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INTRODUCTION

METHODOLOGICAL ISSUES IN FOOD CROP IMPROVEMENT IN EASTERN AND SOUTHERN AFRICA

By

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Historical Background

Crop improvement, defined here as the series of research activities which result in the production of new germplasm and crop management practices that benefit producers and consumers of a crop, has a long history in Eastern and Southern Africa. A large amount of scientifically rigorous work has been conducted, often with relatively rudimentary facilities, since the first research stations were established (e.g. Umbeluzi station, Mozambique, 1903). Research concentrated at first upon cash and particularly export crops, with a few notable exceptions such as the Tanzania sorghum programme started in 1947 (Doggett, 1970). Research on subsistence food crops has developed mostly since 1960, and much of it after Leakey's (1970) review. During the past decade five trends in food crop research have developed, and it is these trends that provide the background of this workshop.

In most countries, improvement of subsistence food crops started with only one or two commodities of primary importance - often maize because of its extensive use in areas of high cropping potential and its popularity with the growing populations in urban centres (see Harrison, 1970). Early in the 1970s, the amount of resources devoted to sorghum research increased with realisation of the importance of this crop for the much larger areas of relatively low potential land in semi-arid environments, and for the generally poorer rural populations who live there. Mushonga describes in his presentation the new focus of sorghum and millet research in Zimbabwe since majority rule added to the research mandate a new type of clientele, the peasant farmer, who generally has lower potential land and different requirements for technology. Improvement programmes for grain legumes and for oilseeds were started partly as a result of concern for nutritional issues related to availability of protein and of concentrated calorie sources.

Still more recently, increased attention has been given to cassava and sweet potato research (which have a long but rather sporadic history in the region), partly because more farmers in Eastern Africa are turning to these crops as sources of food and cash income that are unaffected by the vagaries of government-controlled crop marketing systems (Kirkby, 1983).

In the near future we are likely to see this general trend extend to the formation of new programmes for other traditional crops that have been even more neglected by research. These include bananas and plantains (the staple food crops in large areas of Rwanda, Burundi, Uganda and Tanzania), and the indigenous species of leafy vegetables, which in many places provide in return for very few inputs an essential component of family diet. Papers by Osiru and Mukiibi, and by Kwapata, describe new research proposed in these two areas.

It is pertinent to ask whether there are lessons that those launching new research efforts should learn from longer established programmes. This may improve their prospects of developing technology that will be used by and benefit farmers within a reasonable period of time. This meeting was planned partly to provide a rare opportunity for them to do so.

Regional Cooperation

Indigenous research capacity in the region has gradually expanded as universities increased their output of agricultural graduates and greater numbers of postgraduates took up research posts with local institutions. Many research programmes are now staffed entirely by local scientists, and the participants invited to this workshop from ten countries are reasonably representative of the region.

Local staffing, largely responsible for the rise in interest in traditional food crops, has greatly increased the opportunities for planning and conducting sustained research programmes. It has not been accompanied necessarily, however, with adequate communication and sharing of technical experience among countries, despite many similarities of environment and cropping systems. The demise of the East African Community in 1977 had as one consequence the cessation of the biennial Eastern African Cereals Research Conferences, and as another the dismemberment of the East African Sorghum and Millets Improvement Programme (although the core has continued as the national programme of Uganda, described by Esele

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at this workshop). Since then most scientists have had few opportunities to meet, and more commonly during visits to an International Centre than to one another's countries.

Fortunately, the trend set by CIMMYT and CIP in initiating Eastern African regional programmes for coordinating national efforts on wheat and potato, respectively, has been followed by regional coordination for sorghum (SAFGRAD), maize (CIMMYT), highland oilseeds (IDRC) and cassava (IITA), and for groundnuts in Southern Africa (ICRISAT). These regional activities have considerable potential for exchange of germplasm, ideas and for peer group critique (e.g. Brhane Gebrekidan, 1982; ISAR, 1980). They cannot be expected, however, to address fully those methodological issues, particularly those of an interdisciplinary nature, which are common to the improvement of food crops in general.

Organisation of Crop Improvement

The third trend in crops research has been the organisational focus upon multidisciplinary crop commodity research teams. Typically, a full team would include a plant breeder, an agronomist and relevant disciplines from the plant protection field. Originally, only research on cash crops was normally organised in this manner, but now an increasing number of national teams for major food crops has been formed as research resources, particularly trained manpower, become available.

Formation of a multidisciplinary team is a necessary, but not sufficient, condition for ensuring that the improvement of a crop is tackled in a holistic manner with a rational set of priorities among objectives. Excessive specialisation during postgraduate training can make effective cooperation more difficult. Efficient use of limited resources of manpower in a country can present other problems for coordination, particularly where national responsibility for research rests with a government agency and many well-trained scientists reside in the university. The paper by Gebremariam Shekour discusses some of these issues for the case of Ethiopia, where an elaborate system of annual planning and evaluation meetings has been developed to coordinate research undertaken cooperatively by different institutions within a large and ecologically varied country.

A second organisational issue, related to the above, is the three-cornered relationship between a crop improvement programme, the extension service and farmers. The need for information exchange between crop improvement researchers and farmers is discussed in the next two sections. Another presentation from Ethiopia, by Adugna Haile, treats one approach to the subject and stimulated a lively discussion among participants.

Farming Systems Research

The fourth new trend in most countries has been the development of programmes for cropping systems research or farming systems research (FSR). This move represents a convergence of views of technically trained agricultural scientists who were conducting research to improve inter-cropping systems (see Keswani and Ndunguru, 1980) and of agricultural economists seeking a more appropriate role in technology generation than ex post evaluations. The introduction of FSR (reviewed by Collinson,
/to institutionalise a set of procedures
1982) represents an attempt/for developing useful new technology that should be more rational and realistic than if each commodity research programme were to continue pursuing, in isolation, a strategy for raising production of that commodity. The effect of the commodity orientation upon a programme's objectives is seen in crop substitution experiments aimed at removing interference from another crop commonly grown in association or in rotation with the commodity of interest (e.g. Tollervey, 1971).

Farmers do not plan their production of one crop in isolation from other enterprises, and a programme's objectives may change depending upon whether or not this fact is taken into account. (see Collinson, 1968 for an example). Some improvement programmes already do this, and some may feel that their current priorities, arrived at by good judgement on the part of technical staff alone, should be merely confirmed by formal FSR work. For example, Percy (1975) believed that most plant breeding and insect control research on cotton in Western Tanzania would not have been different had an explicit orientation towards farming systems been used, since new cotton varieties gave greater benefits under adverse conditions
/yield
found on farms than under maximum / conditions applied to most experiments. This occurred because a major selection criterion had been resistance to jassid leaf-hoppers, an important yield limiting factor especially for farmers

who can not afford insecticides. On the other hand, the same author considered that a FSR orientation would have changed the design of agronomic research, which had developed high yielding practices based upon increased labour inputs (e.g. for making ridges) that may not have been feasible. It is appreciated, now that peasant farmers experiment with new ways of growing crops, make introductions of new species or varieties (e.g. Nankumba, 1979) and show a keen interest in new technology from research stations if they appear to fit a need. That many existing agricultural recommendations have not been more extensively adopted by small farmers, and that crop production in Africa is failing to grow faster than human population, cannot be attributed only to deficiencies of extension and infrastructure: first the technology must fit the farmer's needs and situation.

FSR programmes are intended to complement crop improvement and other research station-based activities by conducting interdisciplinary on-farm research in defined areas of the country. By eliciting participation of farmers, they attempt to improve understanding of the constraints and under-exploited potential of the systems in the area, to identify opportunities for technology generation, and to test and if necesssary to adapt technology to local circumstances.

Gaining a better understanding of what one sets out to improve upon is common sense, but implementing this strategy can present several problems,
/for particularly in Africa where trained manpower/conventional research is still inadequate. Eicher and Baker (1982) have suggested that, since FSR depends for success upon there being strong commodity research to provide the bases of technical innovation, an overenthusiastic introduction of FSR could divert critical resources from crop improvement. Certainly, research institutions need to address the question of what constitutes a strong programme of crop improvement: is strength measurable in terms of budget and manpower, or rather by a programme's impact on the well-being of producers and consumers or its ability to make use of new information on farmers' research needs? Crop improvement and FSR need to cooperate closely, but their inter-relationships at present are neither well defined nor obvious. If the FSR programme is given complete responsibility both for providing priorities for crop improvement and for testing the products on farms, crop

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improvement researchers may become isolated from reality and less able to accept and incorporate unexpected information sent back from the farm level. At the same time, crop improvement programmes may find increasing difficulty in integrating national priorities with the more narrowly defined priorities identified at farm level, as more on-farm work reveals differences between farming systems that call for subsets of objectives and criteria for different groups of farmers. Crop improvement programmes require effective linkages at the national level to other disciplines besides those involved in on-farm research if they are to generate useful technology, particularly in the field of post-harvest equipment and food utilisation. For example, the sorghum breeder cannot necessarily decide alone, or even in conjuction with the FSR economist and agronomist, the appropriate grain type to use as a selection criterion in developing new cultivars for an area where farmers currently grow white grain types but

/bitter suffer serious losses to birds. Brown seeded/types that deter birds could be a better option but only if dehulling equipment, capable of producing a quality of grain that is acceptable to the consumer, can be manufactured and distributed (Forrest and Yaciuk, 1980).

Resource Efficient Agriculture

The fifth recent trend in research orientation is the emphasis given, for several reasons, to increasing production at relatively low levels of inputs. Sometimes this is due to a movement of population into drier, low potential areas of a country in response to pressures on land elsewhere (see paper by Onim for Kenya); sometimes to the enfranchisement of a poorer group of farmers previously ignored by research, as in Zimbabwe (see paper by Mushonga); sometimes to the concern that the benefits of agricultural

/to research should reach the poorest farmers; and sometimes/the shortage of foreign exchange for importing agricultural chemicals (Nyerere, 1983). Multilocation testing of new crop cultivars has long been the standard technique for taking account of the heterogeneity of soils, climate and pest distribution within a country - a national network of sites has been particularly well developed in Uganda (see paper by Esele). However, less productive soil types are typically underrepresented on experimental stations and other managed sites due to earlier emphasis upon large scale agriculture and cash cropping. Fertility levels and weed flora also tend to become unrepresentative of surrounding farms due to intensive management.

This has led to concernfor the adaptation and utility of varieties developed under and for high input conditions (e.g. IITA, 1982). The diamond design of treatments to verify the performance of a new cultivar and management practices under both recommended and under farmers' conditions is one technique now widely used to test for interactions before final release of recommendations. This 2^2 design was first popularised by Allan (1969) in Eastern Africa.

Evaluation of technology can assist the appropriate design of programme objectives by way of feedback, but a programme that sets out to develop resource-efficient technology probably would wish to introduce relevant criteria at an earlier stage and could start by examining existing systems from this point of view. Traditional low input systems are often highly complex and incorporate compensatory mechanisms which reduce risk of total failure in a poor season but which may limit responsiveness to more favourable conditions. In Somalia, climatically the harshest of the three countries reporting on sorghum research at this workshop, this crop is not only/food crop but also provides straw essential for feeding the livestock which generally comprise the more stable component of the farming system. Furthermore, much of the crop is ratooned to ensure a small second crop without need to recultivate during an unreliable rainy period, even though a second sown crop potentially could yield higher (see the presentation by Hashi).

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If these farmer strategies suggest, for example, that resource efficient improved cultivars may need to be different in habit from those developed under a high-yield objective, programmes need to ensure that internal allocation of resources reflects a logical set of priorities. This may include the decision as to whether to breed for two or more distinct sets of conditions, or to retain and advance carefully selected segregants for ultimate testing under the diverse range of conditions. Developing recommendations for sub-optimal conditions and low input levels is still a controversial topic, and may cause a crop improvement programme to devise its own novel set of selection criteria which the researchers have not necessarily met in text books of plant breeding.

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Similarly, when it comes to evaluating the technology, the disciplines involved in crop improvement are usually less familiar with procedures for conducting realistic on-farm tests than they are with collecting local germplasm from farmers. The presentations by Manassé and Zeigler, and by Onim, suggest two possible ways to start.

Objectives of the Workshop

This workshop was organised by IDRC so as to bring together a small representative group of scientists working in food crop improvement programmes in Eastern and Southern Africa in order to discuss some of the issues of planning, conduct and development that are introduced above. The intention is to concentrate upon those methodological aspects, common to most crops grown by small farmers, which contribute to the likelihood that the research results will be utilised by farmers.

Participants were asked to prepare brief accounts of local varieties and cultivation practices currently employed in growing their crop, the institutional organisation of crop improvement, their programme's specific objectives and how these were established, and the evaluation procedures used in arriving at a new recommendation for extension. Comments were requested also on any modifications that had been introduced in objectives or evaluation procedures, including the reasons underlying the changes.

Working groups of participants were given the specific tasks of discussing and formulating guidelines or recommendations useful to crop improvement programmes in the region, for the following three interdependent themes and any others agreed by participants:

1. Organisation of crop improvement

   a) mechanisms for effective coordination of improvement activities on a crop:

      i) where more than one scientific discipline is involved;
      ii) where more than one institution is involved in its improvement;
      iii) which is grown in more than one distinct agroecological region of a country; or
      iv) which is grown in more than one type of farming system of the area.

b) desirable relationships between crop improvement programmes and farming systems research programmes in designing and in evaluating crop technology,

c) the roles of multilocation testing and on-farm testing, their organisation and linkages to crop improvement, farming systems research and extension,

d) desirable and effective procedures for the release of a variety or agronomic recommendation,

e) appropriate training for young scientists joining multidisciplinary crop improvement programmes.

2. <u>Setting technical objectives and application of selection criteria</u>

a) useful sources of information on the specific requirements of producers and consumers for new cultivars or management practices,

b) methods by which programmes may improve definition of their technical objectives and selection criteria, and may assign priorities among objectives;

c) implications of technical objectives for management levels used in field experiments.

3. <u>Methodology for multilocation and on-farm testing</u>

a) differences in function between multilocation testing, on-farm testing (researcher managed) and on-farm testing (farmer managed),

b) multilocation testing: approaches to selection of sites and their management,

c) on-farm testing:

i) selection of sites

ii) selection of farmers

iii) methods for managing experimental variables (treatments)

iv) methods for managing non-experimental variables

v) methods for eliciting the participation of farmers in conducting and evaluating on-farm tests

vi) evaluation: types of data to be recorded; methods of combining the analyses of several parameters; analyses across sites.

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Professor John H. Monyo of the University of Dar es Salaam and FAO kindly consented to come and chair this workshop. His long experience of crop improvement in this region and commitment to agricultural research relevant for small farmers contributed immensely to the discussion sessions, and his rapport with participants ensured that the workshop was a lively, constructive and friendly affair. Both I myself and IDRC are indebted to him.

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