Market Reforms, Research Policies And SADCC Food Security

Edited by

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University of Zimbabwe UZ/MSU Food Security Research in Southern Africa Project

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SECTION V: AGRICULTURAL RESEARCH PRIORITY SETTING AND HOUSEHOLD FOOD SECURITY

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Agricultural Research Priority-Setting In Southern Africa: Nutrition And Household Food Security Issues

Carl K. Eicher[1]

BACKGROUND

Since this is the Sixth Annual University of Zimbabwe/Michigan State University Conference on Food Security Research in Southern Africa, it is timely to step back and analyse what has been achieved through applied research, training, networking and building an information base to guide food policy decisions. Sometimes, the accomplishments of a collective effort are more readily perceived from a distance.

Two months ago, at a SPAAR[2] conference in Washington, D.C. on agricultural research in Africa, special attention was directed to the SADCC region because it is considered to be a beacon for the continent in terms of innovations in agricultural research, training and food security policies. The conference participants noted that SADCC has created a number of new institutions, such as SACCAR, to enhance the performance of national agricultural research systems (NARS) through regional cooperation. SACCAR's Blueprint for Regional Specialisation in Higher Agricultural Education was recently completed by a committee of Deans of Agriculture under the leadership of Dean Mandivamba Rukuni (SACCAR, 1990). After only five years of operation, SACCAR is now helping to coordinate, in cooperation with national institutions, nine regional research and training programmes (Kyomo, 1990). These programmes include the path-breaking SADCC/ICRISAT sorghum and millet programme that has moved progressively from a food production to a food systems research

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[2]SPAAR is the Special Program for African Agricultural Research, established by donors in 1985 in recognition that National Agricultural Research Systems (NARS) in Africa were in need of special donor assistance. SPAAR has a secretariat in the World Bank in Washington, D.C.

orientation. Research is underway on production, processing, storage, grain quality, consumer preferences, new end uses for sorghum and millet and market development (Rohrbach, 1990). Finally, the food policy agenda in SADCC countries is moving from national food self-sufficiency to food security. Botswana, for example, recently adopted this position. Howard Sigwele, Chief Economist, Ministry of Agriculture, reports that:

> Botswana's policy decision to shift from food self-sufficiency to food security has been made to ensure long term economic efficiency, sustainability and proper use of the environment . . . After all, food self-sufficiency only tells us about the physical availability/supply of food and not economic access to it . . . Similarly, following the strong drive by the government to diversify the economy, it is hoped this policy initiative will further improve food access through employment creation to increase real income levels (Sigwele, 1990, :15).

The objective of this chapter is to discuss how nutrition and household food security objectives can be incorporated into the research programmes of national agricultural research systems (NARS). Part II presents an overview of food and agriculture in the SADCC region. Part III examines the role of nutrition in agricultural research in historical perspective. We then review the 27-year research programme to increase the protein content of maize through plant breeding because maize is the staple food in at least half the SADCC nations. Part IV discusses studies of the payoff to investment in agricultural research. Part V reviews four quantitative techniques for setting agricultural research priorities in NARS and regional agricultural research systems. We shall then address the key question: Why are these priority-setting procedures rarely used by agricultural research managers in Africa? Because research managers cannot wait until improved techniques are developed to incorporate household food security into research priority-setting in NARS, there is an urgent need to get on with the challenge of promoting rural diversification in less favorable areas in order to expand rural incomes and economic access to food. Part VI addresses rural diversification, a process that can increase rural incomes and economic access to food. Part VII looks to the future and discusses needed research on nutrition and household food security.

FOOD AND AGRICULTURE : OVERVIEW

SADCC, a region of 10 diverse nations and some 82 million people, has the most favorable food outlook of the five sub-regions in sub-Saharan Africa. The aggregate domestic availability of major staples in the SADCC region is 18,60 million tonnes Maize Equivalent (M.E.) for the 1990-91 marketing year, as compared with aggregate regional food requirements of some 17,83 million tonnes M.E. (SADCC, 1990). But at the national level, three countries -- Tanzania, Zambia and Zimbabwe -- have cereal surpluses (mostly maize) while the other seven SADCC countries continue to face serious shortfalls in cereal production.

Moreover, there is considerable diversity of diets in the region. Cassava -- the poor people's crop -- plays a key role in the diets in three SADCC countries: Angola, 29 percent; Mozambique, 36 percent; and Tanzania, 25 percent.

But despite SADCC's relatively favorable macro food outlook *vis-a-vis* other sub-regions in Africa, there are some formidable problems facing the multiplicity of food and agriculture decision makers in the SADCC region. These problems include the following:

1. Food demand will grow at four to five percent per year in the 1990s. While the World Bank's (1989) Long Term Perspective Study calls for African nations to double the annual rate of growth of food production from two to around four percent, there are no high income countries that have achieved and sustained a four percent agricultural growth rate for a period of several decades.[3]

2. Rural employment generation is a crucial problem because the industrial/urban sectors can absorb only a small fraction of the increase in the rural labour force.

3. With the exception of Botswana, which had the fastest growth rate (8.6 percent) of any country in the world over the 1965-88 period (World Bank. 1990b. :178-9), *per capita* incomes are low and stagnant in many SADCC countries. For example, in Zimbabwe "although *per capita* income expressed in 1980 prices, rose from $438 in 1980 to $472 in 1982, it had declined to $470 by 1989. On the average, this means that Zimbabweans in 1989 were worse off then they were in 1982" (Chidzero, 1990).

4. Because of foreign exchange constraints, many countries in the region are scratching for ways to increase traditional and non traditional agricultural export earnings. But as Rusike (1989) has shown, there are formidable barriers to expanding intra-regional and inter-regional trade. UNCTAD (1990) reports that Asian countries gained world market shares in several commodity markets, especially since 1970. In short, Asian nations are proving to be aggressive economic challengers in global commodity markets, including some (cocoa, palm oil), that have long been dominated by Africa. For example, Papua,New Guinea is now producing cocoa and pyrethrum. Kenya's palm oil imports from Malaysia now exceed the value of wheat imports.

5. Sub-Saharan Africa is now importing 75 percent of all wheat consumed. Because wheat is a marginal crop in many African eco-systems, domestic

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[3]Total agricultural output increased at annual compound rate of 1,6 percent in the U.S. and Japan over the 100 year period, 1880-1980 (Hayami and Ruttan, 1985. :166).

production is not keeping up with demand, and *per capita* wheat consumption is increasing. The macro picture for wheat in Africa is disturbing. Production has failed to keep pace with demand and the share of wheat consumption among all cereals in Africa doubled from five to ten percent since 1960. This dramatic shift has come about chiefly from substitution by other cereals, primarily sorghum, millet and maize and wheat imports. If recent trends in wheat production and consumption continue in Africa, imported wheat will become a pan African staple food for most urban consumers when per capita incomes reach about US$1 000 (Morris and Byerlee, 1990). Such a precedent has already been set in tropical Latin America; in the Andean region of Chile and Peru, where production environments are similar to many highland zones in Africa, annual wheat consumption now averages 42kg *per capita*, 92 percent of which is imported. The government of Tanzania recently requested the FAO to assist in carrying out a study of the wheat sub-sector. Clearly, wheat policy is a burning food policy issue in the SADCC region (Morris, 1989).

6. The 1980s has been a decade of economic liberalisation. Despite the debate between the World Bank (1990c) and the ECA (1989) over the relative success of structural adjustment programmes,[4] there is widespread agreement that major policy reforms are needed in many SADCC countries, including the general need to free agriculture from the state (Lundahl and Ndulu, 1987). There is also widespread agreement that agricultural growth is essential for sustained economic growth and the alleviation of poverty in non-mineral and nonpetroleum-based economies.

7. Despite favourable aggregate food production growth in the SADCC region and maize surpluses in Tanzania, Zambia and Zimbabwe, malnutrition is a problem crying for policy attention by agriculturalists, nutritionists and community health workers in the region. The annual Food Security conferences have helped create an awareness in policy and academic circles that the causes of malnutrition cannot be addressed by a single discipline such as nutrition or agricultural economics. Likewise, malnutrition cannot be effectively combatted through the interventions of a single Ministry such as Health or Agriculture (The National Steering Committee on Food and Nutrition, 1990). Louis Msukwa, Director,

[4]Elliot Berg recently assessed the evidence on structural adjustment programmes in the 1980s. He concludes that "The evidence put forward by the World Bank that African countries with reform (liberalisation) programmes have done better than countries without them should not be rejected out of hand, though methodological problems do render those conclusions extremely fragile. Generally, the time is too short and the intensity of liberalising reforms too slight and partial to allow for any general judgment" (Berg, 1990. :7).

Centre for Social Research, University of Malawi, sums up the state of the art of malnutrition in the region:

> Social scientists, agriculturalists, technologists, all have to participate because the problem of malnutrition is multi-faceted. It has to do with technology, economics, as well as people's behaviour. The contribution of every discipline in the research programme is necessary. Not only will the various disciplines have to work together but researchers will have to work closely with the policy makers and implementers. This is the only way we can avoid the past mistakes -- preaching to people to eat more meat when they have no access to meat. Research as far back as 1938 (in Malawi) has shown that the problem was not protein but calorie deficiency (Msukwa, 1990. :261).

Three conclusions flow from this overview of food and agriculture in the SADCC region. Each has implications for agricultural research priorities. First, an agricultural-led industrial growth strategy is essential for the success of structural adjustment programmes, sustained economic growth and the alleviation of poverty. But in the three food surplus countries -- Zambia, Tanzania and Zimbabwe -- where maize is the dominant staple crop, maize cannot fuel widespread growth in the agricultural sector in the 1990s, just as rice did not provide an engine of growth in food surplus Asian economies during the 1980s. Thus, agricultural research has a powerful role to play in generating new technology to create new income streams to increase agricultural growth, speed rural diversification and increase agricultural exports as part of structural transformation.

Second, because of rapid population growth, food supplies from domestic production and/or imports (commercial and food aid) will have to be increased in the region in the 1990s. Thus, agricultural research is essential for accelerating food production, especially in food deficit countries without a mineral base such as Botswana or a petroleum base such as Gabon. Third, increased food production and national food self-sufficiency cannot ensure adequate household food security in the SADCC region. Therefore, the policy question is how to increase household food security through home food production (especially for food deficit households), rural income generation through the selective expansion of traditional exports (*e.g.* cashew and sisal in Tanzania), nontraditional exports and rural small enterprises. Targeted, cost effective food transfers are required for those who cannot secure their food entitlements through their own resources or the market. But, with the exception of diamond-rich Botswana, no SADCC country has the foreign exchange earnings and administrative capacity to finance, mount and sustain a national food for work programme, school feeding programme, *etc.*

Each of these three food and agriculture policy challenges in the SADCC region in the nineties should be matched with forward-looking agricultural research policies. But given the mismatch between available government revenues for agricultural research and research "needs," how does a Director of a national agricultural research system (NARS) decide on research priorities in these three areas? More specifically, how do farmers in less favorable areas, with little political influence, make their research needs known to agricultural research managers? Finally, how can nutrition and household food security needs be incorporated into research priority-setting, especially in marginal areas where rural people generally have little voice in influencing research and extension programme priorities. If food security is incorporated into quantitative research priority-setting exercises, how much weight should be given to food security? For example, in the on-going priority setting exercise in the NARS of Malawi, the priority-setting team has assigned a weight of 15 percent to household security goals and 85 percent to efficiency goals. (Mkamanga, *et al.* 1990). Is 15 percent the optimum weight?

THE ROLE OF NUTRITION IN AGRICULTURAL RESEARCH: HISTORICAL PERSPECTIVES

Four insights emerge from an overview of nutrition research in Africa since the anthropologist Audrey Richards published her landmark study of hunger among the Bemba in Zambia in 1932 (Richards, 1932). The first insight is that, with only a few exceptions, over the past 50 years nutrition research has been dominated by medical practitioners, nutritionists, geographers and anthropologists. Agricultural economists and economists are latecomers to research on nutrition.[5] Several agricultural researchers worked on nutrition and household food insecurity indirectly for decades through research on what were considered "famine" crops such as cassava, and crops for dry areas, *e.g.*, sorghum and millet. Second, some of the current research on household food security can be described as "old wine in new bottles." For example, the pioneering work on seasonal hunger, by Richards, (1932); followed by Hunter (1967), and many others was basically addressing household food insecurity in less favorable areas. Also, current research on the nutritional effect of the commercialisation of agriculture (cash-cropping) was preceded by the massive study of cocoa villages in western Nigeria in the fifties. Collis, Dema and Omololu (1962) found that families producing cocoa were in worse condition from a nutritional point of view than subsistence families not producing cocoa. Third, research on cassava, sorghum and millet has

[5]The sparse literature on nutrition studies by agricultural economists from 1950 to 1970 includes Haswell's (1953) study of seasonal hunger in the Gambia, Joy (1967); Smith (1975) and Simmons (1976).

been underfunded for some sixty years.[6] Fourth, some of the early research on seasonal hunger in the 1930s identified inadequate calorie intake, especially just before harvest, as the greatest nutritional problem.[7] But with the post World War II palaver over protein as the overarching global nutrition problem, the centrality of calories only reemerged in the 1970s with the publication of Sukhatme's (1970) pioneering survey of 5 000 families in Calcutta. Sukhatme found that 95 percent of the families consuming adequate calories were also meeting their protein needs.

We shall now examine attempts to improve household food security and combat malnutrition through research on high protein maize, action programmes to expand the use of cassava and the introduction of a new crop, amaranth, that is high in protein. We shall start with maize. In the 1950s and 1960s, international professional opinion held the view that the shortage of protein was the single most important nutrition problem in the Third World. In fact, the discovery of a mutant gene referred to as opaque-2 at Purdue University in 1963 touched off a long term research programme to improve the protein content of maize through plant breeding.[8] Research on high protein cereals was initiated by CIMMYT and ICRISAT researchers[9] in the heyday of the Green Revolution in the late 1960s and early 1970s when many scientists believed that there was "ample proof that technology could solve food problems in developing countries" (Cantrell, 1990. :2). In fact one nutritionist reported at an international conference in 1975 that the discovery of the opaque-2 gene's effect on nutrition "fired the imagination" of maize breeders, biochemists and nutritionists who believed that it might also offer a "means of correcting social ills as well, mainly by lessening competition between increasingly scarce and expensive protein supplies between the haves and have-nots" (Altschul, 1975).

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[6]Hugh Dogget, the doyen of sorghum researchers in Africa, reports that "In 1946, when I was appointed a government botanist in Tanzania, there were three people working on cotton at my research station . . . But nobody seemed to be paying much attention to sorghum and it was widely grown in the area. So I worked on sorghum from Saturday to Thursday and rice on Fridays." (Quoted in Fisher, 1986). Also, see Norman *et al.* 1988 for a historical review of sorghum research in Nigeria and Botswana.

[7]Msukua reports that Platt's pioneering but unpublished study of nutrition in Nkhotakota district and two urban centers in Nyasaland (now Malawi) revealed that, in all the survey areas, the consumption of protein was enough to meet daily requirements, but there was a shortage of calorie intake over the entire 10 month survey period. In the villages, the largest overall calorie deficit was in January (-28.5%), just before harvest (Platt, 1940. cited in Msukwa (1990, :254).

[8]The opaque-2 gene increases by 50 percent the content of two essential amino acids in maize (lysine and tryptophan) and hence increases the protein content of maize.

[9]ICRISAT dropped its research on high protein sorghum after a few years.

The drive to increase the protein content of maize was popularly known as the Quality Protein Maize (QPM) programme. But formidable technical problems emerged in early trials of maize with opaque-2 genotypes including the basic fact that these varieties yielded less than maize with normal germplasm. Also, the grain characteristics of these high protein maize varieties were unacceptable to many consumers. But through assiduous plant breeding research, many of these technical problems were solved and by the late 1970s, a wide range of tropical QPM (quality protein maize) varieties were available. By 1988 the yield gap had been almost closed and at trials at 69 of 80 locations, QPM varieties yielded as much or more than the normal checks (Cantrell, 1990).

Nevertheless, there are several important economic constraints on farmer adoption of quality protein maize. Ron Cantrell, recent head of CIMMYT's maize programme, offers this cool assessment of QPM in his unpublished paper "Quality Protein Maize: A Better Lunch but not a Free One" (Cantrell, 1990).

> Other countries have experimented with QPM germplasm, but the nine I have mentioned are the only ones that have released QPM varieties, none of which are grown on more than a few thousand hectares, if that much. I suspect that the limited adoption of this germplasm, at least in developing countries, often has little to do with its appearance or performance. The main obstacle in my opinion is the high cost of promoting QPM germplasm among farmers and of ensuring that the grain they produce can move smoothly through market channels to consumers. (Cantrell, 1990. :5).[10]

Meanwhile research continues on QPM at Purdue and CIMMYT. Several scientists believe that it may prove to be an efficient livestock feed in Latin America. Nobel Laureate Norman Borlaug is still a firm believer in QPM. He has recently convinced President Jimmy Carter and the government of Ghana to introduce QPM in the Global 2000 Programme in Ghana.

Cassava represents the second commodity which plant breeders, agronomists and extension workers have given priority in less favourable areas. This is understandable because "cassava research is virtually alone in being able to be targeted on small-scale farmers in marginal agricultural areas" (Lynam *et al.* 1989. :105).[11] Cassava is a new world staple that was introduced into Africa long

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[10]The economic issues that Cantrell refers to are two fold. First, because hybrid QPM seed has to be replaced every year by farmers, it follows that farmers in marginal environments will hesitate to take on the added cost of purchasing hybrid maize seed every year rather than using open pollinated varieties from the family granary. Second, it is difficult for farmers to gain a premium for QPM over local maize in rural markets where grain is sold in small quantities.

[11]See Sarma (1989); Dorosh (1989) for a review of cassava research.

before colonial research systems were established around 1910 to 1920. Colonial powers promoted cassava in famine-prone areas and today it accounts for about one-quarter of the calories in average diets in Angola, Mozambique and Tanzania. Without question, cassava is ideally suited to mixed cropping but there are many processing, marketing, demand and policy issues that constrain the use of cassava in combating household food insecurity. For example, UNICEF developed a cooperative agreement with IITA (International Institute of Tropical Agriculture (Nigeria) in the mid 1980's to diffuse IITA's high yielding cassava varieties as a means of improving household food security. But UNICEF quickly learned that IITA's high yielding cassava varieties that were performing well in Nigeria's ecosystems had to be adapted through applied research in technology borrowing countries. UNICEF has gradually learned how to deal with the technical and economic issues surrounding the cassava food system (Toole, 1988). In Tanzania, UNICEF no longer uses cassava as the primary intervention in improving household food security. It now focuses on a broad range of interventions (*e.g.*, health, water), including cassava and other crops to improve family food security and welfare.[12]

The third commodity, amaranth, is a plant of potential use in combating household food insecurity because of its high protein quality (Vietmeyer, 1986). But amaranth is not well liked in many third world countries, including Zimbabwe, where it is called pig weed. But amaranth's protein content of 15 to 16 percent (9-10 percent for maize) has aroused the attention of researchers in China, Peru, Thailand and Kenya. Yet Kenyans are reluctant to grow or consume the grain. Several university of Nairobi researchers report that until amaranth is accepted in the United States it will not be accepted in Africa.[13]

In short, the saga of Quality Protein Maize illustrates the point that the improvement of human nutrition through plant breeding has "proven to be an elusive goal" (Tripp, 1990; Pinstrup-Andersen 1990). The promotion of cassava illustrates the need for research on cassava processing, marketing and effective demand, before pushing ahead with cassava action programmes to improve household food security. In the final analysis, the aggressive promotion of "technological bullets" of quality protein maize, cassava or new crops such as amaranth should be replaced by a food systems approach supported by research on marketing, processing and consumer preferences.

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[12]Latin America's experience with cassava points up the need to keep effective demand, processing and marketing considerations foremost in cassava action programs designed to improve household food security (Lynam *et al.* 1989).

[13]*Economist.* January 27, 1990. :88.

THE PAYOFF TO INVESTMENT IN AGRICULTURAL RESEARCH

Research priority-setting is now a "hot" topic in agricultural research circles. Part of the reason for its sudden popularity is donor uneasiness about past and future payoffs to investments in national agricultural research systems in Africa compared with alternative investments in agricultural extension, roads, and credit for private firms, to speed market liberalisation.

But the SADCC region is unencumbered by evidence on the payoff to agricultural research. In fact, studies of the rate of return (ROR) to investment in agricultural research in the SADCC region and in Africa are as rare as the white rhino. For example, there are only four published rate of return studies in sub-Saharan Africa as compared with 25 in Asia and 66 in Latin America (Daniels, *et al.* 1990). The most recent ROR study (the fifth in Africa) was completed by Daniel Karanja, an agricultural economist from KARI, the NARS of Kenya. Karanja computed the returns on investment in hybrid maize research in Kenya over a 33 year period, 1955 to 1988 (Karanja, 1990). Research on hybrid maize was initiated in Kenya in 1955 and the first hybrid maize variety, H-611, was released in 1964 after a decade of research. Subsequently 20 more hybrid varieties were released over the 1964-88 period. To carry out his ROR study, Karanja dug through the archives in Kenya for five months and computed the total cost of research on hybrid maize over the 33 year period, 1955-88. He then estimated the area planted to hybrid maize by district, and the increase in yield attributed to maize research, in order to figure out the increase in maize output, year after year, over the 33 year period. The costs and benefits data were then used to compute an average ROR (rate of return) on investment in maize research. The average ROR measures the average benefits that accrue from all previous expenditures on maize research over the period studied (1955-88). The average ROR over the 33 year period was found to be 68 percent.

But Karanja's ROR study only reports what happened in the past (*i.e.*, 1955-88). The ROR of 68 percent can be used to inform policy makers that maize researchers have been creative and productive in the past. But the average ROR of 68 percent cannot prescribe how much Kenya should spend on maize research or research on any other commodity, in the future. To answer these questions, extant research is required on the likely future payoff to a particular commodity research programme or research problem such as soil conservation.

Karanja's study shows unequivocally that research is not a luxury -- it can be a profitable investment. For example, the World Bank uses a minimum ROR of 10 percent on projects such as roads, dams and irrigation. One can conclude that the 68 percent ROR on public investment in hybrid maize research has yielded high returns to farmers and consumers in Kenya. But hybrid maize varieties were rapidly adopted because of complementary public investments in agricultural extension, credit, roads, and public and private investments in seed distribution. These activities represent a system of interactive and complementary investments that contributed to the high return on investment in maize research.

INCORPORATING NUTRITION AND HOUSEHOLD FOOD SECURITY ISSUES INTO FOOD SECURITY POLICIES AND AGRICULTURAL RESEARCH PROGRAMMES

We shall examine five approaches to incorporating malnutrition and household food insecurity into research and policy agendas. The first approach focuses on policies and public action to help people gain control over their food entitlements. This approach is spelled out in a recent book *Hunger and Public Action* (1989) by two economists -- Jean Drèze and Amartya Sen. The second approach comes from an economic geographer, Barbara Harriss, who boils research priority setting down to a simple matter of agricultural scientists "getting their politics right" and orienting their research to mass welfare objectives:

> Historical experience in countries as different as Sri Lanka, China and Israel shows that nutritional considerations are not needed to be introduced formally into agricultural research in the way currently being advocated, when agricultural scientists are socially and politically responsible and have furthermore oriented their research to mass welfare objectives and nutritional impact. Moreover, malnutrition can be all but completely eradicated by policies which are sanctioned, endorsed and implemented by the state, unaccompanied by special nutrition-oriented agricultural research as is being proposed (Harriss, 1987. :34).

The third approach to nutrition priorities in agricultural research is to "shoot from the hip" as Michael Lipton and Richard Longhurst do in *New Seeds and Poor People* (1989). To Lipton and Longhurst its all very simple. Research on Green Revolution varieties is for sub-Saharan Africa's poor "the only real hope. It is the only game in the country side" (1989. :359). The authors pinpoint the crops that need research attention -- the poor people's crops' that support, both as producers and consumers, large numbers of nutritionally vulnerable farming households: cassava, yams, cocoyams, sweet potatoes, bananas and plantains, sorghum and millets. Lipton and Longhurst criticise past research efforts because they have:

> greatly emphasised high-cost production of rice on large irrigation schemes, of tropical wheats, of fashionable crops such as soybeans, and of hybrid maize, a crop much eaten by the poor (though more in urban than in rural places), but vulnerable in years of low rainfall, and competitive for land with safer crops that have suffered from relative neglect by researchers (Lipton and Longhurst, 1989. :362).

In a review of the Lipton/Longhurst book, Robert Herdt notes that the authors "seem to believe that just about any desired social change can be produced by changing plants" (Herdt, 1990. :838). Also, Lipton and Longhurst castigate hybrid maize as a "fashionable" crop in Zimbabwe and throughout the SADCC region,

even though research progress on hybrid maize has outstripped that of sorghum and millet over the past 40 years. For example, Shumba reports that at the Makoholi Experiment Station in the low rainfall area (Natural Region IV) of Zimbabwe, "maize always out yields the small grain cereals (sorghum and millet). Averaged over a four year period, maize yields were almost double those of pearl millet, the highest yielding small grain cereal" (Shumba, 1990. :8). Moveover, the expansion of hybrid maize in marginal areas is reinforced by the "preference of maize as a starch (source of calories) and cash source, the ease of preparation of maize flour and susceptibility of small grains (sorghum) to bird damage . . . (Shumba, 1990. :7).

The fourth approach to integrating malnutrition into agricultural research priorities was pioneered by the United Nations and the CGIAR in the early 1980s when they joined forces to examine how to incorporate nutrition into the everyday work of the CGIAR centers. The results of these early deliberations are reported in (Pinstrup-Anderson, Berg and Forman, 1984). But to date there are few nutritionists employed in the IARC's.

The fifth approach to addressing nutrition and household food security draws on recently developed quantitative techniques for agricultural research priority setting. There are four common quantitative priority-setting methods available to NARS and regional organisations such as SACCAR in Southern Africa and INSAH in the Sahel:

1. **Weighted Criteria (Scoring) Models.** Several studies have established multiple criteria for ranking commodities (or research areas) and then weighted the individual criteria to arrive at an aggregate priority ranking. The relative weights attached to each criterion to arrive at the final list of research priorities are sometimes left unstated and sometimes made explicit. This procedure is often called a scoring model approach. A few studies also have used a crude scoring model, called congruence analysis, in which all weight is placed on the criterion value of production. For example, if 25 percent of the value of agricultural GDP is derived from tobacco, 30 percent from cotton, 15 percent from tea and the balance of 30 percent to food crops, then the same proportion of the research budget should be assigned according to these percentages.

2. **Benefit-cost Expected Economic Surplus Analysis.** The benefit-cost approach to selecting research priorities has been used in different forms. Most studies have employed consumer-producer surplus analysis and have incorporated "expert" opinion to determine projected research impacts, adoption rates, and probabilities of research success. These studies provide estimates of the economic efficiency and distributional implications of agricultural research resource allocation. They typically calculate benefit-cost ratios, internal rates of return and net present values for alternative types of research or for research on difference commodities. These analyses may or may not include regional and

international research spillovers and the effects of domestic pricing policies on research benefits.

3. **Mathematical Programming.** Mathematical programming is another alternative for research selection. It relies on mathematical optimisation to choose a research portfolio through maximising a multiple goal objective function to the weighted-criteria model but selects an 'optimal' research portfolio rather than simply ranking research areas.

4. **Simulation.** Finally, simulation has been used to identify and select research priorities. For example, Pinstrup-Andersen and Franklin built a mathematical model to project the contributions and costs of alternative research activities. They established goals and then identified changes in supply, demand for inputs and demand for output needed to meet those goals. They identified needed technologies, time and financial costs, and the probability of research success and adoption (Norton and Pardey, 1987).

A research team engaged in priority-setting requires information on the national development goals and the relative weights to attach to these goals. Next, the research needs of the country should be debated by the scientific community and displayed by commodity, research problem (*e.g.*, striga, soil fertility) and location. For example, the Gambia has recently completed a priority setting exercise using the scoring approach (Cessay *et al.* 1989).[14] Similar studies are underway in Malawi (Mkamanga *et al.* 1990)[15] and Tanzania (Teri *et al.* 1990). But, as Emil Javier, former Minister of Science and Technology in the Philippines points out, "priority-setting methodologies have not found much practical use yet in NARS." The reasons for the lack of use of quantitative priority-setting start with some basic questions. First, even if national development goals are clearly stated in a development plan, the assignment of relative weights to favorable versus less favorable areas or to commercial versus communal farmers is a "political act beyond the competence of the research community" (Javier, 1987, :1). It is obviously difficult for political leaders to decide on public investment programmes (*e.g.*, research, roads and production campaigns) in less favorable areas such as the maize belt in Zimbabwe, the central highlands of Kenya or the United States. For example, IRRI agricultural economists found that the expected yield gains from rice research in favourable rainfed areas in Asia were twice those in less favorable rainfed areas (Barker and Duff, 1986).

Randolph Barker recently summarised some of the reasons why priority setting exercises have not been institutionalised by NARS:

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[14]The scoring approach was developed at ISNAR (Norton and Pardey, 1987).

[15]Editor's note: See chapter 20 in this volume.

- choosing weights for national goals (favorable versus less favorable areas) involves subjective political as well as scientific judgments;[16]
- it is difficult to handle noncommodity priorities such as erosion, integrated pest management, policy analysis (and household food security);
- it is difficult to handle the sequencing of competing research programmes;
- it is hard to "guestimate" the level of expected scientific and financial capacity of a NARS ten to fifteen years down the road;
- it is difficult to guess what type of technology will become available from neighbouring NARS and regional and international systems; and,
- it is difficult to estimate future demand prospects for commodities in regional and international markets (Barker, 1988).

The only published priority setting study in Africa is for the Gambia (Cessay *et al.* 1989). This joint ACIAR/ISNAR study used a simple scoring model to decide how to allocate the 20 person years of scientific talent in the national research system. However, the team found it difficult to rank the 21 major commodities in the Gambia other than listing them in groups of seven under categories of high, medium and low research needs. In Kenya, the National Agricultural Research Project carried out a long-term planning exercise and identified high, medium and low research priorities but these were not matched with likely available human and financial resources. As a result, "this made subsequent short-term planning and programming very difficult" (ISNAR, 1990. :v).

These illustrations point out why very few NARS and regional research organisations such as SACCAR are presently using quantitative priority setting approaches. But the scoring model has great appeal to NARS managers and scientists because it is simple, relatively quick to execute, (three to six months) and it is not data intensive. Moreover, the scoring model approach encourages scientists to discuss their problems and exchange views on research priorities and likely future technical payoffs. One can sense the enthusiasm for the scoring model in the paper describing research priority setting in Malawi (Mkamanga *et al.* 1990).

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[16]After seven years of farming systems research in Botswana, the FSR team led by David Norman has generated some valuable insights on technical payoffs in less favorable areas. See Heinrich *et al.* 1990a., 1990b.

But a cautionary note is needed at this juncture. Priority setting exercises that are carried out under the direction of agricultural economists may oversell the various models much like economists have done in many FSR projects in Eastern and Southern Africa. And the same phenomenon may come into play with rate of return (ROR) studies of agricultural research. There is a danger that agricultural economists, armed with their micros, will undertake priority setting and ROR studies and fail to tackle more important political economy-type problems such as financing agricultural research. For example, it is well known that a critical problem facing agricultural research in Zimbabwe is funding on-farm research. Shumba (1990) reports that because of funding difficulties and transport problems, Zimbabwe has reduced the number of on-farm trials by "51 percent between 1987-88 and 1990-91" (Shumba, 1990. :9)[17] How will a national priority-setting exercise help address this problem? Critical questions such as financing research and paying scientists a living wage are tough issues that cannot be addressed by quantitative priority-setting exercises.

Nevertheless, the scoring model has great appeal and it should be encouraged in the SADCC region. Veteran researchers in national agricultural research systems can draw on the results of these scoring models as they form judgments about future payoffs to new lines of research, market prospects for traditional and nontraditional exports and the mix of commodities to achieve multiple national objectives such as household and national food security, foreign exchange earnings, employment generation and regional balance.[18]

Turning to research priorities in the SADCC region in the 1990s, because of rapid population growth, research should be pursued on food crops such as maize in favorable areas and maize, sorghum, millet and cassava in unfavorable areas. At the same time, research on economic diversification in marginal areas should be expanded in order to develop/borrow new technology capable of generating new income streams and employment for rural people. Finally, action research on household food security should be pursued through multi-disciplinary research teams consisting of nutritionists, community health specialists, social scientists and technical agricultural scientists such as agronomists.

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[17]Editor's note -- see Chapter 21 in this volume.

[18]For example, the government of Kenya pragmatically adapted a policy document in 1986 that identified seven "essential" commodities that formed the core of its food and agricultural policy: maize, wheat, milk and meat for food security; horticultural crops for both export and home consumption; and coffee and tea for raising farm income and foreign exchange (Kenya, 1986).

THE ROLE OF RESEARCH IN ACCELERATING AGRICULTURAL EXPORTS AND PROMOTING RURAL DIVERSIFICATION

Rural diversification programmes designed to increase rural incomes, jobs and economic access to food, should not be held up until research findings are available from household food security studies. The simultaneous pursuit of research on rural diversification and household food security research is mutually reinforcing.

We now turn to the role of agricultural research in speeding rural diversification and increasing economic access to food, because at the end of the day, raising rural incomes across the board is a powerful avenue to increasing household food security. Table 1 reveals that Africa's share of world exports declined for 9 of 15 nonpetroleum commodities over the 1970-87 period. This explains why tough-minded decisions are required on how to rebuild Africa's export commodity research capacity, drive down the cost of production, regain home markets from international competitors, develop new commodities for export (ostrich hides and meat, crocodile skins, jojoba, *etc.*) and ferret out windows of opportunity in regional and international markets.[19] Agricultural research should give high priority to rural diversification, the selective expansion of export commodities and the development of nontraditional exports in the 1990s. Public and private sector investments are crucial when going head-to-head with Asian competitors to regain African and European markets (*e.g.*, rice, groundnuts and edible oils).

But Africa lags behind Asia in its capacity to organise, execute and deliver new technology to enable agri-business firms to exploit new markets at home and overseas. For example, Malaysia is currently spending six times more than Nigeria each year on oil palm research. Malaysia has vigorous R&D underway in the development of a) new uses for natural rubber; b) methyl esters of crude palm oil and crude palm stearin as a diesel fuel for vehicles; c) firewood from oil palm and cocoa logs; d) furniture from palm wood; e) mini papayas for the Japanese market; and, f) special cooking and frying oils for the Korean market (PORIM. 1985). Thailand is aggressively promoting pineapple exports (in competition with the Cote d'Ivoire) for European markets. Public sector research and private banks have teamed up to shift Thailand's traditional emphasis on supplying maize to the poultry industries in Taiwan and Japan, to feeding maize to broilers at home and exporting broiler meat to Korea, Taiwan and Japan. Thailand is now the third largest broiler exporter in the world following the United States and Brazil.[20]

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[19]The discussion in this section draws on Eicher (1990b).

[20]For a recent synthesis of agricultural diversification experiences in East Asia, see World Bank, 1990b. and Barghouti *et al.* (1990a).

Table 1
Africa: Agricultural exports as a percentage of world exports, 1970, 1980, 1987

Commodity	1970	1980	1987
Livestock	6,3	3,2	2,6
Fishery commodities	3,1	2,9	4,1
Coarse grains	1,5	0,7	1,7
Bananas	12,2	12,6	13,0
Sugar	4,5	5,2	5,5
Coffee	33,6	24,1	19,9
Cocoa beans	72,6	61,6	58,7
Tea	9,5	9,9	10,6
Spices	15,0	6,7	5,8
Groundnuts	27,7	24,3	21,1
Palm oil	57,3	27,3	18,4
Tobacco	3,4	5,2	4,8
Natural rubber	7,5	5,2	5,7
Cotton	11,0	8,3	7,9
Sisal	47,7	31,8	25,5

Source: UNCTAD, 1990.

Turning to agricultural diversification, the starting point is to realise that diversification is needed in both food exporting countries, such as Zimbabwe, and in the cocoa-dominated economies of Ghana and the Cote d'Ivoire. But advocates of the expansion of agricultural exports in the 1990s will come under heavy attack. For example, the widely-cited paper *African Alternatives to Structural Adjustment Programmes* by the Economic Commission for Africa (ECA 1989) reports that devaluation fails to stimulate production of exportable goods or import substitutes because of "technological rigidities." But surprisingly this pessimism is not shared in Asia where rice farmers from Thailand, Vietnam, Pakistan, *etc.*, are on the lookout for new markets for rice in Africa and in Thailand where farmers are developing new nontraditional exports such as broilers.

Diversification is not a short term affair. Research on diversification and pilot projects on new products such as jojoba will not pay off until the early part of the 21st Century because, on the average, it takes about ten years to develop, test,

and calibrate improved crop technology for micro environments. It takes about 15 years to develop, test and release improved animal technology. Nevertheless, the payoff to a specific investment in basic science, applied research and agricultural extension will be low unless these investments are coordinated and careful attention given to the sequencing of investments in strengthening the institutional base for export production, processing and trade. Such coordination and sound research management are hallmarks of Asia's market penetration in Europe and Africa. For example, Malaysia's national palm oil research system has 60 percent of its scientific staff engaged in research, while Nigeria has 31 percent in research and 69 percent in administration and peripheral tasks (ISNAR, 1988. :94). Nigeria's bloated administrative structure for palm oil research illustrates the basic point that the solution to Nigeria's export malaise is not simply one of spending more money on research. The challenge is to find ways to increase the productivity of agricultural research systems in Africa through improved coordination, management and sequencing of public and private investments in science, R&D, extension and international marketing.

Africa's experience with agricultural diversification also proves that public, private and joint public/private R&D organisational models are all capable of achieving agricultural diversification (Blackie, 1989).[21] For example, Kenya's 150,000 member Kenya Tea Development Authority (KTDA) provides solid evidence that a public sector parastatal can be a highly successful organisation (Lamb and Muller, 1982). Likewise, the 80,000 farm families producing cotton in the Mali-Sud cotton project in Mali illustrates the payoff to a multi-country, vertically linked cotton research and extension system that is supported by public and a private agencies from France (Lele, van de Walle and Gbetibou, 1989). The private investment of Zimbabwe's 45,000 families engaged in smallholder cotton production is supplemented with assistance from a public cotton marketing board.

In short, there is a critical need for food surplus countries such as Zimbabwe to push ahead with agricultural diversification as an important route to increasing rural household food security. The expansion of smallholder cotton production in Zimbabwe is one of the best kept household food security secrets in the SADCC region. Although Zimbabwe has been lionised for its smallholder maize production success, a study of cotton and food security would probably reveal that

[21]Even though Thailand is a consistent rice exporter, it has aggressively pursued agriculture diversification to generate new sources of agricultural growth. For example, in 1970, four crops – rice, rubber, maize and cassava products – comprised about 85 percent of its agricultural exports. By 1985, this share had fallen to 65 percent because Thai producers branched out to a wide variety of nontraditional products such as orchids, canned pineapple, coffee, canned fish and dried cuttlefish (World Bank, 1990a. :18). Malaysia is now exporting a sweet mini-papaya to Japan and Taiwan, after 12 years of horticultural research and market research about Japanese food preferences.

household food security is higher on farms growing cotton than subsistence farmers producing maize or sorghum.[22]

New Zealand's kiwi fruit industry illustrates the need for the architects of diversification programmes to invest heavily in international marketing to ferret out windows of opportunity in international markets. Sometimes, these windows are "open" for only two to three weeks.[23] The seed of the kiwi fruit (*Actinidia deliciosa*) was introduced into New Zealand from China in 1906 and was promoted under the name 'Chinese gooseberry.' But it stagnated and, by 1953, only 31 hectares were cultivated. New Zealand exported small quantities in the 1950s and exports gradually started to pick up by the 1960s when the name of the fruit was changed to "kiwi fruit" and the Kiwi-fruit Marketing Authority was established. Aggressive international marketing campaigns paved the way for the introduction of Kiwi fruit to European and North American consumers. The United States and other countries have begun production, but New Zealand, with around 24,000 ha under cultivation, still has the lion's share of the world market (Barghouti, *et al.* 1990. :95).

Kenya's success in expanding horticultural exports (fruits, vegetables, and cut flowers) should be closely studied by SADCC states. In 1967, Kenya created the Horticultural Crops Development Authority (HCDA) to develop its horticultural industry. The subsequent growth of local consumption and exports has been extraordinary, especially for flowers. In fact, cut flowers increased from 458 tonnes in 1972, to 8 164 tonnes in 1986. Cut flowers are the leading foreign exchange earner among the air-freighted horticultural exports (Schapiro and Wainaina, 1989). Around 100 large growers and 5 000 to 7 000 smallholders are currently producing horticultural products for some thirty countries. About 60 percent of the volume comes from smallholders, mostly on farms of less than four hectares in total size, with about 0,25 to 1 hectare of land in export crops (Lele, Kinsey, and Obeya, 1989). About 90 percent of Kenya's horticultural products are consumed locally in urban areas and increasingly in rural areas. Yet Kenya's horticultural export success is not attributable to any single factor such as good weather or favourable market opportunities. Two researchers recently concluded that:

> "Government-sponsored research, training, monitoring and other activities facilitated the expansion of the horticultural sector. However, it is what the Government did not do -- create a large bureaucratic structure and interfere to a significant extent with the

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[22]In Mali, Josue Dione found that families producing sorghum and cotton have generated per capita grain equivalents three to four times higher than families producing millet (Dione, 1989).

[23]For example, Israel is developing high quality melons to slip into European markets during a few weeks during the winter. Israel air freights melons and other fruits to Europe via 747 airplanes and brings home new automobiles on the return flights.

market mechanism -- that is most impressive. Without this combination of government assistance and government restraint, it is highly unlikely that the expansion in horticultural exports would have been as rapid or as large" (Schapiro and Wainaina, 1989. :93).

AGENDA FOR THE FUTURE

This paper has stressed the need to examine household food security and malnutrition in historical context and to learn from past experience. Increasing the protein content of cereals through plant breeding remains an elusive goal. There is much wisdom in Barbara Harriss' dictum that scientists should "get their politics right" in focusing their research on poor people's crops in less favorable areas. But this simple guideline does not tell us how much research effort in human and financial terms should be spent on research in favourable *versus* less favourable areas or even on crops versus livestock within less favourable areas. To address these tough questions, we turn to economists and analyse whether some of the recent work on priority setting in national agricultural research programmes can be of use to the managers of national research systems. Research priority setting is now a hot topic in agricultural research circles, partially because many donors helped expand the total size of national agricultural research systems in the 1980s beyond the capacity to finance these systems from national sources for the foreseeable future. This explains why priority setting exercises are being used to "slim down" NARS and make them more efficient and sustainable (Eicher, 1989, 1990a., 1990b.).

In the 1980s, donors provided generous project assistance to many NARS of Africa under the general guideline that African countries should spend one to two percent of their agricultural GDP on agricultural research. But over the course of the 1980s, scientific, political, bureaucratic and donor interests interacted to inflate the size of many NARS and enabled some NARS directors to postpone tough decisions on priorities in terms of the number of scientists, number of research stations and number of research projects. Also, during the eighties, the ready availability of foreign aid for NARS served as an "escape valve" for some NARS administrators who were reluctant to make hard scientific and financial decisions on the size of the scientific enterprise and research priorities. Many African countries are making some of the same mistakes that Asian and Latin American countries made in the 1960s and 1970s when the emphasis was placed on expanding the size of NARS to the point where there were many research facilities and researchers "without programmes" (Ruttan, 1987. :78). With this background, it is easy to understand why some donors are raising some tough questions about bloated NARS and the questionable payoff to agricultural research. This, in turn, has sparked a great deal of interest in priority setting and rate of return studies.[24] The priority setting technique that

[24]For a global survey of ROR studies see R. G. Echeverria. 1990.

is most appropriate for Africa is the simple scoring model that has been used in the Gambia and is currently being tried on an experimental basis in Malawi and Tanzania. The great advantage of the scoring model is that it promotes communication and dialogue among scientists in a NARS. But conceptual and empirical work needs to be done on priority setting and in figuring out how to incorporate household food security issues into these exercises.

In practical terms, this means that there is a need for joint conceptual and empirical work by nutritionists, agricultural scientists and social scientists on both the development of improved priority setting approaches and village studies of malnutrition.[25] Yet, I am not aware of a single team composed of a nutritionist, social scientist and agriculturalist that is presently carrying out village studies of household food security and malnutrition in the SADCC region. Forming a partnership between nutritionists, social and technical scientists and community health researchers is a challenge for universities in the SADCC region in the 1990s. Until more information is available from these joint studies, policy makers and agricultural research managers must rely on experience and judgment to find the right balance (mix) between support for primary food production such as maize, secondary foods such as cassava and groundnuts, and higher value crops such as soybeans, fruit and vegetables. In closing, the recent World Bank's agricultural diversification study in East Asia has some valuable insights for Africa:

> Allowing the market to be the sole determinant of this mix (of crops) runs the risk of undervaluing foods for the poor and food security in general, whereas high-income consumers and export markets are well served. Concentrating too much on basic foods, however, can lead to rigid production systems that are unable to adjust rapidly to surpluses and discrimination against earning foreign exchange"
> (World Bank, 1990a. :17-18).

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[25]See Weber *et al.* 1988 for a discussion of how research results from studies undertaken by the MSU Food Security cooperative agreement have been used to provide an information base for policy makers.

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