chapter III contends that Javanese village society has long been characterized by differential control over the means of production and by asymmetrical patron-client relationships. Political and economic forces operating over the past decade have produced an environment in which subsistence guarantees within patron-client relationships are disintegrating, and relations of production and exchange becoming increasingly commercialized. This strong trend towards a clearly stratified agrarian class structure has important implications for different households' access to land and income earning opportunities. Chapter IV describes the manner in which these trends are being manifested in the study village, and develops criteria for dividing the sample households into three asset classes; these constitute the basis for the descriptive analysis of labor allocation, income and consumption in Chapter V and VI.

On the basis of the major features which emerge from the descriptive analysis, a model of household labor allocation, consumption and production is developed in Chapter VII which takes account of the effect of proximity to subsistence on the household's perceptions of wages and prices. This in turn is related to the extent to which the household is able to cover its rice needs from own production. The model is particularly concerned with the impact of rice price increases on labor market conditions.

The study concludes with an analysis of the possible influence of various policy measures on household economic organization and welfare. The emphasis throughout is on the marked limitations of interventions which attempt to treat the symptoms of poverty while neglecting its underlying causes.

THE NUTRITIONAL STUDY OF PRESCHOOL CHILDREN IN A FELDA (FEDERAL LAND DEVELOPMENT AUTHORITY) SCHEME IN WEST MALAYSIA

Sungai Buaya Felda (Federal Land Development Authority) Scheme was settled more than a decade ago. Research was carried out there to study the impact of organized land settlement on the nutritional status of preschoolers which might also indirectly reflect the nutritional status of the community. Anthropometric analysis using the weight/height² as the index of malnutrition demonstrated that about 50% (N = 126) of the preschoolers were malnourished. This was further confirmed by the results obtained from the 24 hour food recall of the families (N = 243) and the preschoolers (N = 120). The problems of high morbidity, low food production, low purchasing power and insufficient educational innovations continued to plague the community even after a decade of settlement. The advantages accrued from a steady income, as professed by Felda planners, was offset by the persistence of the above mentioned problems. There is a need for an integrated program encompassing social and economic disciplines with greater emphasis on the former. The low consumption of important nutrients was attributed to the loss of nutrients with the consumption of overcooked and reheated foods, frequent infections during childhood that resulted in anorexia and physiological nutrient losses, withholding of 'cold' foods during illness or vulnerable stages of life, high consumption of carbohydrate foods and the unavailability of certain foods due to economic constraints.

An analysis of environmental variables indicated that the number of dependents, mother's education, average income and morbidity all affect the nutrient intake of the families, and the preschoolers. Although the path analysis of their regressions revealed the importance of the number of dependents in the family, it must be emphasized that the success of a nutrition program will depend on the integration and the management of all these variables.

The Scheme had the advantage of settlers who originated from various parts of the country and the possibilities of rich cultural exchanges which remained untapped. These are the people who had high aspirations to change their ways of life. Such initiative coupled with their capacity to break away from strong family and traditional ties merely reflect their strong characters as pioneers

of our time. The positive inclinations of the settlers toward modern medicines which often transcend cultural and religious barriers, the presence of a well developed infrastructure, and the organizational set-up of the Scheme meant that the community had a tremendous potential for change and for improvement of their standards of living. Felda is privileged to have such important and precious assets and also has the capacity to unleash such progressive energy which should be capable of transforming potentiality into reality. Thus there is a strong need for local planners and most important, for the planners of Felda at the national level, to reevaluate the development strategy of the area. The revitalization of available inputs and services and greater participation of the settlers in the decision making process are initial steps in the right direction. The rapport at regional and national level is highly desirable.

The importance of nutrition with respect to productivity has been discussed. Nutrition programs as a strategy for overall development programs (using the Development Model System) was proposed. The influences of the main (direct) variables and associated (indirect) variables relating to nutrition should be constantly gauged to ensure continued effectiveness of the program.

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Hawes, Robert Alan

Natural Resources

A LAND EVALUATION METHODOLOGY FOR NATURAL RESOURCE PLANNING IN MOUNTAIN REGIONS
IN THE AMERICAN TROPICS - - A CASE STUDY OF RIO GUANARE, VENEZUELA

This study deals with the collection, interpretation and application of environmental information to regional land use planning and policy formation through a case study of a watershed in the Venezuelan Andes.

A land evaluation methodology is developed by collecting and integrating data on landforms, surficial deposits, climate, geology, soil, surface water resources and vegetation. Forty-six land types are described for the study area. A land type is a recurring pattern of landforms with their associated soil and geological materials within an area of relatively homogeneous

macroclimate or life zone. The land types are essentially permanent, homogeneous environmental units on a geomorphological base. The determination of land type class limits are made with a view towards land use interpretations, and the resulting land types are thought to have similar performance characteristics thereby providing similar opportunities and constraints for various land uses.

Land types provide basic environmental information for assessing the suitability of the land for defined, sustainable uses. Interpretations are developed by considering the land's performance potential under specified levels of management or inputs. Suitability analyses are made for 5 agricultural crop types, coffee, bananas, cassava, citrus and maize, and for grazing, for forestry, including watershed protection, timber harvesting of natural forests and plantation forestry, and for water based recreation use. A scenic inventory was also made of the high quality scenic areas along the major highway corridors.

The land type and suitability data provided are used to assess alternative policy and management objectives, such as if coffee production could be expanded, where, and approximately how many hectares would be suitable and what yields could be expected.

The methodology has a broad application for regional planning of mountain watersheds of developing countries in the American tropics. It provides a comprehensive, rapid, low cost land evaluation methodology, it is reproducible by others, and provides interpretive assessments relevant to the existing biophysical, social and economic conditions of these areas.

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Hoopes, Robert Wayne

Plant Breeding and Biometry

YIELD AND FERTILITY OF RECIPROCAL-CROSS HYBRIDS OF TUBEROSUM AND ANDIGENA POTATOES

To broaden the genetic base of the Cornell breeding program, a population of South American Andigena potatoes is being selected for adaptation to New York

conditions. Selected Andigena clones are being crossed extensively with North American Tuberosum materials. Reciprocal yield effects have been noted in some hybrid progenies, favoring the offspring of Tuberosum x Andigena (TA) crosses over their Andigena x Tuberosum (AT) reciprocals. An advantage to receiving the cytoplasm from the better adapted parent was postulated. In addition to yield differences, a high degree of sterility had been reported for TA, but not AT, hybrid progenies.

This project was undertaken to confirm the reciprocal yield effects for New York and to see whether they would occur when the Andigena parents were in later stages of selection for New York conditions; to test the hybrids in an environment in which Andigena would have adaptation superior to that of Tuberosum; and to examine the fertility-sterility relationships in the hybrids. Trials were conducted at Ithaca (Mt. Pleasant) in 1976; at Huancayo and San Ramon, Peru, in the 1976-77 season; and at Ithaca (Ellis Hollow) in 1977.

Significant reciprocal yield differences in favor of the TA hybrids were observed in both Ithaca trials. The difference in mean total yield per plant was 18% at wide spacing (1 m between plants) and 12% at narrow spacing (30.5 cm). In yield of tubers in the largest size category (over 5.72 cm in 1976, 6.35 cm in 1977), the TA's out-yielded the AT's by 22% at wide and 23% at narrow spacing. The TA's had an average of 8% more tubers per plant at wide spacing and 4% more tubers at narrow spacing. In 11 of 12 families tested in 1976, the TA reciprocals had a higher total yield than the AT's; this was true of eight of 11 families tested in 1977.

The results were less consistent in the trials in Peru. The San Ramon trial was hampered by an uneven stand and poor growing conditions. The overall yield difference of 11% in favor of the TA's was not consistent over families and was not significant. At Huancayo, an overall difference of 4% in favor of the TA's, but it was not consistent with families nor was it significant.

There were striking differences in male fertility at all locations, with a high proportion of the TA's being male sterile. Differences in female fertility, however, were not found. The TA's produce far fewer berries in the field, compared to the AT's, even though they are generally female fertile. This difference in fruit set did not, however, account for the reciprocal differences in tuber yield. These differences persisted in experiments in which no plants were allowed to produce any berries.

These results indicate that the cytoplasm should be considered in a breeding program utilizing Tuberosum and Andigena parents. Under New York conditions, a yield advantage goes, in most cases, to the progenies of Tuberosum females and Andigena males. Based on these results, it cannot be said that there is a consistent yield advantage for either reciprocal in Peru. The male sterility of most of the TA's, however, will require consideration if these hybrids are to be used for further cross as well as for varietal selection. The use of Andigena cytoplasm also offers an opportunity to incorporate cytoplasmic, as well as nuclear, diversity into North American potato varieties.

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Karunasekera, Malavana Vidanelage D. J.

Agricultural Economics

PRODUCTIVITY, TECHNOLOGICAL CHOICE AND DISTRIBUTION OF INCOME IN TAIWAN'S
AGRICULTURAL SECTOR, 1946-1975

The major objectives of this study are: a) to examine the factors that contributed to the rapid growth of agricultural output since the second world war; b) to determine the technological choice that characterized the transformation of the agricultural sector; and c) to establish the implications of rapid growth of agricultural output on the relative share of income accruing to labor.

The growth of agricultural output during the post-war period (1946-1975) was analyzed using a Cobb-Douglas type production function. Time series data were used for this purpose. Further to review the growth of agricultural output more intensively the post-war period was divided into three sub-periods--(i) Epoch I (1946-1953), (ii) Epoch II (1954-1967) and (iii) Epoch III (1968-1975). The sub-periods were analyzed with the help of production functions. Time series data were used for the first two sub-periods and cross-sectional data for the third sub-period.

A number of models are formulated to identify technological change. First, a factor price model is specified and estimated to measure the trend towards

mechanization. Secondly, a labor intensity model is presented to evaluate those variables which influenced labor absorption until the mid-sixties and subsequently mechanization. Both time series and cross-sectional data were employed to estimate the two models described above. Since differential wage rate between regions of a country would induce mechanization, a crop shift index was developed to ascertain whether there have been any significant changes in the cropping patterns on a regional basis.

A constant elasticity of substitution (CES) type model was specified to examine the relative shares of income accruing to labor and capital. Cross-sectional data relating to the years 1964, 1968 and 1974 were used for this purpose.

Our findings indicate that the efficient combination of factors of production such as human energy, mechanical energy, chemical fertilizer and capital was instrumental in achieving the rapid growth of agricultural output during the post-war period (1946-1975). The sub-period analysis revealed the gradual substitution of traditional inputs--human labor, animal labor and farm produced fertilizers. It is evident from our result that during the first sub-period, the efficient combination of inputs, human energy, animal energy, chemical fertilizer and capital enabled the rapid growth of agricultural output. The second sub-period reveals the significance of land, human energy and capital inputs. The third sub-period analysis indicates the importance of the withdrawal of the artificial constraint--rice-fertilizer barter scheme--culminated in an optimal allocation of resources. During this sub-period, crop area, biochemicals mechanical power and labor (human) inputs provided significant results.

An empirical study was undertaken to derive the determinants of mechanization. Our results indicate that the wage rate is the foremost factor in the mechanization decision. Furthermore, factors such as cropping intensity, diversity of cropping patterns and irrigation tend to accentuate the mechanization process. The modern inputs, biochemicals and mechanical energy that accompanied the rapid growth of the agricultural output had the expected effects on labor requirements per unit of land. The introduction of modern inputs had no bearing on the concentration of crops regionally. Hence we could discount the possibility of disparities of wage rates between regions as a factor in the mechanization decision.

Two significant conclusions emerge from the empirical analysis on distributive shares of income in the agricultural sector, i.e., (i) the relative shares of income accruing to labor in agriculture has increased during the period 1964-1974. Hence, disparities of income within the agricultural sector has been reduced; and (ii) Taiwanese agriculture is characterized by labor-saving technological progress during the period 1968-1974.

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Kawamura, Yoshio

Development Sociology

URBANIZATION, PART-TIME FARM HOUSEHOLDS, AND COMMUNITY AGRICULTURE: JAPAN'S EXPERIENCE AFTER WORLD WAR II

This thesis deals with a conflict between micro-level economic objectives of farm households and national or macro-level objectives in the use of resources. Since World War II, as a consequence of the rational adaptation of Japanese farm households to economic growth in the nonagricultural sector and limits on expansion of operating units in agriculture, the majority of Japanese farm households have not only become part-time but preponderantly have more than 50% of their labor supply engaged in nonfarm work. These farms realize significantly lower levels of agricultural productivity than full-time farm households or part-time ones with more than 50% of their labor force engaged in agriculture.

National census data for 1945-75 reveal the sequence of developments responsible for this state of affairs: (1) land reform, which equalized asset distribution but limited possibilities of expanding farm size; (2) increase in wages in the nonagricultural sector, which produced a wage gap; (3) the combination of low income-forming potential and limits on expansion in agriculture with expanding opportunities in the nonagricultural sector, causing farm households to shift available family labor to nonagricultural jobs so as to maximize family income and producing a labor shortage within

agriculture and driving up agricultural wages; and (4) accelerated mechanization because of these wage increases, making additional labor available for nonfarm work. There has been a substantial increase in large-scale farms accompanied by a decrease in middle-scale farms, producing a U-shaped distribution. For most small-farms, part-time farming has become the stable response of farm households to the external pressures of economic growth.

Cross-sectional analysis of census data for Shiga Prefecture identified factors contributing to this development at two levels--municipality and community. Factor analysis was used to test the dimensionality of variables, and multiple regression was used to test hypotheses. The 50 municipalities in the prefecture, classified into 6 types based on opportunity variation for agricultural and nonagricultural pursuits, were studied to clarify the effects of urbanization and physiographic condition on choices of income activities of farm households. The community-level analysis dealt with all the communities in 6 municipalities--one of each of the 6 types--to clarify the relationships among urbanization, physiographic conditions, internal conditions, income activities, and agricultural production.

Principal findings were that (1) urbanization outside the community was a pull factor and urbanization inside a push factor, both encouraging adoption of nonagricultural pursuits; (2) urbanization and internal conditions (farm land size and agricultural mechanization) were important in explaining income activities; (3) the cooperative work system for common resources was directly associated with urbanization, while farm dependence on rice production was directly associated with labor-income dependence on agriculture in income activities; (4) variation in land productivity of rice was mainly explained by physiographic (topographic and climatic) and internal conditions, although the cooperative work system was significantly related to it; and (5) land utilization in farming was more strongly and directly associated with rice dependence than with physiographic and internal conditions.

These results indicate that urbanized areas have developed better agriculture despite high opportunities for nonagricultural pursuits, and less urbanized areas with poor physiographic conditions have had serious problems in both agricultural development and securing income stability.

WATER AND NUTRIENT MANAGEMENT WITH DRIP IRRIGATION IN HIGHLY WEATHERED SOILS OF THE TROPICS

Laboratory studies of profile water movement from line source were conducted using one clayey Oxisol and one sandy Oxisol. Functional relationships between water application rates and vertical/horizontal advances were established. In both finer and coarser textured soils, the horizontal advance tended to approach to a limit with prolonged time, while a linear relationship was found between the vertical advance and the square root of time. Higher application rates resulted in further lateral water movement and shallower downward movement.

P distribution, together with water movement, was also examined in the laboratory in both sandy and clayey soils. High P concentration was observed in the vicinity of the water source in both soils under various water application rates. P moved as far as 30 cm from the application point in the sandy soil profile, but no significant P movement was noticed in the clayey Oxisol.

Based on the laboratory results, a drip irrigation system was designed for the field experiment to study the feasibility and operational techniques of drip irrigation and fertilization in a tropical acid soils (Coto Clay) area. Sweet pepper (Blanco de Pais variety) was the test crop. A randomized complete block field experimental design was chosen to compare three different fertilization techniques. In addition to the check plot, the three other treatments were: fertigation (drip application of N and K, banded P); banded N, P, and K; and broadcast N, P, and K. All treatments but the control plot received the same total amount of fertilizer and the whole experimental area was uniformly drip irrigated. The fertigation treatment and the banded fertilizer treatment resulted in the highest yield, and therefore, are considered more desirable.

The drip method recommended in this thesis is a technique developed under a genuine tropical environment. Generally speaking, the drip method is feasible and may be profitable for certain crops in the tropics. However,

results of the root system development, and fertilizer distribution under field conditions suggested that detailed studies on drip discharge rates and irrigation and fertilizer schedules are needed in order to modify and standardize the drip system operations.

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Latham, Lani Stephenson

Nutrition

NUTRITIONAL AND ECONOMIC IMPLICATIONS OF ASCARIS INFECTION IN KENYA -
STUDIES IN EXPERIMENTAL ANIMALS AND PRESCHOOL CHILDREN

The human roundworm, Ascaris lumbricoides, is one of the most common intestinal parasites in the world. It has been estimated to infect about one quarter of the world's population, or one billion people. It is most common in preschool aged children and often co-exists with protein-calorie malnutrition throughout the tropics and subtropics.

A study was conducted in Ascaris-infected pigs to determine whether infection decreased growth, interfered with absorption of protein and fat or caused pathological changes in the small intestine. A second investigation was undertaken in Kenya to measure the effects of Ascaris infection on growth, nutritional status and health of preschool age children, and to estimate countrywide economic implications of ascariasis.

In the first study, three week old weanling pigs were infected with intestinal stages of Ascaris suum. The infected pigs received either a low (12%) (LP) or high (18%) (HP) protein diet. Controls, not infected, from the same litters were also studied. At 8 weeks following infection, mean worm burdens for pigs fed the LP diet were 50.8 per pig while those from the HP diet were 30.8. The weight of the small intestine was markedly heavier in infected compared to non-infected pigs (6.94 vs. 3.71 g/dry wt/kg body wt, $p < .005$) but did not differ significantly due to protein level. The weight of the intestine correlated directly with worm burden ($r_s = 0.45$, $r_a = 0.096$)

and the increased weight was due mainly to hypertrophy of the tunica muscularis, which was about 150% larger in cross sectional area in worm infected animals vs. controls and also correlated directly with worm burden ($r_s = 0.61$, $a = 0.033$).

Nitrogen (N) balance studies during week 4 showed 5% less N absorption and retention in 3 infected pigs fed the LP diet compared to 4 littermate controls (70.8 vs. 75.5% absorption, 42.4 vs. 48.4% retention) but these differences were not statistically significant probably due to small sample size and varying worm burdens. A similar but non-significant difference in fat absorption was observed between infected and non-infected pigs fed both protein levels.

The study in children was conducted in 2 Kenyan villages where 186 children (12-72 mo.) were examined 3 times (I, II, III) at 14 week intervals and anthropometric, clinical and stool exams were performed. At Visit I, 85% of children were below 90% wt/age, 27% had Ascaris ova in their stools and mean anthropometric measurements between infected and control children did not differ significantly. All children received an anthelmintic (levamisole) at Visit II and the mean number of worms expelled was 7 per infected child.

In the 14 weeks between Visits I and II (before deworming) children with Ascaris (n=61) did not differ from uninfected children (controls) (n=125) in weight gain or in percent expected weight gain. In the 14 weeks after deworming (II-III) previously infected children showed higher weight gain (0.7 vs 0.5 kg, $p < 0.05$) and percent expected weight gain (130 vs 98%, $p < 0.025$) than controls. Before deworming, triceps skinfold thickness decreased in Ascaris-infected children vs controls (-1.6 vs. 0.3 mm, $p < 0.0005$). After deworming, skinfold increased markedly in previously infected children vs controls (2.0 vs -1.1 mm, $p < 0.0005$). Multiple regression analysis showed that Ascaris infection was the main variable of 37 possible variables explaining decrease in skinfold before and increase after deworming. Thus even light Ascaris infections adversely influence nutritional status, and deworming enhances growth.

The costs of Ascaris infection in Kenya in 1976 were conservatively estimated to be over \$5,000,000 (41,000,000/=), including costs of health care, anthelmintic drug use, lost work time and transport, and malabsorption of food. Various control measures for Ascaris infection were reviewed. It

was concluded that a mass anthelmintic treatment program is likely to be the only way in which Ascaris and related soil born helminthic infections can be economically and significantly reduced in Kenya in this decade. The cost of the drugs using a dose schedule likely to be effective, based on a wide spectrum anthelmintic supplied to every inhabitant of Kenya, is estimated to be \$800,000 per year.

It is concluded that ascariasis is a significant health problem in Kenya, it retards the growth of children, it is an important cause of morbidity, and it is a very costly disease. Its control is feasible, and a program to do so would contribute both to Kenyan development and to the quality of life of her people.

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Lyakurwa, William Mshabaa

Economics

EXPORT INSTABILITY AND ECONOMIC DEVELOPMENT IN TANZANIA

Problem: Tanzania is a dependent underdeveloped country which relies primarily on the export of primary commodities to finance her development programmes, with no direct foreign investment, while other forms of foreign inflow--loans and grants are also limited. Can such a state of affairs lead to a self-generating and self-sustaining growth? This is a difficult question, the answer to which requires a broad study covering all aspects of the national economy. As a subset of this broad problem, we chose the effects export instability may have on the economic development of the country.

Most studies on export instability and economic development utilize cross-country data in cross-sectional analyses to determine the effects of instability on the economic development of the underdeveloped countries. Such studies, however, do not take into account the specific conditions of each of the underdeveloped countries included in the study--cultural differences, differences in factor endowments and socio-political conditions--and as such cannot be reliably used to explain the effects of instability in such countries.

Methods Used in Obtaining Data:

Part of the data were obtained by the author from the Central Statistical Bureau--Dar-es-Salaam, Tanzania, which made available the returns of questionnaires sent out to various government ministries, parastatal organizations and several individuals who conduct business related to foreign trade. The rest of the data were government published statistics and data from international organization gathered through library research.

Main Results and Conclusions:

Previous studies, which concluded that export instability does not have deleterious effects on the economic development of the underdeveloped countries, have been refuted in this study at least in so far as they refer to Tanzania. Using time series data from 1954-1973, it was established that a significant negative relationship existed between export instability and economic development, especially as it relates to capital formation, inflation, unemployment, government revenue and expenditure, and peasant incomes.

Export instability was found to be higher in Tanzania than had been found to be for a group of underdeveloped countries. On a commodity-by-commodity basis, instability was even higher for some of the most important export crops than the aggregate for export earnings.

Though some measures have been devised to deal with the instability problem, some of them are not without some drawbacks. National stabilization measures, though helpful in ameliorating the internal impact of external shocks, cannot change the level of export earnings because such levels are determined by forces outside the national economy. International Commodity Agreements, and especially the International Coffee Agreement, have not achieved their objectives. Economic integration in East Africa has been hampered by economic and political differences between the neighbouring states and by external forces that exploit such differences to further their own courses.

Reliance on the export of primary commodities has further been dampened by the fact that the marginal propensity for the advanced countries to import raw materials has been declining and is likely to decline still further. The reason being that, either the raw materials are produced in the advanced countries themselves and/or that 'there has been a sharp decline in the raw material content of the advanced countries' manufactures.

For Tanzania, a raw material producing country, a whole new development strategy is required. What is required is a thorough study of the domestic resource potential and then, initiation of an industrial programme based on domestic resources to satisfy domestic needs, where exports become an extension of the domestic market and at the same time make a concerted effort at self-sufficiency in food production.

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Madjd, Mohammad Gholi

Agricultural Economics

POLICIES CONCERNING SUGAR PRODUCTION IN IRAN

Protection of domestic agriculture from foreign competition has been widely used as a means of channeling resources into agriculture and improve its income share. Given the importance of sugar in the Iranian diet, the sugar industry has received substantial amounts of direct and indirect protection. With rapidly rising demand during the decade of the seventies, the share of imports in consumption started to increase again. This was accompanied by a rapid rise in the cost of imported sugar.

This study deals with policies aimed at increasing the domestic output of sugar. The government uses administered sugar prices and direct investment in sugar production. The thesis deals mainly with sugar beets which at present provide the bulk of domestically produced sugar. Accordingly, the marketing of sugar beets and the structure of production are of importance in determining the extent of the price response.

The sugar beet industries of Khorassan and the Central Province are studied. There is evidence of price competition in the regions studied; government policies can increase competition in other parts. The structure of sugar beet farming is highly concentrated. There has been an increase in concentration at the farm and processing levels. The bulk of the output is produced by commercial farmers; semi-subsistence producers supply 20 percent to 25 percent of the output.

The economic health of the factories has to a large extent depended on the structure of farms in the supplying regions. Large factories have been associated with large farmers. The marketing of sugar beets is designed to aid both small and large farmers. Many factories have experienced instability in annual supply and low average yields, indicating the importance of small producers in the supply structure. Where yields are low and small farms predominate, supply instability is inevitable. New measures are needed to protect the factories from output instability, and improve the income of the small farmers from sugar beet production.

The long-run elasticity of supply of sugar beets was estimated to be 1.67 with a likely range of 1.5 to 2.0. The cross-price elasticity with respect to the price of cotton is between $-.3$ and $-.5$. In 1976, the total domestic output of sugar was 647.4 thousand tons from sugar beets and 74.5 thousand tons from sugar cane for a total of 721.9 thousand tons. By 1985, total demand is likely to be between 1.5 and 1.8 million tons. Given the recent rates of growth in output, self-sufficiency in sugar does not appear a reasonable goal, even with substantial increase in the output of cane sugar. A more reasonable goal is maintenance of present rate of 65 percent to 70 percent self-sufficiency.

The areas of Iran with a comparative advantage in sugar beets are Khorassan, Azarbaijan, Kermanshah, Lorestan, Kuzestan, and Fars. Substantial decrease in output in Isfahan and Central Province can be expected. The industry is in a state of disequilibrium with excess capacity in some regions and a shortage of capacity developing in other regions. Slicing capacity is expected to increase in Kuzestan and Khorassan. The aim of a rational sugar policy should not be self-sufficiency during the 1980's. Such a course would be too costly in terms of wasted resources. The purpose should be a level of output that would allow the domestic beet factories to operate at a satisfactory level of capacity. Six and a half million tons of sugar beets would be a satisfactory level producing 800 thousand tons of sugar. Given the extent of price elasticity, this should not be a difficult task.

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Mateus, Hernan

Nutrition

STUDIES TO DETERMINE THE NUTRITIONAL VALUE OF "UNCOMMON" FEEDSTUFFS FROM NORTHWEST MEXICO

Experiments were conducted to determine the chemical composition, metabolizable energy and nutritive values of several vegetable and animal products indigenous to Northwest Mexico hitherto not considered useful as nutrient sources for man. Intensive investigation was made into the nutritional values of the giant brown alga Macrocystis pyrifera; the sea mussel Mytilus californianus or M. edulis; the desert shrub jojoba Simmondsia chinensis; and the desert tuber canagria Rumex hymenosepalus. The effects of these materials upon feed consumption, growth and efficiency of feed utilization were determined in chicks fed diets calculated to be nutritionally adequate in all respects.

Kelp meal (KM), kelp residue meal (KRM), treated kelp residue meal (TKRM), mussel meal (MM), whole jojoba meal (WJM), press-extracted jojoba meal (PEJM), and canagria meal (CM) were used in the investigations.

Dry ground KM was found to contain 7.5% crude protein, 1.2% fat, 41.4% ash, 12.8% neutral detergent fiber, and 37.1% soluble carbohydrates. The chemical composition of KRM was 31.4% crude protein, 3.5% fat, 11.4% ash, 41.8% neutral detergent fiber, and 12.0% soluble carbohydrates; of TKRM, 6.9% crude protein, 1.0% fat, 69.4% ash, 20.3% neutral detergent fiber, and 2.4% soluble carbohydrates; and of MM, 69.4% crude protein, 8.0% fat, 10.8% ash, 4.3% fiber and 7.5% soluble carbohydrates. The nutrient composition of WJM was 17.5% crude protein, 42.1% fat, 2.8% ash, 32.9% neutral detergent fiber, and 4.6% soluble carbohydrates; PEJM contained 22.6% crude protein, 22.2% fat, 3.8% ash, 32.6% neutral detergent fiber, and 18.8% soluble carbohydrates; and CM contained 7.5% crude protein, 0.2% fat, 2.1% ash, 28.5% neutral detergent fiber, and 61.6% soluble carbohydrates.

The metabolizable energy of these products, determined by biological analysis with young chicks, was found to be for KM, 1.707; KRM, 2.026; and TKRM, 0.412 kcal/g, showing that the kelp residue meal resulting from removal of alginic acid not only contained over 30% protein but also was a moderately

good energy material for young chicks. The energy value of TKRM was too low to be of any practical nutritional value.

Biological determinations of the metabolizable energy of mussel meal gave a value of 3.77 kcal/g while the metabolizable energy of canagria meal was only 1.82 kcal/g.

Using the classical method for biological determination of metabolizable energy, the whole jojoba meal appeared to contain 4.66 kcal metabolizable energy and the PEJM apparently contained 5.15 kcal ME/g. These values undoubtedly were erroneously high and apparently resulted from the fact that the chicks tended to retain large quantities of these materials in the intestinal tract and thus eliminated in the feces very small amounts of the consumed energy over the four-day experimental period. Growth studies using WJM and PEJM showed that these materials, although consumed in large quantities, actually resulted in significant depressions in growth.

The addition of 10% KM, KRM, TKRM, MM or CM produced good growth of the chicks fed these diets. High levels (40%) of KM and TKRM, like WJM and PEJM, significantly depressed growth.

This work has established that most of the meals investigated could be used satisfactorily in feed formulation at levels of approximately 10% in the diet. The mussel meal, which not only produced excellent growth and excellent feed conversion in the chicks but also produced a desirable yellow color to the flesh of the broiler chickens, obviously has a very great potential value as an excellent protein and energy feedstuff for poultry. These findings demonstrate that chicks can serve as an excellent supportive industry for utilization of any surplus mussel meal which might be exploited by Mexico as a primary food for humans in that the chicks could readily use to great advantage any surpluses of Mexican mussel meal over that needed for human consumption.

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McGregor, Andrew Maxwell

Agricultural Economics

THE LOMÉ CONVENTION AND THE ACP SUGAR EXPORTERS: THE POLITICAL ECONOMY OF CONFLICTING POLICIES

In January 1975 the European Community and a group of 46 African, Caribbean and Pacific countries signed the Lomé Convention. The Convention has been presented as the first concrete response from a group of industrial countries to the collective plea of Third World countries for a "new international economic order". A critical part of the Convention is a sugar protocol. This protocol, that essentially replaces the Commonwealth Sugar Agreement, commits the Community to import a substantial quantity of ACP sugar at a price equivalent to that paid its own domestic producers.

The arrangements for sugar directly threaten the interests of the Community's politically strong domestic producers and as such provides a good test of the Community's development rhetoric. This thesis examines how the resolution of inconsistent external and internal policy objectives has led to the generation of a re-occurring EEC sugar surplus. The impact of these surpluses on the major ACP sugar exporters is explored in detail. The necessary re-export of ACP sugar is shown to have a significant price depressing effect on the world market. This in turn has substantial revenue implications for a number of ACP exporters. The existence of costly surpluses has, and will, mean very modest increases in the ACP guaranteed price. In contrast ACP production costs are expected to increase at a very fast rate. Domestic political expediency has forced the Community to turn its back on the newly negotiated International Sugar Agreement. The world's cane sugar exporters desperately need an effective agreement to revive a chronically depressed world market. Yet without Community participation, amongst other things, the prospects of the agreement are not good.

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AN ECONOMIC ANALYSIS OF EMPLOYMENT IN SMALL FARM AGRICULTURE: THE CENTRAL VALLEY OF CHILE

This study analyzes the employment situation in the small farm sector of Chilean agriculture. The specific objectives of the research were to determine and analyze the magnitude and dimensions of the employment problem in small farm agriculture, and to identify and study the factors which determine the employment structure of small farm families. Data were collected by means of a survey from 150 small farmers for the agricultural year 1974-75. A stratified random sample was drawn from all farms having up to 10 B.I.H. (Basic Irrigated Hectares) in three areas of the Central Valley of Chile.

The study of underemployment is conceptually approached by using four different criteria: duration of work, labor productivity, income, and volition. Statistical and econometric techniques including production function and probit analyses are used in the study of underemployment.

The employment structure is analyzed by means of an econometric model which incorporates the main demand and supply aspects of labor utilization on small farm agriculture. An interdependent system is postulated, including the demand and supply of family labor to on-farm activities, the demand for hired labor and the supply of family labor to off-farm activities.

The main results are summarized below:

Based on the duration approach, there is a high rate of underemployment (35%) among the small farmers of the study area. A major part of this labor underutilization corresponds to permanent rather than to seasonal underemployment. The productivity criterion shows that the marginal productivity of family and hired labor is positive among the sample farms, and the analysis suggests that farmers use labor efficiently. The volition criterion indicates that close to 40 percent of the family heads are underemployed. Underemployment based on low income levels is largely but not always related to underemployment in terms of work duration.

The findings on the demand side of farm employment show that the use of modern inputs has a positive impact on labor utilization. Mechanization

presents a negative although low employment elasticity for family labor. Farm size, cropping pattern, and implicit farm wages are additional important determinants of the demand for family labor.

The supply of family labor to on-farm activities shows a clear response to changes in the implicit farm wage. Inclusion of willingness to work, health, education and other qualitative aspects of the family labor force are found to be important factors influencing the supply of labor to the farm.

Off-farm work, which is a major activity among the sample farms, is also found to be responsive to changes in relative wages. The distance to urban areas, the pressure of a larger family size and qualitative aspects such as health, age and education play important roles in the supply of family labor to off-farm activities.

A general conclusion of this study is that small farmers respond to changes in the economic conditions they face, and that decisions and reactions based on the family, the farm, and the surrounding environment conform to a logical decision system. On-farm employment may be significantly increased, for those farmers who are not critically limited by a very small farm size, by programs which give proper attention to the constraints which limit adoption of improved techniques. Nevertheless, more and better opportunities for the small farmer to participate in other activities in the rural sector will play an essential role in solving the problems of small farm agriculture. It is concluded that a comprehensive rural development strategy must be defined, dealing with farm production, technology, infrastructure, rural industrialization, social services and the development of the wide range of institutions required for development.

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Mwima-Mudeenya, Elijah

City and Regional Planning

A NEGLECTED COMPONENT OF DEVELOPING ECONOMIES--SMALL SCALE PRODUCTION AND
EMPLOYMENT IN UGANDA: A CASE STUDY OF SMALL HOUSEHOLD AND NON-FARM ENTERPRISES
IN BUKEDI DISTRICT

This study addresses itself to the growing problems of unemployment and

underutilization of labor in the developing countries. These problems have assumed alarming proportions and pose major theoretical and policy challenges in these countries. The solutions to them, based on the conventional strategy of rapid and large-scale industrialization, have not had satisfactory results. Neglected in this strategy has been the role that small-sector enterprises can play towards the development effort. The alternative strategy proposed in this study gives cognizance of this sector and assigns it a positive role.

The model postulated in this study provides a three-fold strategy in facilitating the process of economic development, while, at the same time, mitigating the problems of unemployment and underemployment: by increasing agricultural productivity through the adoption of better methods; by expanding the formal sector through capital investment and by increasing the productivity of the traditional non-farm activities through the substitution of small-scale enterprises for household or cottage industry.

The study, however, focuses mainly on the potential contribution of small-scale enterprises, particularly those located in the rural areas. The central hypothesis investigated is that small-scale activities can lead to higher levels of productivity and labor absorption through increased specialization and division of labor in a developing economy. To explore this prospect, an economic case study was undertaken in a comparatively less developed rural region (Bunyole County) of Bukedi District in Uganda. Data for the study were obtained through two extensive sample surveys.

One survey gathered detailed information on a sample of households which were treated as production and consumption units. It revealed that the rural economy is dominated by subsistence agriculture and household industries, which are characterized by low levels of productivity and low incomes compared to activities of the formal and, to a less extent, the informal sectors. It was also found that a substantial amount of household labor engages in the production of cottage industry goods and services in varying degrees throughout the year. With increased development in agriculture, a tremendous opportunity exists to transform many of the cottage industry activities into small-scale enterprises through increasing elaboration of the economy arising from increasing specialization and division of labor. By so doing, labor productivity is upgraded, higher incomes are realized and more employment opportunities created.

The other survey collected data on non-farm enterprises and the major findings were that they constitute a major form of economic organization in the rural areas, employ substantial amounts of local labor, mobilize individual capital resources, utilize better skills and have higher levels of labor productivity and incomes than the cottage industries. The goods and services produced in this sector had positive income organizational and financial problems which constrain its development and expansion. This notwithstanding, small-scale enterprises possess the potential to facilitate the process of economic growth and development through increased productivity of labor and as they expand, they would create more employment opportunities and coalesce with activities of the formal sector. Overt government support in assisting their growth and development is therefore justifiable and necessary. Steps towards evolving a small-scale sector development policy and institutional mechanisms to carry it out have been outlined in this study.

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Olaitan, Samson Ojo

Education

A STRATEGY FOR IMPROVING THE TEACHING OF AGRICULTURAL SCIENCE AT THE SECONDARY SCHOOL LEVEL IN ONDO STATE OF NIGERIA

Problem

Nigeria is a country with very rich agricultural resources but with acute shortage of food supply for her increasing population. Present farmers are becoming older and continue to use traditional tools to till the soil. The youths need to be encouraged to take up jobs in agricultural occupations to increase food production hence the government introduced the teaching of agricultural science into the secondary schools. The basic problem of agricultural science in the State's secondary schools is the acute shortage of professionally competent teachers of agriculture.

The purpose of this study was to identify professional competencies needed by prospective teachers of agricultural science in Ondo State and to

provide decision-makers guidelines for implementing teacher preparation programs in agriculture.

Method

A review of research literature was made to identify 324 professional competencies assumed to be needed by a teacher of agriculture. A jury of 15 experienced educators from five Nigerian Universities were requested to validate the 324 professional competencies. Based on the responses of the jury, 248 professional competencies were finally selected.

The 248 professional competencies were developed into questionnaires administered to 100 educators to solicit their perceptions on the importance of the competencies to the teacher of Agricultural Science. The same questionnaires were administered to 98 field teachers of Agricultural Science to solicit their perceptions on their performance level.

An instrument consisting of "factors" and "alternatives" to be considered when making decisions on 10 issues on teacher-preparation in agriculture were administered to 98 principals and 7 ministry of Education Officials.

Mean, Median, Standard Deviation and Percentages were involved in processing the data through the computer using SPSS files.

Findings

The findings from the study indicated that:

1. 239 out of the 248 professional competencies are important to the prospective teacher of agricultural science.
2. The prospective teacher of agriculture should be adequately prepared in Professional Ethics and Development; Teacher-Professional relationship; Program Management; Guidance in Agriculture; School discipline; Student Organizations; Program planning, Implementing, and Evaluation.
3. Field teachers need varied degrees of professional improvement in Planning, Implementing and Evaluation of Instruction; School discipline; School community relationship; Recruitment and Selection of students.
4. Decisionmakers should consider the following when making decisions on teacher preparation in agriculture:
 - a. That the purpose of agriculture should be to provide students with adequate skills to make a living and progressively advance in farming.
 - b. That a four year program of professional and technical agriculture is appropriate for secondary school graduates in division

one or two (science biased); Grades one or two teachers interested in agriculture and graduates of the school of agriculture who are interested in being prepared as teachers. c. That the teacher preparation program be located in suitable land abundant rural areas of the state and admission requirements to be feasible and clearly defined. d. That promotion should emphasize academic achievement and success in professional experience. Professional experience should include a minimum of 3 months work experience in an established farm and 3 months student practice teaching. e. That government makes specific provisions for teacher preparations in agriculture in her development plans; these provisions should accommodate a division in the ministry of education for the supervision, organization, administration and evaluation of agricultural education programs; training, research and curriculum development in teacher education programs in agriculture for primary, secondary and post-secondary levels.

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Onagoruwa, Adenuga Olukayode

Food Science and Technology

THE DEVELOPMENT, CHEMICAL AND BIOLOGICAL EVALUATION OF A BLEND OF YAM FLOUR,
COWPEA POWDER AND SESAME MEAL

The problems of malnutrition in Nigeria have been associated with the poor quantity and quality of staple foods and insufficient supply of animal proteins. The supplementation of yam flour with cowpea powder and sesame meal will increase protein quantity and quality and consequently lead to the production of a high quality staple food without altering the food habits of the people and at the same time reduce the effects of a deficiency of animal proteins.

Yam tubers were peeled, washed, sliced, treated with citric-ascorbic acid solution and dehydrated in cabinet drier at 60°C DB and 56°C WB temperatures for the first 3 hours and completed at 110 DB and 105 WB temperatures. A small sample of yam slices was dried in a vacuum oven for 6 hours at 70°C to

serve as a control. The flakes were ground, sieved and stored at 4.4°C.

Cowpea powder was prepared by soaking cowpeas in water for 16 hours at 27°C. Soaked cowpeas were dehulled manually, ground and the puree obtained was diluted to 40% solid and drum dried at 75 psi steam pressure and 4 rpm drum speed with 0.04cm nip clearance between the drums.

Sesame seeds were ground to fine meal with Strauss Colloid Mill and used without further processing.

The protein contents of yam flour, cowpea powder and sesame meal prepared by the above methods were 8.77%, 25.35% and 22.30% respectively.

Citric-ascorbic acid solution was only active along the surfaces of yam slices in preventing oxidative enzymic browning. The exclusion of oxygen was very important in preventing oxidative enzymic browning.

Twenty-five blends prepared from different proportions of yam flour, cowpea powder and sesame meal were screened down to one by using estimated PERs, calculated chemical scores, experimental PERs and organoleptic properties. The biological evaluations did show that the selected blend was significantly ($P < .05$) better than any of the basic materials. The nutritive value of the yam flour was not determined because the rats fed the diet containing only yam as a protein source died within a few days. No cyanide could be found in the yam flour.

Methionine, lysine, isoleucine and threonine were the most limiting amino acids in the selected blend in a decreasing order. The enrichment of the selected blend with 0.01%, 0.024% and 0.1% DL-methionine showed a trend toward concomitant increase in the protein efficiency ratios. Only the blend enriched with 0.1% methionine showed any significant difference from the unenriched blend. The addition of 0.1% lysine, 0.1% isoleucine or 0.1% threonine along with methionine and a combination of all four amino acids to the blend showed an increase in PER over that of the blend enriched with 0.1% methionine only and at the same time the PER was significantly ($P < .05$) different from the unenriched blend.

No significant difference in taste and color could be observed between the pastes prepared from yam flour and the selected blend enriched with different combinations of amino acids. The use of melon stew improved the acceptance of the products. In texture evaluation, the discrepancies obtained cannot be explained in the sense that some of the enriched blend pastes were

and were not significantly different from yam flour paste. The differences were subjective. Although the real yam flour paste was recognized, the overall acceptability of the selected blend pastes was very impressive and highly rated. The storage of selected blend powder at temperature as high as 26°C for 12 weeks did not affect the color and odor.

The addition of different combinations of limiting amino acids did not appear to have any pathological effect on the experimental animals.

From the overall experimental results, the blend enriched with methionine and lysine is recommended for human feeding trials. These amino acids are very cheap, readily available and have been used in human foods.

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Onuoha, Chioye Isaac Chinaka

Education

THE EDUCATIONAL NEEDS OF SUBSISTENCE FARMERS IN IMO STATE, NIGERIA

Problem. The overall purpose of this study was to further define the problems encountered by subsistence farmers in attempting to increase their agricultural production. The specific objectives were to: (1) determine the personal characteristics of subsistence farmers, (2) indicate the level of farming achievement of subsistence farmers with respect to selected farm business factors, (3) determine the extent to which certain approved practices were adopted, (4) identify farm problems with which these farmers needed assistance, (5) determine the level of participation in and preferences concerning educational activities, and (6) establish the relative importance of the identified problems.

Procedure. Mbano was selected as typifying the agricultural regions of Imo State. A tentative interview schedule was constructed, field-tested in Mbano Division, revised and pre-coded. Personal interviews were conducted on the farm from a stratified random sample of 103 subsistence farmers. The IBM Computer 370-168 at Cornell University was used to process the data.

Findings. Almost all subsistence farmers in Imo State were married males with an average of seven children and at least one child in school. Many were illiterate, with 56 percent having completed less than three years of school. The farming operations were small in size but labor-intensive with the average farmer tilling 5.5 acres. They kept an average of six goats, three sheep, 21 hens and 162 chicks per farm.

The crop production rates were low in general, but varied widely with the average yields as follows: yams, 3700 lbs.; cassava, 3780 lbs.; cocoyams, 3015 lbs.; maize, 392 lbs.; peppers, 122 lbs.; fluted pumpkins, 237.4 lbs.; okra, 104.4 lbs.; dry beans, 45.4 lbs.; palm oil, 19 gals.; palm kernels, 720 lbs.; oranges, 490 lbs.; bananas, 611 lbs.; and coconuts, 323 lbs. per acre. Apparently, this quantity of production seems high for these subsistence farmers. However, when one considers the high level of production by subsistence farmers in other countries, it is evident that most of the Mbanjo farmers hardly produced beyond the level of subsistence.

Subsistence farmers were low in labor efficiency with a mean man equivalent of 5.0 and 1.1 acres per man. The frequency in the use of approved practices were: yams, twelve (57 percent); cassava, seven (58 percent); maize, four (33.3 percent); and palm oil, five (45 percent). These farmers indicated need for help to solve their problems.

Very few approved practices were used. Seventy-eight percent of the subsistence farmers were not members of any farm organizations. A little more than half (54 percent) of the respondents listened to the radio in the evening, but less than one-third (32 percent) in the afternoon, thus indicating the time of day that they could be available for programs of instruction. More than half of those interviewed preferred to attend meetings in a school on Friday evenings. Half of them looked to farm neighbors as the best source of new ideas.

Conclusions. Twelve recommendations based on the findings of this study were addressed to non-formal educational program planners for subsistence farmers. They included: (1) educational programs for subsistence farmers should be addressed to men, but with provisions for women and children, (2) the instructional materials should be written at not more than second grade level, and the focus of the programs should be on improvement of staple food crops and livestock, (3) the adoption of approved practices could be increased

by offering incentives, (4) the content of educational programs for subsistence farmers should be determined by identifying problems and setting priorities using the Farm Business Chart and a list of approved and effective practices. In conclusion, subsistence farmers needed educational help in the fifty most frequently cited problems grouped as follows: farm management, twenty-one (42 percent); livestock, fifteen (30 percent); crops, nine (18 percent); and farm equipment, five (ten percent).

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Opio-Odongo, Joe Martin Aldo

Development Sociology

THE COTTON COOPERATIVE AS AN INSTITUTIONAL INNOVATION IN UGANDA

This study examines the development of the cotton cooperative as an institutional innovation. Its basic premise is that the current problems facing the cotton co-op in Uganda are closely linked to the development of the agricultural export sector in particular and the pattern of national development in general.

On the basis of archival data pertaining to the institutionalization of the cotton co-op, four explanations of the origin of this innovation are assessed. These are the hypotheses of countervailing power, reactive subsystems, agrarian revolution, and the reform commodity movement. All seem to be reasonable explanations, but a somewhat deeper insight is provided by the reform commodity movement thesis, which links the genesis of the co-op to the social organization of smallholder agriculture. A quantitative examination of this thesis was achieved through a multiple regression analysis of data from the 18 districts of Uganda to predict the levels of cooperativism at two points in time, 1963 and 1973. The results indicated that the earlier consolidation of the agricultural export sector, proximity to the geographic origin of the co-op innovation, and the greater predisposition to collective ventures influenced the levels of cooperativism in the different districts as of 1963. Only the level of rural commercialization was a strong predictor in 1973, suggesting the confounding influence of government cooperative policy during the post-1963

decade.

The influence of the social organization of smallholder agriculture on the adoption of the cotton co-op is also investigated. The comparative cost, the market potential, the community structural effects, and the structural congruence hypotheses are assessed in seeking a comprehensive explanation for the differential adoption of the cotton co-op by 1959. The structural congruence hypothesis seems more comprehensive and is therefore tested. Data from 40 sub-counties of Lango district are subjected to both multivariate probit and ordinary least squares techniques in order to determine what structural factors influenced the adoption of the co-op. The results from both techniques are identical and reveal that the extent of rural commercialization and the agricultural potential of the subcounties determined adoption.

The managerial capability of the committee members as measured by their knowledge of cooperative business principles and practices is also assessed. Low levels of cooperative knowledge prevail, and these are attributed to poor organizational structure and inadequate member socialization. These in turn are linked to government cooperative policy which has insured cooperative monopsony and has permitted an intensified government involvement in the management of cooperatives. However, a multiple regression analysis of the determinants of managerial knowledge reveals that the amount of formal education and the frequency of in-service managerial training are the significant factors.

In examining the problem of member participation, two forms of participation are analyzed--attendance at the annual general meeting and willingness to share corporate liability. Ordinary least squares and multivariate probit are applied in predicting the two decisions. The results of the analysis indicate that the two decisions, as expected, were differentially motivated. The decision to attend the annual general meeting was mainly influenced by the member's age, co-op knowledge, cotton acreage, and by perceived co-op leadership integrity. The decision to share corporate liability was mainly influenced by the amount of graduated tax (as SES indicator), functional level of living (an SES indicator), original motivation to co-op membership, and cotton acreage.

This analysis suggests that cooperative functional education be enhanced in order to improve the managerial process. This should be reinforced by increased involvement of the cooperative movement in critical managerial decisions, and this would encourage members to assume their responsibilities.

Perosa, Roberto Mario, Jr.

Economics

THE INDUSTRIALIZATION OF BRAZILIAN AGRICULTURE: A STUDY OF AGRICULTURE IN THE RIBEIRÃO PRETO AND ALTA MOGIANA REGIONS

The purpose of this dissertation was to study the changes which have taken place in the agriculture of the Southern and Southeastern regions of Brazil in the last two decades. It is divided into two parts: the first, in Chapter I is an attempt to explain the historical evolution of Brazilian agriculture, since the development of coffee economy of the last century. The second part tries to explain the more recent transformations, where industrialization and government policies have had crucial importance in the changes in labor relationships and techniques employed in agriculture (Chapter II), as well as the development of agriculture in two selected regions of the state of São Paulo (Chapters III, IV, and V).

The method adopted in the thesis was a historical one, that is, it assumes relationships are valid only within the period of dominance of the specific form of production that give rise to them.

The procedures for gathering data consisted of field research projects conducted in November 1976 and May 1977. In both questionnaires and interviews were used. Data from the Agricultural and Demographic Censuses have also been utilized.

The main conclusions of the thesis can be summarized as follows:

- 1) The basic changes in labor relationships in Brazilian agriculture, which consisted of the increase in the employment of wage laborers and the displacement of primitive labor regimes (such as sharecropping and colonato) can only be understood in the framework of broader transformations, such as industrialization and urbanization.
- 2) The introduction of modern techniques in agricultural production, such as mechanization and the use of fertilizers, was decisively influenced by the rise of the domestic manufacture of agricultural machinery and inputs, as well as by changes in the rural credit policies of the period.

- 3) The above-mentioned transformations were brought about by industrial capital, both in the production of machinery and other agriculture inputs and in the industrial elaboration of agricultural raw materials.
- 4) Industry originated in the Alta Mogiana region as a result of the capital accumulated from commercial activities, rather than from agricultural ones.
- 5) The mechanization of agriculture in Alta Mogiana has forced many farm laborers to leave the region, as urban economy was not sufficiently developed to absorb workers who could not find jobs in agriculture. The picture is different in the Ribeirão Preto region, as the city of that name experienced a strong development in service employment, thus absorbing most rural workers expelled by mechanization.
- 6) Regional population declines, like those occurring in the Alta Mogiana region, were not due to mechanization of agriculture alone. Actually, the beginning of the process can be traced back to the 1950's, when the substitution of wage labor for sharecropping and the colonato regimes started, transforming workers from permanent farm residents into temporary workers who live in the outskirts of cities and are hired for short-term tasks.
- 7) The way agriculture has developed in the Ribeirão Preto and Alta Mogiana regions had as a consequence the displacement of most small farms, thus increasing the degree of land tenure concentration. Small farmers, using family labor force, began to reduce the monetary expenditures for the reproduction of costs of production provoked by new techniques they could not afford. In a second move, as the process continues, they began to sell their labor force to the larger farms, which represents the first step in their proletarianization. Finally, they sell the lands they are no longer able to keep because of strong competition from larger mechanized farms.

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Posner, Joshua Lowe

Agronomy

SOLAR RADIATION AND THE GROWTH AND PRODUCTIVITY OF UPLAND RICE (ORYZA SATIVA)
IN WEST AFRICA

The studies reported in this dissertation examined the effects of low radiation on upland rice growth and productivity. Reduced radiation levels in the humid tropics have been considered as a partial cause of the lower yields observed during wet season plantings of cereals by many authors. In an attempt to examine this hypothesis several types of experiments were undertaken. Shade cloths were employed to create different ambient light environments, and planting density and nitrogen additions varied in order to create different light penetration patterns into the vegetation. In addition, canopy manipulations and mixed cropping were used to further alter the light environment and study its role in rice growth.

With respect to the actual radiation levels in West Africa, a literature search indicated that sites in the forest belt receive 15% less radiation during the rainy season than do savannah locations. This spread is accentuated in August when the difference increases to 25%.

Shading experiments indicated that this range in mean radiation levels can account for yield differences of .45 tons/ha. Also, in another experiment with temporary shading, low light during the reproductive stage was found to be the most damaging period in yield determination. Fifty percent shading for the month of panicle initiation to flowering (August) resulted in a 25% reduction in yield. Although yield potential is lower in the forest belt, experimental results indicate 3 to 4 tons/ha are possible at mean radiation levels of only 300 ly/day. Present yields are one-third this amount so many factors other than radiation levels intervene in yield determination.

A variety trial was conducted in order to study the interaction of plant type and light level. A range in susceptibility to shading existed but no single morphology appeared best. Subsequent sidedressing and density experiments also showed no clear advantages for one plant type over another. As a result it appears that in breeding upland rice, canopy architecture need not be a criterion. Both short cycle and tall plants appeared most sensitive to

shading and intermediate IRAT-13 consistently gave top yields.

Further manipulations with thinning experiments and canopy modification re-emphasized the importance of reproductive stage radiation and light penetration in final yield determination. A final series of mixed cropping experiments were conducted to study the effects of shading of one plant by another. When IRAT-9 was shaded by IRAT-13 its yield dropped by 34% while concomitantly IRAT-13's yield did not increase. With rice and maize, it was estimated that the rice in the mixture yielded 24% less than in monoculture. These results indicate that rice in the mixed cropping context is sensitive to shading but when sown as an understory crop can still give economically promising yields.

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Rukandema, Fred Mwita

Agricultural Economics

RESOURCE AVAILABILITY, UTILIZATION AND PRODUCTIVITY ON SMALL-SCALE FARMS IN
KAKAMEGA DISTRICT, WESTERN KENYA

Mounting population pressure on limited arable land and urban unemployment are two of the most serious problems facing Kenya today. Thus, there is a rapid decline in farm sizes in many areas, leading to widespread underemployment and landlessness in a generally low productivity agriculture.

To stem further deterioration in the living conditions of the rural masses, the Kenya Government is earnestly attempting to effect measures for accelerated agricultural output and improvements in resource productivity. However, these endeavors are handicapped by insufficient knowledge as to specific circumstances and constraints prevailing in particular locations. This is the point of departure for this study. Specifically, the major objective was to assess the nature and magnitude of constraints to increases in agricultural production on small-scale farms in Kakamega District.

On the basis of the hypothesis that production constraints in different locations will differ according to differences in relative resource endowments,

sample farms for the study were randomly selected from areas having significantly different man/land ratios. Data were collected weekly from these farms over a period of twelve months. Analysis of resource stocks and their utilization revealed the following:

1. Some parts of the district have a severe land shortage problem while others still have adequate supplies of land relative to labor. Consequently, measures to expand agricultural output in these two situations should be differentiated.
2. The technology of production in the district is very rudimentary. The hand hoe and, to a limited extent, the ox-plow constitute the major forms of capital equipment on most farms. The application of purchased material inputs is limited only to improved maize varieties.
3. There is widespread underemployment of labor. This results mainly from the combination of seasonal rainfall variability and the monocultural nature of farming. Scarcity of land in some areas reinforces the problem.
4. Labor productivity and incomes in all areas are extremely low. Scarcity of complementary factors to family labor in the relatively land-surplus areas and land shortages in the high density areas are the major causes. Moreover, seasonal food shortages tend to reduce labor productivity further by occurring during the period of maximum labor demand.

Analysis of factors which determine maize yields in the sampled areas led to the following conclusions:

1. Yields could be increased significantly by increasing plant density.
2. Yields are substantially reduced by late sowing and weeding.
3. Intercropping maize with beans enhances maize yields per acre.
4. Farms using ox-plows for seedbed preparation realize significantly higher yields than those relying on hand hoes.
5. There appears to be a negative relationship between maize yields per acre and the number of weedings performed, probably because current weeding methods are inappropriate.

The major policy implications of the study are that (1) land-scarce areas urgently require rapid intensification of production involving significant improvements in existing crop husbandry practices, application of yield-in-

creasing, land-saving technologies and introduction of high-value enterprises; (2) while the relatively land-surplus areas also require improvements in cultural practices, substantial increases in farm output could be realized through selective mechanization, designed to make optimum use of mechanical, animal and human power. The basic government inputs required for these changes are an effective extension service and appropriate credit/input supply arrangements.

Since the measures just suggested are short-run and stop-gap, a lasting solution requires that the national land resources be used more efficiently, unused or underutilized land being made available to the landless.

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Sambrani, Shreekant

Economics

STRUCTURAL CHANGES IN THE INDIAN ECONOMY, 1950-51--1965-66

Underdevelopment in India became institutionalized under colonialism and underwent little improvement during the first three five-year plans. The East India Company was interested chiefly in expropriating surpluses through plunder, tribute and exports. The imperial rule, working mainly through land revenue systems and monetization of agriculture, induced a stagnation of foodgrains production and encouraged plantation crops. It weakened traditional crafts, encouraged commerce and industry linked to external trade and controlled by Europeans, and developed railways mainly to serve foreign trade and colonial control.

The educational system produced low-level bureaucrats. Anti-Indian prejudices existed in technical, administrative and entrepreneurial hierarchies. Industries competing with metropolitan imports suffered from discriminatory treatment. Indian firms had to start large and imitate European practices to coexist with monopolistic foreign-owned enterprises.

The techno-bureaucratic middle class had concerns for its own survival.

It aspired to Western amenities without adopting Western values. It preserved its exclusiveness through its early control over lower bureaucracy.

Political leadership before Gandhi was either traditional and reactionary or liberal and ineffective. Gandhi's championship of independence united the country across classes but not religions. He sought to restore idealized, sanitary, self-sufficient village communities existing harmoniously in dignified poverty. His pervasive influence stifled ideological clarity and dissent. Leaders with radical views had to modify their stance.

After independence the established political, technical and bureaucratic elites undertook the task of framing five-year plans to achieve constitutional goals of egalitarian distributions of income and wealth. Plans were drawn up, however, on the basis of growth-oriented theories. Redistribution of incomes, needing a focus on agriculture and related sectors of mass employment, was not the major goal of planning. Considering capital as the scarce factor of production, successively higher investments were planned, mostly in the public sector, to achieve desired growth rates and intersectoral balances.

The first three plans together resulted in an investment of Rs. 200 billion, a third of which was for agriculture. Targets for the First Plan were more or less met. A growing shortfall in achievements of the next two plans led to a weakening of beliefs in and commitments to planning.

A comparison of 14-sector input-output data (in pre-planning constant prices) at the end of each of the three plans showed that agriculture and traditional industries (textiles, and food processing) were the slowest to grow, but continued to contribute over 60 percent of gross output and domestic product. Engineering products, chemical and electricity outputs grew rapidly, but being small and interdependent sectors, they did not appreciably contribute to the overall growth rate of about 3 percent a year. Only a small number of technical coefficients showed significant changes over this period. Employment creation lagged behind growth of labor. Per capita income grew at 1 percent per year. Agriculture continued to be the main source of livelihood to 70 percent of the population. A declining share of agriculture in the gross output indicated a worsening of income distribution. The availability of consumer goods per capita increased little. Thus, these changes signify an absence of both growth and development.

Small farmers, over 80 percent of the total, were excluded from the benefits of interventions in agriculture. Experiments in democratic decentralization served only to strengthen the rural elite. Industrial policies led to the emergence of capitalism, not socialism. Controls aided private capitalism, which continued to dominate the economy.

Only a redistributive concern, resulting in a continuous increase in agricultural output per worker, could have caused significant structural changes in India. This needed a break from the past. The numerically and institutionally strong Indian elite, mainly the middle class, aspiring for a good neo-colonial life-style, could not achieve this break, nor could its power be reduced. India's elite-based intermediate regime was no more modernizing than the colonial one it replaced.

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Schlegel, Charles Clifford

Development Sociology

SOCIAL INDICATORS AND SOCIAL STRUCTURE IN PENINSULAR MALAYSIA

This study compares the level of living of the 70 administrative districts of Peninsular Malaysia as of 1970, and it investigates the degree to which district differences may be accounted for in terms of several dimensions of social organization of the districts themselves and of the 11 Peninsular Malaysian states in which they are located. Level of living was defined as comprising the objective conditions of life and life opportunities which have a clear normative interpretation. Seventeen indicators were selected from census and vital statistics sources. These indicators covered a considerable range, including health and longevity, education, material possessions, etc., along with four indicators which, though normatively undesirable, tend to occur in conjunction with the positive welfare measures. These were suicide, unemployment, housing congestion, and deaths due to nonvehicular accidents.

The level of living index was constructed by summing the standardized

indicators, with the four pathology measures subtracted out of the composite score. This procedure provided a rough measure of the "net" welfare level for each district. An examination of district scores revealed a strong regional differential. By this measure, the average level of social welfare among districts of the eastern and northern states is considerably lower than those of the western core region.

Principal components analysis was used to extract the main dimensions or factors of social structure among both states and districts, using roughly parallel variables at each level. Factor scores were then used as independent variables in a series of multiple regression analyses to estimate the welfare scores for all districts. The district factor urban differentiation and the state-level factor which combined variables relating to both urbanization and estate agriculture were the strongest predictors of district well-being. The district estate agriculture factor had no significant independent effect. Surprisingly, the district factor delineating very small and unequally distributed land holdings had a positive impact on the level of living. The parallel state factor, however, which also includes measures of political opposition and single-party dominance, showed a negative effect on the dependent variable. A dummy variable for region had no effect on district welfare after both state and district structures were accounted for.

In the final stage of the analysis, the 17-item level of living index was broken down into several subgroups of similar items. Each of these measures was entered as a dependent variable in further regressions, using the same independent variables as before. The explanatory pattern was similar to that found for the general index. Health and suicide are not strongly predicted by the five structural measures, but otherwise they explain around 70 percent of the variance in the dependent variables. However, the structural patterns which contribute positively to welfare status are also associated positively with the level of social pathology.

The analysis supports the claim that the well-being of families and individuals is strongly influenced by the social structural environment, and it casts doubt on the applicability of a dependency interpretation of urbanization and plantation agriculture in the Malaysian context. Though the study cannot provide specific policy recommendations, it suggests that the most effective

means of overcoming the disparities which exist between Malay and non-Malay communities may be through policies which emphasize structural modernization in those states where Malays are heavily concentrated.

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Sepulveda-Silva, Sergio

Agricultural Economics

THE IMPACT OF MODERN TECHNOLOGIES UPON FACTOR SHARES AND EMPLOYMENT IN INTEGRATED RURAL DEVELOPMENT DISTRICTS IN COLOMBIA

Agricultural technologies used in most developed nations have both increased yields and displaced human labor per unit of land. However, the adoption of these technologies has exacerbated income disparities in rural areas of developing nations. The displacement of laborers is further complicated by the failure of the industrial sector to provide adequate employment alternatives. The Colombian Integrated Rural Development (DRI) program utilizes new technologies, combined with other services, to increase yield per hectare as well as increase employment in regions of minifundios. This study attempts to measure the success of DRI. Specifically, the major objective is to assess the impact the new technologies have had upon factor shares and employment on minifundios in the districts of Caqueza and Rionegro.

Data were collected using a stratified random sample of farmers planting the most frequent crop mixtures, maize-beans and potato-peas, in the two districts for the 1975 agricultural year. Farmers planting each crop combination were stratified on the basis of crop-production technology. The strata were farmers using traditional and farmers using modern technologies. Analysis of the resource endowments revealed the following:

1. Farmers in Rionegro have a less stringent land constraint than those in Caqueza. Actions to increase crop yield in the two districts ought to allow for this important difference.
2. The relative proximity to infrastructural services was found to be the factor most significant in differentiating traditional and modern

farmers. These services facilitate the activities of personnel from the Instituto Colombiano Agropecuario (ICA) and improve the access farmers have to local markets, thereby expediting the adoption of induced technological change.

Analysis of productivity, factor shares, and marketable surplus in the sampled districts led to the following conclusions:

1. Remarkable gains in yields per hectare were noted for both crop mixtures due to the use of new technologies.
2. The use of new technologies intensified the use of labor and working capital per hectare.
3. Labor and land productivity showed substantial increases for production activities using the new technologies.
4. Absolute shares of labor and capital for both production activities, maize-beans and potato-peas showed considerable gains. Although the relative share of labor failed to show increases potato-peas under modern production methods.
5. A large percentage of the maize-beans productivity gains in Caqueza are allocated to home consumption instead of the market.

The analysis of time schedules and labor demand revealed the following:

1. There were no chronological changes in the production schedules due to the use of new technologies. Consequently, the periods of peak and slack in the demand for labor were the same for both new and traditional technologies.
2. The seasonal increases in labor demand generated by the new technologies were primarily met through increases in hired labor.

The major policy implications of this study are:

1. Infrastructural services must complement to a package of new crop-production technologies.
2. There is a need to generate nonfarm rural employment in order to eliminate the occurrence of seasonal unemployment. Farmers should be encouraged to develop labor-intensive, small-scale, nonfarm enterprises as supplements to farming activities.
3. Efforts should be made to provide irrigation facilities where water availability can facilitate double cropping. This would help in

smoothing out the demand for labor throughout the year.

These measures are short-run policy suggestions. Permanent solutions require that the national land resource base be used more efficiently and that the minifundistas have greater access to capital.

Teri, James Mneesi

Plant Pathology

BROWN LEAF SPOT AND CERCOSPORA LEAF BLIGHT OF CASSAVA: EPIDEMIOLOGY AND IMPORTANCE

Cassava, *Manihot esculenta* Crantz is considered to have considerable potential in the tropics. Its *Cercospora* or *Cercospora*-like diseases have historically been considered economically unimportant without substantive data. This widely held but unsubstantiated view has hindered any serious studies on these diseases. The major objective of this study was to elucidate the epidemiology and determine the importance of these diseases with the purpose of guiding future work in their control. Some characteristics of the fungi were also studied.

Cercospora henningsii (*Cercosporidium henningsii*), *Cercospora vicosae*, and *Cercospora caribaea* (*Phaeoramularia manihotis*) - which incite, respectively, brown leaf spot, Cercospora leaf blight and white leaf spot grew slowly in culture and sporulated only sparingly. *C. caribaea* had a faster growth than *C. henningsii* and *C. vicosae*. *C. henningsii* and *C. vicosae* formed pale olivaceous globose and floccose colonies with few folds. *C. caribaea* formed dark, flat, villose colonies with prominent folds. *C. henningsii* and *C. vicosae* sporulated abundantly in Riddel slide cultures, but *C. caribaea* sporulated only sparingly forming mostly sterile conidiophores.

The epidemiology and importance of brown leaf spot and Cercospora leaf blight were studied in split plot experiments using nine cassava genotypes and fungicide sprays. The cassava genotypes were either resistant, tolerant or susceptible to the two diseases and were randomly allocated to main plots. The

fungicide benomyl was randomly allocated to sub-plots as sprayed vs. unsprayed plots.

Methods for assessing disease severity were developed. Disease severity and the effect of the diseases on plant growth and development were determined at approximately three-week intervals until harvesting.

As studied in Colombia, the two diseases appeared to have epidemics of the same nature which were typically of compound interest in the sense of van der Plank. Infection started randomly within plots on old leaves only. Lesions of brown leaf spot were randomly distributed on leaves. Lesions of *Cercospora* leaf blight showed a tendency to appear first on leaf margins.

The diseases had a long lag stage starting when the plants were about one and a half months old to when they were about five months old. The logarithmic stage was comparatively short and lasted during the period the plants were about six to eight months old. The post-logarithmic stage lasted for three months as the crop was harvested at 10 months.

The diseases did not have significant effects on plant height and number of leaves per plant. However, premature defoliation was a general effect of the diseases. Disease severity, number of lesions per leaf and percent defoliation were positively correlated.

The diseases had significant effects on root yield and quality of susceptible cultivars. Average yield reductions by brown leaf spot were: fresh root yield, 18%; dry matter root yield, 17%; and root starch yield, 13%. Reductions due to *Cercospora* leaf blight were: fresh root yield, 23%; dry matter root yield, 21%; and root starch yield, 24%. They did not have significant effects on root dry matter content, sugar content, or root number per plant. The effect on root starch content was not great. The cultivar Chiroza with severe disease suffered no apparent loss in yield or quality. It was apparently tolerant. The defoliation from the diseases will assume greater importance if the foliage is to be used as human or animal food, and weeds are likely to be more serious in disease defoliated than undefoliated plantations.

Factors inherent in subsistence agriculture where cassava was grown could account for the early reports that the diseases were not important. Further studies are needed to establish this conclusively.

Resistance and avoidance by planting to have the susceptible stages of crops coinciding with onsets of dry seasons should be valuable control strategies. There is also a need to examine the characteristics of tolerant cultivars since cultivars with high leaf area indices or early root bulking are likely to be more tolerant to the diseases than low leaf area index or late cultivars.

Tschanz, Arnold T.

Plant Pathology

INCORPORATION OF RESISTANCE TO PHYTOPHTHORA INFESTANS AND PSEUDOMONAS SOLANACEARUM INTO THE ANDIGENA POTATO AND THE INTERRELATIONSHIP OF MELOIDOGYNE INCOGNITA AND PSEUDOMONAS SOLANACEARUM ON POTATOES RESISTANT TO P. SOLANACEARUM

The research was divided into two general sections. The first section was; a) the determination of the feasibility of combining resistance to Pseudomonas solanacearum, originating from Solanum phureja, into an andigena (Solanum tuberosum subsp. andigena) potato population with general resistance to Phytophthora infestans, b) the enhancement of the levels and frequency of resistance to both organisms in each subsequent population, and c) an evaluation of the effectiveness of a greenhouse screening technique used to select clones with high levels of general resistance to Ph. infestans. The second section was the determination of the effect of Meloidogyne incognita, the southern root knot nematodes, on the disease severity of bacterial wilt of potatoes caused by Ps. solanacearum, and particularly the effect of interrelationships of M. incognita and Ps. solanacearum on the disease severity in potatoes resistant to Ps. solanacearum.

Clones for the experiments in the first section were developed from true seed. The seedlings were first tested for resistance to Ph. infestans, and those deemed resistant were allowed to tuberize. Tubers were then used to produce sufficient plants for all subsequent greenhouse, growth chamber and field experiments. In the interrelationship study, the second section, two potato

cultivars, Hudson and Katahdin, and two isolates of Ps. solanacearum, K-60 and LB-6, were utilized. Four populations of M. incognita, 0, 3,000, 10,000 and 30,000 eggs per pot, were used as well as three different bacterial inoculum concentrations of each isolate.

Results indicate that the greenhouse screening test was very effective in identifying high levels of general resistance to Ph. infestans and was also very effective over a broad range of potato germplasm. Resistance to Ps. solanacearum was incorporated into the andigena population while the general resistance to Ph. infestans within the population was maintained. The level and frequency of progeny with general resistance to Ph. infestans was increased within the andigena population while the resistance to Ps. solanacearum was maintained, and conversely, the resistance to Ps. solanacearum was increased while the general resistance to Ph. infestans was maintained. The results also indicate that the general combining ability of parental clones may be a factor influencing the observed frequency of progeny resistant to either of these organisms. The data also indicate that the phenotypic expression of general resistance to Ph. infestans in specific clones was differentially influenced by the environmental conditions of different locations during a particular growing season and of different growing seasons at a particular location.

The results from the interrelationship study indicate that the presence of M. incognita generally increased the severity of bacterial wilt caused by Ps. solanacearum. The presence of M. incognita in the resistant combination (cultivar Katahdin - Ps. solanacearum isolate K-60) was associated with a proportionately greater increase in the severity of bacterial wilt than were similarly treated susceptible combinations. The final bacterial wilt severities of the susceptible combinations (cultivar Hudson - Ps. solanacearum isolates K-60 and LB-6 and cultivar Katahdin - Ps. solanacearum isolate LB-6) in association with M. incognita at the low and intermediate bacterial inoculum concentration were similar to the final bacterial wilt severity of the same susceptible combination at the next higher bacterial inoculum concentration without M. incognita. The bacterial wilt severities of the resistant combination in association with M. incognita at the intermediate and high bacterial inoculum concentration were similar to the wilt severities of the susceptible combinations without M. incognita but at the same respective bacterial inoculum concentration.

THE IMPACT OF AN ALTERNATIVE PRICE POLICY WHICH INCORPORATES TRANSPORTATION AND STORAGE COSTS INTO THE SET OF TMO PURCHASE AND SALE PRICES WITH KONYA AS A BASE

The Turkish government intervenes in wheat pricing and marketing through a State Economic Enterprise called the Soil's Product Office or TMO. This agency runs a buffer stock operation in the domestic market and is also solely responsible for the exports and/or imports of cereals. It purchases any amount that is offered at the government set TMO purchase price and transports the product around the country so as to achieve a desired level of available supplies to each region. A rationing system is used to allocate sales among urban and rural areas.

One important aspect of the current price support policy is that no regional or seasonal price differentials are considered in TMO purchase or sales. Thus prices stay constant throughout the year and between regions for a given quality of wheat. The private sector is said to be outcompeted in many areas due to the fact that TMO operations are subsidized and its purchase-sale price margin is too narrow to include all the purchase, storage and transportation costs.

This study was conducted in order to generate a set of efficient regional and seasonal price differentials that would take transportation and storage costs into account and to investigate the feasibility of incorporating these differentials into the price support scheme. A simple transportation model with fixed supplies and demands was used as the main analytical tool. An availability-disappearance approach was used in determining the surplus or deficit of each region.

The model was used in determining the optimal shipment pattern that would simultaneously satisfy the demands of deficit regions and minimize the total transportation cost. The spatial price margins were computed based on the given optimal solution. Three years (1972-1974) were chosen as test cases to illustrate the changes in the optimal solution depending on the level of wheat out-

put. 1972 represented a surplus, 1973 a self-sufficient and 1974 a deficit year.

The main conclusion of this study was that the alternative policy under investigation could not be recommended. The following were some of the important reasons for this conclusion: First, the optimal solution and hence the relative regional price margins showed a great deal of variation from year to year depending on the production conditions. This implied that the margins should be computed every year. This could be a problem in Turkey since the production can not be estimated with confidence. It could be risky for TMO to specify the regional price differentials before harvest. Second, it was discovered that even the optimal solution for a given year was not very stable. A small change in the transportation rate between certain origins and destinations could easily change the optimum shipment pattern and thus the set of relative prices. Third, the alternative policy could increase the uncertainties for TMO as far as its expected purchases and sales are concerned and it could become more difficult for this agency to make export and/or import decisions. Finally, the impact of the alternative policy was found to be undesirable as far as the income distribution implications were concerned. It was found that the consumers, especially in low income eastern provinces, would be spending much more on wheat. While eliminating TMO losses, a transfer of income was foreseen from low income consumers towards the medium and high income groups.

Another conclusion of this research was that there was need for more storage and port capacities in certain years. It was found out that the available storage capacity was not sufficient in a surplus year such as 1972. The extra storage capacity needed in this year was computed and the optimum location of storage facilities as well as the resulting cost savings were determined. These findings indicated that Ankara and Konya, the two major wheat growing regions in the country, had comparative disadvantage with respect to interregional trade in a surplus year.

Icel region was found to have comparative advantage in exports and Trabzon in imports. However, the lack of sufficient wheat handling capacity in the latter port was stated as a problem and the resulting cost savings that could be realized, if the port capacity there was expanded, was computed.

The possible impact of the alternative policy on production, farmers' receipts and consumer expenditures were discussed. It was found out that the

production changes due to alternative policy would not be substantial. However, the resulting income effects were found to be to the advantage of large farmers who market the largest absolute amounts and high income consumers who spend relative a smaller percentage of their income on wheat and wheat products.

Wilson, John Thomas

Microbiology

FACTORS LIMITING THE DEVELOPMENT OF NITROGEN-FIXING ALGAE IN FLOODED SOILS

Several factors that might limit development of nitrogen-fixing algae in lowland rice soil were studied. Flooded soil samples were incubated in plastic containers at 24-26°C under 250-500 μ Einstein per m² per s of light from fluorescent lamps. After an appropriate interval, the activity of nitrogen-fixing algae in the soil was assayed by sealing the containers, adding 0.07 to 0.09 atm of acetylene, and measuring ethylene production in the headspace and floodwater after 8 h. Total algal development was assayed by extracting chlorophyll from the soil with acetone and determining chlorophyll by fluorescence.

All of the 12 soils examined developed light-dependent acetylene-reduction activity within 21 days. The maximum acetylene-reduction activity encountered in each soil ranged from 0.4 to 20 nmol ethylene per h per cm² of soil surface. Phosphate additions (100 μ g P/ml floodwater) stimulated acetylene-reduction activity in 10 of the 12 soils. Maximum acetylene-reduction activity encountered in each soil after phosphate addition ranged from 1.4 to 250 nmol ethylene per h per cm² of soil surface. When the soils were amended with phosphate, addition of iron (5.0 μ g Fe⁺³/ml floodwater) stimulated maximum acetylene-reduction activity in two soils with pH values of 7.9 and 6.3 but not in a soil with a pH value of 5.5.

Simple correlation coefficients were calculated between the assays of algal development and the chemical properties of the soils. Acetylene-reduction activity or chlorophyll development did not correlate (95% level) with extractable phosphate or iron, even though phosphate or both phosphate and iron were often

limiting for nitrogen-fixing algae. The soil test procedure failed to measure the availability of these elements. Neither assay of algal development (with or without added phosphate) was correlated with quantities of nitrate-nitrogen plus ammonia-nitrogen or soil organic matter. Chlorophyll development correlated (90% level) with pH, extractable potassium, and the sum of extractable calcium and magnesium. When phosphate was added to the flooded soil, acetylene-reduction activity also correlated (95% level) with pH, potassium, and calcium plus magnesium. If phosphate was not added to the flooded soil, acetylene-reduction activity was not significantly correlated with these factors (90% level), suggesting that phosphate limitation masked their influence.

The development of indigenous algae in phosphate-amended soils was compared to development of an introduced nitrogen-fixing alga, Aulosira sp. 68. Inoculation with Aulosira increased the maximum acetylene-reduction activity in two soils, but there was no effect in three other soils.

A variant of Aulosira was developed that was resistant to a concentration of the herbicide simetryne (0.8μ g/ml floodwater) that prevented development of indigenous algae in flooded soil. If the resistant alga was inoculated into flooded soil containing simetryne, the maximum acetylene-reduction activity attained was greater than maximum activity in soil containing only indigenous algae or in soil containing both the parent strain of Aulosira and indigenous algae. Competition from the indigenous algae must have inhibited development of the parent strain.

Predation from Daphnia pulex (initial density of one individual per 2 cm^2 of soil) delayed development of acetylene reduction in soil inoculated with Anabaena sp. but had no effect on the maximum acetylene-reduction activity attained.

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