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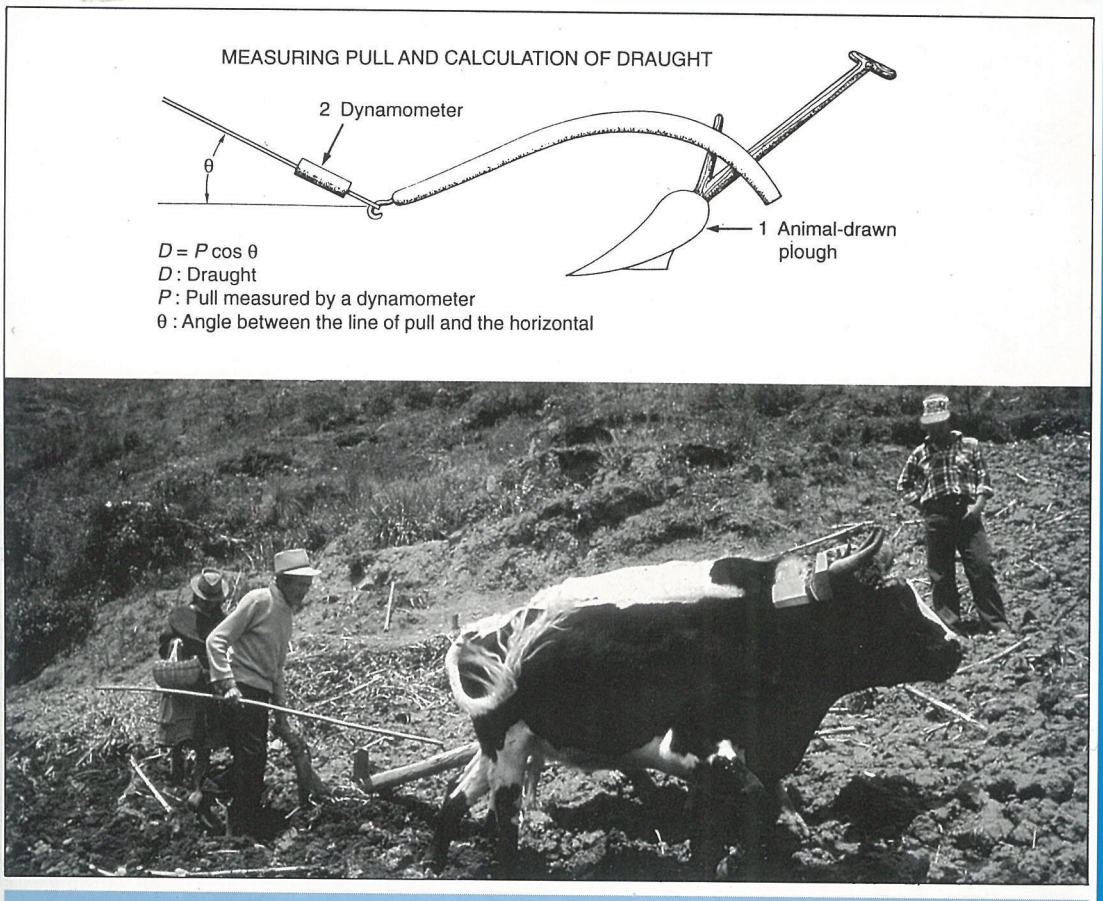
Selection, testing and evaluation of agricultural machines and equipment

Theory



Food and Agriculture Organization of the United Nations

Selection, testing and evaluation of agricultural machines and equipment

Theory

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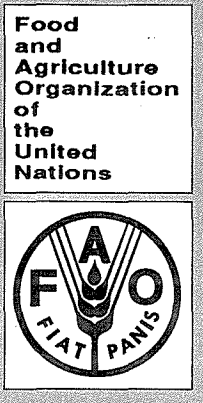

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Foreword

Because of misconceptions associated with selection, testing and evaluation of agricultural machinery, the FAO decided that its Panel of Experts on Agricultural Engineering should discuss these topics at its Eleventh Session in October 1992. One of the Panel recommendations was the preparation of two Bulletins: one directed towards testing and evaluation stations, universities and students in developing countries, and one towards government policy makers, entrepreneurs and farmers. The first of these two Bulletins "Testing and Evaluation of Agricultural Machinery and Equipment - Principles and Practices" has been published as Agricultural Services Bulletin #110.

Concentration on supply-side testing has been indicative of the top-down approach which has frequently been applied to machinery selection. A user-responsive approach will require a reorientation of existing services, supported by revised arrangements for funding. Proposals for this are discussed in this Bulletin. The Bulletin further emphasizes that testing and evaluation activities should be substantially centred on farmers' fields. A small vigorous unit should be able to provide the necessary service with back-up from, for example, university expertise: a large elaborately equipped centre is in most cases not justified. Practical solutions are necessary to help the farmer deal with the wide range of circumstances which surround her or him. It is hoped that the analyses and suggestions presented in this bulletin will provoke discussion in directions leading to acceptable solutions.

This Bulletin has been prepared by Prof. Frank Inns, working under an FAO contract. Members and resource persons of the Eleventh Session of the Panel, as well as staff of the Agricultural Engineering Service, AGSE, made valuable comments on an earlier draft and Mr.T.Lester of AGSE was responsible for final editing and layout. Their inputs are highly appreciated.

Adrianus G. Rijk
Chief
FAO Agricultural Engineering Service

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ABBREVIATIONS

AMTEC	Agricultural Machinery Testing and Evaluation Centre, University of the Philippines at Los Baños, Laguna, Philippines.
ART	Agricultural Research Trust, Harare, Zimbabwe,
CIRAD-SAR	Centre de Coopération Internationale en Recherche Agronomique pour le Développement: Département des Systèmes Agroalimentaires et Rureaux, Montpellier, France.
DLG	Deutsche Landwirtschafts Gesellschaft e.V., Frankfurt am Main 1, Germany.
ESCAP	Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand.
FAO	Food and Agricultural Organization of the United Nations, Rome, Italy.
FAO/AGS	Agricultural Services Division of the FAO.
GTZ	Gesellschaft für Technische Zusammenarbeit, Eschborn, Germany.
IAR	Institute for Agricultural Research, Ahmadu Bello University, Nigeria.
IMAG	Instituut voor Mechanisatie, Arbeid en Gebouwen, Wageningen, The Netherlands
IRRI	International Rice Research Institute, Manila, Phillipines.
ISO	International Standards Organization.
MIAS	Mechanization Information and Advice Service
NCAM	National Centre for Agricultural Mechanization, Ilorin, Nigeria.
OECD	Organization for Economic Cooperation and Development.
RNAM	Regional Network for Agricultural Machinery, a project established by ESCAP (see footnote on page 10).

EXECUTIVE SUMMARY

IDENTIFICATION OF PROBLEMS

Machinery selection

Machinery selection implies that a potential user makes a choice based on information relating to the probable performance of competing machines on the user's farm. Technical performance of the machines is only one of the items to be evaluated and arguably not the most important. Machine profitability, compatibility and sustainable use also contribute to overall performance.

Machinery selection is a user based activity. It must be undertaken in conjunction with farmers according to their particular circumstances and under their control. The prescriptive approach by which decisions on machinery selection have been passed down from above must be replaced by an interactive approach with full involvement of users.

Machinery selection depends for its success on access to relevant and reliable information on the full range of available machines. In the past farmers have rarely had access to available information, *e.g.* from machinery test reports, and the content and form of the information has been inadequate in meeting their requirements. The flow of information to machinery users must be improved.

Machinery testing

Machinery testing is generally believed to have two major objectives: to assist development of the industrial sector through machinery manufacture and of the agricultural sector through improved mechanization. In practice testing has concentrated on the first (supply-side) objective, making them technology-driven rather than consumer-responsive.

New testing procedures must be developed. Farmers require information on the comparative performance of the complete range of available machines, tested in field conditions which are similar to their own and reported in user-friendly terminology and format.

Many machinery testing units have devoted a considerable proportion of their staff and financial resources to machinery research, design and manufacture. Such activities have not been cost effective and should be left to the private sector, allowing the resources to be concentrated on developing and executing user-responsive tests.

Machinery evaluation

Information is the raw material for machinery evaluation. Users require reliable information in comparative format on machine quality, technical performance, costs and benefits of use, user friendliness and the technical and financial arrangements available to support sustainable use. Procedures for collecting, processing and delivering necessary information to the end user in digestible form must be systematically developed.

Alternative and complementary programmes

The viability of additional mechanization does not depend on machinery selection alone. The costs of mechanization must be paid from profits generated by the farming system. It cannot be assumed that mechanization will assure increased profitability. Alternative or complementary programmes may be necessary to create the conditions for sustainable mechanized production. Farmers need information which will help them to assess potential viability before starting a process of machinery selection which might be fruitless.

WORKING TOWARDS A SOLUTION

A 'Mechanization Information and Advice Service' for machinery users

Farmers who need help with machinery selection will be looking for an easily accessible one-stop source of information and advice on mechanization in general and, in particular, on choosing profit-enhancing machines which will help them to improve the welfare of their families in their particular circumstances. Sources of such information and advice are not generally available to farmers and it is necessary to propose the formation of a 'Mechanization Information and Advice Service' (MIAS) to satisfy this need.

Suggested functions of a MIAS, as listed on pages 62 and 63, are aimed at responding quickly to farmer requests on mechanization and machinery selection matters by collecting and making available all relevant information and providing advice on its application. The MIAS would identify information gaps and fill them by commissioning work, such as carefully targeted surveys or machinery tests. Information might be delivered by a variety of means, including for example locally arranged machinery field days with working demonstrations.

The MIAS is visualized as a small specialist unit, possibly with a few regional satellites, to be established at minimal cost. It would work with and through existing institutions, shaping and coordinating their activities as necessary and commissioning work to be undertaken by them according to the needs of farmers, not of the institutions. Such activities should be undertaken through contracts awarded, monitored and paid for by the MIAS using funds provided for that purpose.

It may be advantageous for a MIAS to work within or in close association with an institution selected for demonstrated expertise and achievement in mechanization development. Potentially suitable institutions are reviewed on pages 65 and 66.

RECOMMENDATIONS

Recommendations must be as comprehensive as possible to deal with circumstances existing in a wide range of countries. Therefore not all of them will be applicable in any particular country and they must be interpreted accordingly.

1. Put the machinery selection problem in context by identifying constraints on mechanization as faced by the farmer. A rapid appraisal technique should enable major problems to be identified using the following list:

- use of additional machinery is unprofitable:
  - the farming system itself is unprofitable;
  - machinery costs are too high:
    - high purchase price;

    - ¤ high running costs;
- there is no choice of machinery:
    - importers are not supplying;
    - local manufacturers are not producing:
        - ¤ there are no local manufacturers;
        - ¤ local manufacturers are not able to make the required machines:
            - o shortage of materials;
            - o no suitable designs;
- information on which to base a selection is not available:
    - ¤ the information does not seem to exist;
    - ¤ the information exists but is difficult to obtain:
        - o technical information on machine performance;
        - o information on costs and potential benefits of machine use;
        - o information on problems occurring in use;
            - reliability;
            - ease of adjustment;
            - ease of maintenance and repair.

This will help in identifying factors requiring priority attention. Efforts and resources may be allocated accordingly.

2. If machinery selection is identified as an area for attention:

- identify the expertise available from institutions in-country, assessing the relevance and quality of their outputs together with the effectiveness with which they have disseminated them. The list of proposed functions for a MIAS, as given on pages 62 and 63, may be used for guidance in defining relevant areas of expertise. Give special attention to institutions such as machinery testing units which have been set up specifically to undertake duties of direct relevance to machinery selection.

- identify those institutions with a noteworthy performance record in terms of quality and practical relevance of their work and relationships with typical farmers.

- identify those institutions with an unacceptably low performance with a view to reallocating their resources for more productive use.

3. Set up an organization with authority and funding to coordinate all work relevant to machinery selection and to make it available to farmers. The organization will probably be designated from one of the noteworthy performers or it may be a separate unit such as a Machinery Information and Advice Service as proposed in this bulletin.

4. Close down redundant institutions.

It must be emphasized that it is possible and desirable to undertake consumer testing for machinery selection in the field without incurring high equipment costs. Output quality depends more on staff skills and initiative than on high-technology instrumentation.

Chapter 1 Introduction

1.1 FUNDAMENTALS OF AGRICULTURAL MECHANIZATION DEVELOPMENT

Mechanization involves the use of machines ranging from simple handtools to complex machines, and their associated power sources. Mechanization has been a fundamental factor in the development of agricultural production from early times — the first agricultural handtools were probably made from selected timber, bone or stone and used for soil preparation. Mechanization may facilitate beneficial changes in agricultural production systems by introducing additional power and/or new or improved machines or by devising better ways of using existing equipment. Innovations to crop production system, including the use of fertilizer, insecticide and high yielding crop varieties, have often depended on the development and use of specialised machines.

1.1.1 Stages of mechanization development

The development of agricultural mechanization depends on the farmer's willingness and ability to identify opportunities for achieving sustainable benefits by improved and/or increased use of power and machinery, selecting the most worthwhile opportunity and carrying it through to successful implementation. Awareness and adoption of mechanization-related innovations may be expected to follow S-curves of the general form shown in figure 1.1, where the horizontal axis represents the time scale over which an innovatory machine or technique is taken up by potential beneficiaries and the vertical axis represents the proportion of the farming population who have benefited by that particular time. Adoption will linger behind awareness because some users will need to be convinced that a particular innovation will be beneficial while others will need time to mobilise their resources prior to adoption.

Stage I: investigation — represents a period of time necessary to investigate and develop a proposed new mechanized system (or a new mechanized operation), exploring machinery requirements in general and experimenting with practical techniques for their use, leading to identification of a potentially viable mechanized operation or system (set of operations). Much of the work in this stage will be undertaken by innovative farmers, possibly in conjunction with local manufacturers, enterprising universities or research institutions. Experienced testing organizations may have a role to play in associated research and development.

Stage II: build-up — represents a period when awareness and adoption of new systems, machines or techniques are progressing at increasing rates as indicated by the increasing slope of the curves. The number of machinery manufacturers and suppliers will be increasing, with a diversity of machines entering the market. This should be the period during which testing organizations will be working most intensively with manufacturers on machinery testing for development and marketing purposes and with consumers to assist them in machinery selection.

Stage III: adoption — is the time when a particular aspect of mechanization is making fast and sustained progress. Most of the developmental work will be completed during the first part of this phase and testing for manufacturers will tend to decline. Evolutionary development will ensure the continuous refinement of existing machinery and techniques, with occasional further advances arising from the introduction and adoption of significantly improved machines or methods of use.

Stage IV: maturity — represents the final stage relating to a particular development. Most of the potential users will have adopted the new technology and the rate of adoption will gradually slow to a virtual standstill. Some potential users will have opted out and others may have difficulty in finding the additional resources needed to make the change. By this time most supply-side testing will be for

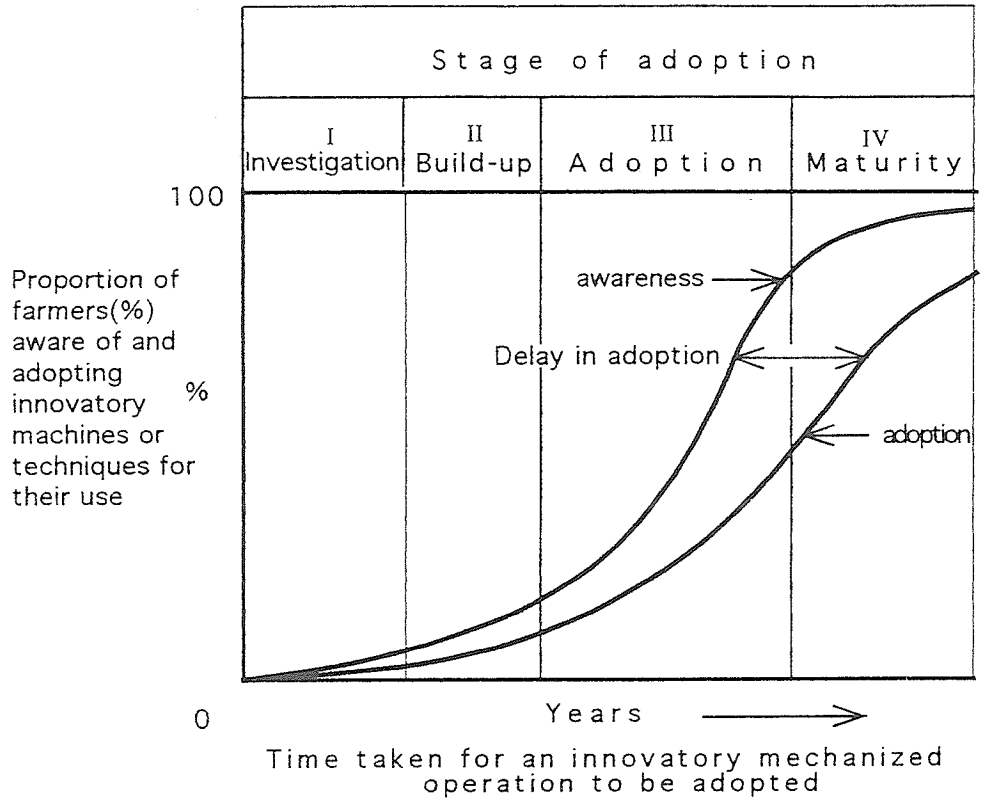

Figure 1.1 Stages in the introduction and adoption of innovatory machines or techniques in mechanized agricultural production and processing

statutory purposes while consumer testing will be aimed at technology conscious farmers, providing them with detailed quantitative information on the performance of technically advanced machines.

A number of innovations may be proceeding alongside each other at any one time, each at a different stage in the cycle of awareness and adoption, but with the rate of new introductions slowing down as a state of comprehensive mechanization is approached.

In developing countries many traditional human-powered operations, such as field cultivation using a hand hoe, have already reached the stage of maturity and are unlikely to benefit from attention by testing organizations. Other human-powered operations, such as for crop processing, may provide greater opportunities for development. Animal-powered operations have reached the stage of maturity in many countries where animal power is traditionally used, while attempts to introduce them in other countries are making slow headway. The use of tractor power for mechanized operations varies widely between countries. In some countries it is barely out of the investigation stage while in others it is achieving reasonable rates of adoption.

1.1.2 Mechanization development: farmers' choices

Farmers and other agricultural producers seeking to improve or extend their use of power and machinery must make two major selection decisions. First they must select a new or improved mechanized production system and check that it will bring intended benefits without undue risk. Second they must select the machines and power sources most suited to putting the new system into effect. Each decision depends on collecting and evaluating information on alternative solutions (including the existing one) and selecting whichever is judged most likely to help in bringing about the desired improvements.

Selection of a mechanized farming system

Selection of a mechanized farming system involves making a rational choice from a number of options, each of which includes the use of power and machinery for one or more operations. Each option must be evaluated, using information collected for the purpose, to determine which systems are potentially viable with minimum risk, within the technical, economic and social infrastructure which already exists or which can be improved as necessary to provide additional support.

System selection sets the stage for machine selection, which is aimed at finding the best equipment to make the system work successfully. An iterative approach may be needed to find the optimum combination of system, power source(s) and machine(s).

Machine selection

Power sources and machines must be selected to meet specified targets for technical performance and operational costs, as set by the selected production system. They must also meet other criteria, such as reliability and user-friendliness, to ensure that their use can be sustained in local circumstances. Selection is based on an item-by-item evaluation of available machines using information collected on each.

Selection should be demand-led, with farmers free to make their own evaluations and judgements in the light of all relevant information and with a choice of machines which is restricted only by their affordability. The extent to which this is possible is limited by local circumstances. Choice is restricted in many countries by government actions, deliberate or unwitting, on which farmers are not consulted and over which they have little influence.

1.2 MACHINERY SELECTION, TESTING AND EVALUATION: BRIEF HISTORICAL REVIEW

Farmers have been involved in selecting handtools from the earliest days of mechanized agriculture and in selecting more advanced machines as they became available. Selection has been based mainly on their personal evaluations, aided by informal testing and experience of use on their own farms or farms of their neighbours.

A review of more formal activities in machinery testing, evaluation and selection tends to be influenced by the volume of recorded information on each of them. Testing the performance of agricultural machinery is a high profile activity which has been supported in many countries by considerable investments of scientific staff, equipment and associated technical committees, resulting in the production (but not necessarily the publication and dissemination) of numerous machinery test reports. Consequently the process of machinery evaluation and selection appears to be dominated by considerations of machine performance. This appearance is misleading. Other factors also affect the

sustained use of a machine in the longer term and are often more important to the farmer than small variations of performance, but comparatively little attention has been given to collection of relevant data and to techniques for its evaluation.

1.2.1 Testing

Farmers must have made their own *ad hoc* tests on agricultural handtools and machines from the earliest days of mechanization but formal testing is of more recent origin. New developments have sometimes been tried out publicly in competitive demonstrations, as was the case with the development of steam ploughing systems in England in the 1850s. More formal testing aimed at consumer protection was initiated in 1919 in the State of Nebraska for tractors, which had to pass the 'Nebraska Test' before they were allowed to be sold in the State. By 1960 most European countries had set up government-funded machinery testing stations aimed at assisting manufacturers and consumers to develop, test and select more productive agricultural equipment suited to national and local needs.

Formal testing of agricultural equipment in developing countries was started in the surge of development following the World War of 1939/45, in recognition of the different crops, soils, climates and operating conditions in those countries. For example the regional East African Testing Unit was set up at Nakuru, Kenya in 1956 with technical assistance from the National Institute of Agricultural Engineering at Silsoe, UK. Such testing units generated information of use to government departments engaged in development and extension activities in mechanized agriculture and were thus indirectly, but not specifically, consumer-orientated.

Machinery testing facilities have now been set up in many developing countries, most commonly as the result of government initiative and funding. Facilities may be incorporated within an appropriate unit of the Ministry of Agriculture, as in Thailand where testing is undertaken within the Agricultural Engineering Division of the Ministry, or jointly with a University, *e.g.* at the Agricultural Machinery Testing and Evaluation Centre (AMTEC) in the Philippines which operates in conjunction with the University of the Philippines at Los Baños. Autonomous (usually quasi-government) organizations with responsibility for machinery testing have been set up in some countries, *e.g.* the National Centre for Agricultural Mechanization (NCAM) in Nigeria. Organizations within the industrialized countries are able to arrange technical support when required, *e.g.* the Centre de Coopération Internationale en Recherche Agronomique pour le Développement: Département des Systèmes Agroalimentaires et Rureaux, (CIRAD-SAR) in France or development agencies such as the Gesellschaft für Technische Zusammenarbeit (GTZ) in Germany.

Overall, a considerable investment has been made in establishing and running machinery testing units in developing countries and a significant number of test reports have been prepared (the Commonwealth Secretariat (1981) lists about 170 reports by East and Central African testing units). More recently their output seems to have declined and some have developed into 'white elephants' which consume resources to little effect.

There are a number of reasons for this, of which a general lack of funding, equipment and staff must be one. Possibly, however, this is the result of a low level of customer interest? Many testing units seem to act in isolation from machinery users who have little access to their findings — published reports may be circulated in official circles but their distribution and impact at grass roots level is often minimal.

1.2.2 Evaluation and selection

Machinery evaluation and selection depend on collecting information on available machines and assembling it systematically to allow relevant comparisons to be made easily by the potential user. This process is greatly assisted by comparative testing of a range of machines with guidance to consumers on how to interpret the resulting information according to their own particular interests. Consumer testing organizations in industrialized countries have been successful in establishing userfriendly formats for presenting the results of tests on domestic equipment. Similar formats have been used occasionally to present the results of tests on farm machinery, *e.g.* Theißen (1992) compared the technical performance of 22 spinning-disk type fertilizer distributors which were on sale in the European market.

Some comparative performance data for farm machinery has also been published in developing countries, for example AMTEC (1991) lists detailed results of tests carried out on 28 corn shellers. Such publications have generally confined themselves to tabulating technical performance data without attempting to interpret it in user-friendly terms.

Farmers in developing countries have been poorly provided with the information, and the guidelines to its interpretation, which are needed if they are to make realistic machinery evaluations. Technical performance data gained from machinery testing has been limited and rarely presented with the consumer in mind while other information needed for effective evaluation and selection is not available. Realistic methodologies for collection and evaluation of information and its use in machinery selection are not yet established, while consumers have had little encouragement to participate in formulating them.

1.3 MACHINERY SELECTION TESTING AND EVALUATION: SCOPE OF THIS BULLETIN

The primary aim of this bulletin is to outline procedures which, if instigated by governments, will help farmers to make sound judgements when selecting power sources and machinery for profitable mechanization of their farming activities. It reviews the information needed for informed evaluation and selection of farm machinery, including the contribution made by machinery testing in the past and the need for a more consumer-orientated approach to testing in the future. Machinery users must be involved in setting the objectives and methodology of tests according to their requirements and to available facilities. Valuable information can be generated by tests made using relatively simple and inexpensive equipment — AGS Bulletin 110 gives examples of some relevant procedures, equipment and techniques.

It is intended that the two documents will provide a basis for discussions involving farmers and other operators of agricultural equipment, leading to an efficient information and advisory service which will generate and publicize information in response to consumer demand, as necessary to make sound decisions relating to mechanization development and investment. The service must provide farmers with positive assistance in making comprehensive and realistic assessments of the potential benefits to be achieved by sustainable machinery use, together with help in machinery evaluation and selection. Machinery testing must be adapted to fit this need.

Chapter 2 Concepts and Terminology

Mechanization technology is still at a relatively early stage of development when compared with other disciplines contributing to agricultural production. At present there is no general agreement on the concepts and terminology used in the testing, selection and evaluation of agricultural machinery and equipment. The concepts and associated definitions used in this bulletin have been devised to be reasonably rigorous but readily understood. They have no 'official' endorsement at this stage.

2.1 AGRICULTURAL MACHINES AND EQUIPMENT

Equipment is a term used to describe the complete range of artifacts (products of human art and workmanship) needed to undertake a particular task or set of tasks. In the context of this bulletin the tasks to be considered are those involved in the production of agricultural produce, both arable crops and livestock products, and in the associated activities which affect the benefits which farmers achieve by their production. Associated activities include transport, marketing, storage and primary processing; the efficiency with which these tasks are undertaken will strongly influence the profits which farmers earn for their labours. Most of the production activities occur 'in-field' and most of the associated activities occur 'post-harvest'.

Machines constitute the majority of the equipment used in mechanized production and for convenience in this publication the terms 'machines' or 'machinery' will be used to denote both machines and other equipment. The precise terminology is explained below.

2.1.1 Machines

Machines are devices which are designed to accept a work input in mechanical form, *i.e.* as an applied force or torque combined with movement, and produce as an output some desired effect, such as soil disturbance of a particular kind (cultivating, ploughing, *etc.*) or a processing operation such as grinding grain. Even the simplest hand-tools are machines in the technical sense; this document is concerned with three classes of machines:

- tools (simple machines);
- implements (intermediate machines); and
- complex machines.

The distinction between these three classes of machines may be clarified by the following definitions.

A **tool** *(simple machine) consists of either a single component imparting a mechanical advantage or changing the direction of a force, or, a few components fixed together or pivoted in order to apply mechanical power. Most tools require very little maintenance other than sharpening or replacement of cutting edges. They are relatively light and usually operated by human power (hand-tools).*

An **implement** *(intermediate machine) is usually heavier than a tool with more component parts, so that maintenance requirements are usually greater. Some of the parts may move relative to each other in a random manner, e.g. soil engaging disks rotating freely on a shaft. It may be powered by human, animal or tractor sources.*

A **complex machine** *(often called simply a machine) has some components which are fixed rigidly together and others which form mechanisms, i.e. sets of components joined to move relative to each other in a controlled manner. Such a machine is not necessarily large and/or expensive. Regular maintenance is usually needed to keep it in good order. It may be powered by human, animal, engine*

or other (e.g. electric motor) sources.

These definitions are not watertight, but are reasonably workable.

2.1.2 Power sources

To drive a machine, power must be supplied in the form of mechanical work, *i.e.* the application and movement of a force or torque, in accordance with the requirements of the machine it is driving. The most widely used sources of mechanical work and power for agricultural production are humans, animals and internal combustion engines, all of which are 'energy converters', transforming chemical energy in the form of food or fuel into mechanical energy. Additional types of energy converters produce their mechanical work output by converting electrical, wind, water or other energy forms.

Some equipment (but not machines) need a power input in a form other than mechanical work. Crop driers are a particular example, requiring a basic power input in the form of heat energy but often supplemented by mechanical energy to power moving parts such as fans.

2.1.3 Equipment other than machines

Examples of equipment which are not machines are:

- simple crop driers having no mechanically driven parts; and
- transport devices such as trailers and sleds.

In strict scientific terms trailers and sleds moving on a level surface do not perform work on the load carried, although they require a work input to overcome resistance to forward movement.

2.1.4 Machinery classification

Machines are commonly classified in various ways according to, for example:

- the power source which drives them — human, animal, engine, other;
- the complexity of the machine — tool, implement, complex machine;
- ideal work capacity (but not realisable in practice) — hectares per hour, tonnes per hour; and
- machine function — specifies the job to be done, *e.g.* cultivation, planting, ... weeding, spraying, harvesting etc.

A combination of these factors may be used to describe a machine, *e.g.* animal- powered weeder. Usage of the classifications is self-evident and will not be expanded on here.

2.3 CUSTOMER-RESPONSIVE TESTING

2.3.1 Testing stations and their relationship with customers

In the past most formal testing organizations have been set up and funded by government with two major objectives — to assist development of the industrial sector through machinery manufacture and of the agricultural sector through improved mechanization. The balance between support for the industrial and the agricultural sectors is a policy decision influenced by their relative importance within a particular national economy and their prospects for development. Priority will normally be

given to strengthening a weak sector, so helping it to satisfy an increasing proportion of national needs. When the agricultural machinery manufacturing sector is strong, emphasis may be given to developing its export potential.

A present-day trend is for governments to disengage from direct control of testing organizations, encouraging them to deal directly with their customers. Individual manufacturers may have to pay for tests made on their products, at least in part, while advisory and/or extension services to the industrial and agricultural sectors move to a system of funding which enables them to place contracts directly with the testing stations on normal commercial terms.

There is little doubt that many customers in the past, particularly machinery users, have been disillusioned with the poor services provided by testing stations. Their weak performance has been tolerated (or ignored) only because their intended customers have not been required to pay directly for costs incurred. The trend towards direct contracts between testing organizations and their customers requires that testing services should be more responsive to customer demands, if they are to survive. Private organizations are already customer-responsive. For example the Agricultural Research Trust (ART) in Harare, Zimbabwe, undertakes demand-led testing as part of its service to members and also sells its services more widely, in cooperation or competition with government-backed services, as a result of the reputation for competence and impartiality which it has built up.

2.3.2 Classification of customers

Testing stations undertake work for a range of customers, most of whom may be classified into one of the following categories:

- suppliers:
  - manufacturers;
  - salespeople — agents and dealers;
  - importers;
- regulators:
  - policy makers — who restrict the free supply of machinery through legislation on importation, standards, health and safety, *etc.*;
  - bankers and other money-lenders — banks, agencies and individuals who provide funds for machinery purchase;
- advisers:
  - extension officers — government or private companies;
  - consultants and technical advisers;
  - journalists;
- users (consumers):
  - farmers; and
  - managers of agricultural enterprises.

Suppliers and regulators operate on the supply side of the machinery market while users constitute the demand side. Advisers operate mainly on the supply side of the market, although their credibility is strongly linked to their ability to appreciate the users' viewpoints.

2.3.3 Supply-side testing and its customers

The supply of machinery to consumers is the direct responsibility of suppliers comprising manufacturers, importers and distributors (agents and dealers). The free market may be distorted by other agencies (banks, governments, technical assistance programmes, *etc.*) intervening to provide loans or subsidies to assist in purchase of machines which they select or promote. In addition, government may impose statutory requirements for testing of specified machines to ensure protection of the consumer, the operator and the environment at large, and/or to restrict imports in order to conserve foreign exchange or to protect local industry from unwelcome competition.

Interventions by regulators distort the free market, often with consequences which may be very different from those intended. Consumer choice is invariably reduced, thus restricting the opportunity for trying out developments which might be found beneficial.

2.3.4 Consumer-responsive (demand-side) testing and its customers

Machinery users are the 'consumers' of machinery, mainly individual farmers and operators but including managers and supervisors of machinery operations on larger farms, estates and plantations. Consumer-responsive testing must be aimed primarily at satisfying their needs for information to help in system selection and in the evaluation, selection and use of machines to undertake particular identified purposes within a selected system. Thus consumers comprise a distinctive group having their own testing and information needs which supply-side testing and reporting cannot be expected to satisfy fully.

2.4 TYPES OF TESTING

2.4.1 The background to types of testing

Agricultural machinery testing has been a long-standing activity in the industrialised countries. The concept of 'comparative testing' was used in the 1850s when steam ploughing trials were held publicly in England. Engines could be compared working side-by-side in the field on a competitive basis. Such trials remain popular with farmers to the present day — working machines demonstrated alongside each other at agricultural shows or at field demonstrations always attract an attentive farming audience. Reports on comparative tests are a favoured format in the European farming press.

The Nebraska test for tractors, started in 1919, was of a different nature. Each model of tractor was subjected to a 'single-machine' test to ensure that it reached an acceptable level of quality and performance. When machines are tested singly the variability of working conditions makes it virtually impossible to ensure comparability of test results achieved in the field by different machines tested on different occasions. The Nebraska test dealt with this problem by measuring characteristics which are essentially functional rather than operational. For example drawbar pull and power characteristics were measured on a concrete or tarmacadam test track, thus ensuring repeatability even if the hard surface is quite untypical of field conditions. Similar procedures are used in present-day tractor tests for the Organization for Economic Cooperation and Development (OECD). Single-machine tests on other machines such as sprayers, fertilizer distributors and seed drills are usually made mainly on the basis of functional tests made in the laboratory rather than operational tests in the field.

Farmers know that field conditions vary enormously with soil type, moisture content, surface conditions, vegetational cover, *etc.* There is no known procedure for adjusting single-machine test results obtained in such a range of conditions to make them comparable. To meet farmers demands for comparative information on in-field performance of different machines it is necessary to

complement functional tests with field or workplace tests, undertaken on a comparative basis.

2.4.2 Functional testing

Functional testing *is the process of assessing and reporting the construction and performance of a machine or other equipment using specified objective procedures in repeatable conditions. Most functional testing is undertaken using specialized rigs and facilities in the workshop, laboratory or outdoors.*

Functional testing assesses the design, construction and functioning of a machine, power source or other equipment from an engineering viewpoint. Preliminary checks are usually made to confirm that physical characteristics agree with the manufacturer's specification, including dimensions, weight, volumes of tanks and hoppers, pressure in hydraulic systems, *etc.* The quality of design and construction, including materials and components such as bearings, pulleys and gears, may also be assessed. Tests for functional performance will vary with the machine. Power units such as internal combustion engines will be tested for power and fuel consumption characteristics over a range of operating speeds and for other factors such as noise and vibration. Specialised machines will be tested to ensure that they meet essential physical performance criteria, for example spraying machines are tested in still air to assess the range of droplet sizes produced and their distribution over a target working area — factors which strongly influence the effectiveness of the spraying operation.

Testing procedures for many types of machines have been formulated and embodied in Test Codes and Procedures aimed at ensuring uniformity in testing techniques and comparability of results obtained by different testing stations. Some, such as the OECD procedure for testing tractors, are recognized and accepted internationally. Others such as the procedures formulated and published by the Regional Network for Agricultural Machinery (RNAM, 1983)[1] have been agreed regionally by the Economic and Social Commission for Asia and the Pacific (ESCAP). Others have been agreed on a national basis only.

Because the results of functional tests are specifically designed to be repeatable under standardized conditions in all countries, there is little justification in repeating them from place to place. Testing facilities, such as the load car needed for tractor testing to OECD standards, are extremely expensive in terms of capital cost, running costs and the commitment of highly skilled technical staff. The replication of such facilities in developing countries soaks up scarce resources which might be used to investigate the solution of other more urgent problems.

Most formal test codes deal with functional testing of single machines, in recognition of the possible need for manufacturers to commission testing at appropriate points in their development programme, or as an aid to marketing the machine when it is put into production. However, while functional testing is able to determine whether a machine is capable of performing the function for which it has been designed, it must actually be operated in the field or work-place to find out the degree to which its capability is achievable in practice. Functional testing stops short when it becomes too difficult to deal with the variability of a wide range of agricultural conditions.

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[1] The RNAM project promotes an interactive relationship with and between the national agricultural machinery institutes of twelve participating countries, *viz* Bangladesh, India, Indonesia, Islamic Republic of Iran, Nepal, Pakistan, People's Republic of China, Philippines, Republic of Korea, Sri Lanka, Thailand and Viet Nam.

2.4.3 Field (workplace) testing

Field (or workplace) testing *complements functional testing by assessing the performance of a machine or other equipment in working conditions typical of those for which it is offered for sale. The machine's performance will normally be compared with that of a standard reference machine, or with a range of similar machines (comparative, group or series test).*

Field testing or workplace testing (field testing for short) complements functional testing by investigating the performance of a machine, or group of machines, in conditions which are typical of the places where the machines are required to operate. Tests can be made more user-orientated and user-friendly and testing organizations may feel encouraged to devise field test procedures to suit particular circumstances in their own countries.

All tests should be formulated and conducted to provide the information needed by the particular group requesting the test. Both functional and field tests are relevant to the interests of suppliers and users, but with differences of emphasis. Field testing is generally the more user-orientated and is often aimed at identifying a 'best buy' from a number of machines competing for the consumer's attention. Finding the best buy is made easier if the testing procedures enable the machines to be compared with each other in representative conditions.

2.4.4 Single-machine or comparative testing?

Single-machine testing *involves testing a single machine according to a specified procedure in defined conditions. Procedures and conditions are generally laid down in a Test Code aimed at ensuring that test results are comparable for machines of the same type even when tested at different times.*

Comparative testing *involves testing a variety of competing machines at the same time to ensure that the results are strictly comparable between machines. A series of tests is usually made to cover a range of typical working conditions.*

Single-machine tests are convenient for suppliers, who may arrange for their machines to be tested as and when required, without the complications involved in assembling a group of machines for comparative testing. Also, because the results of a single-machine test are usually confidential to the supplier who commissioned it, they are not published unless the supplier agrees. There may be good reasons for confidentiality if a test is for development purposes, less good if it shows that the machine is poorly designed but the dealer is allowed to go ahead with marketing it without publishing the test report.

Comparative tests (sometimes called series tests or group tests) are generally more useful for machinery users. When properly formulated they provide information which is directly useful and readily understood by the farmer or other user, allowing machines to be ranked for each of a number of characteristics related to performance, quality, ease of operation, adjustment and maintenance, *etc.* Individual farmers can decide which of the various factors are the more significant ones for their particular circumstances.

Comparative tests are normally made on a number of machines working at the same time in the same place to ensure, so far as possible, closely similar conditions of soil and/or crop. An alternative method of assessing comparative performance is to select one of the machines (usually of a widely known and used make) to act as a fixed reference machine against which others may be compared, allowing more flexibility in testing single machines on demand while retaining the essential advantages of comparative testing. Tests may be formulated and analyzed statistically if it is

considered necessary for particular purposes.

It is interesting to note that in the industrialized countries consumer based testing organizations dealing with motor cars and domestic products almost always test on a comparative basis. These organizations are generally independent and self-supporting. In Europe comparative tests on agricultural machines are conducted by organizations such as Deutsche Landwirtschafts-Gesellschaft e.V. (DLG) and the Instituut voor Mechanisatie, Arbeid en Gebouwen (IMAG), often sponsored by journals which run features presenting the results.

2.5 EVALUATION

2.5.1 The differing role of evaluation for the machinery supplier and the machinery user

Evaluation is the process of assessing an object or situation, preferably in numerical or quantitative terms, to judge how closely it will meet a specified purpose. For machinery suppliers (mainly manufacturers and salespeople) the purpose is to ensure that their machine will meet the general needs of a diverse group of farmers for whom the common denominator is machine quality and performance. For machinery users it is the specific needs of an individual farmer which must be considered. Individual needs can, in contrast to group needs, be specified in more detail and on a wider range of relevant issues — not only machine quality and performance.

The supplier and the purchaser have a common interest in finalising a sale/purchase contract but approach it from different directions. One important difference is highlighted by the legal warning *caveat emptor* — 'let the buyer beware'. Purchasers must make their own evaluations of whether the machine meets their needs in all respects. They cannot rely on the seller to ensure that the machine meets their exact needs.

Current definitions of evaluation do not generally make a distinction between the needs of the supplier and the more extensive needs of the purchaser. For example the definition proposed by the FAO states:

> *Evaluation - consists of the engineering parameters established during testing, combined with economic and ergonomic parameters, all of which relate to the performance of the equipment, machine or tool.* (FAO, 1992)

Centres engaged in machinery testing do not generally distinguish between testing and evaluation, nor between the special needs of suppliers and users for different forms of testing and/or evaluation. The distinctions are considered to be important and definitions are given in this document to clarify the terminology used. 'Testing' has already been defined (pages 13 to 16) and two definitions of 'evaluation' are given below, one relating to suppliers and the other to users.

2.5.2 Evaluation for the machinery supplier

Evaluation *for an agricultural machinery supplier is aimed at ensuring that machines meet all statutory requirements and will satisfy the needs of the maximum number of potential purchasers/ users. Basic assessments normally comprise tests for functional and field performance, but many suppliers will find it beneficial to make additional assessments for operational costs, ergonomic efficiency, etc.*

It is obviously desirable for machinery suppliers, if they are to maximize sales, to ensure that their machines are better at satisfying the needs of a greater number of users compared with the machines of other suppliers. Functional tests together with field tests in a range of typical conditions

help to achieve this. Additional tests for less typical conditions might be desirable but are limited by time and cost.

2.5.3 Evaluation for the machinery user

Evaluation *for an agricultural machinery user is aimed at collecting sufficient comparative information on a range of machines to ensure selection of the most suitable for the user's purposes. Evaluation will take account not only of performance but also of costs, user friendliness, support services needed and available, social acceptability, etc., all judged against the specific circumstances in which the machine is to be used.*

The machinery user can define quite precisely the local circumstances in which he/she will be using a machine. Particular conditions, such as crop and soil, may not be the same as the more generalized ones in which the machine has previously been tested for the supplier. More importantly such tests will have been conducted in isolation from many factors which influence machinery use in real life, such as the overall profitability of machine use in a specific situation, the availability of repair and maintenance facilities and of trained and experienced operators. A serious user orientated evaluation must assess many factors which are by-passed by conventional performance testing but which are crucial to successful mechanization.

2.6 SELECTION

Selection *is the final act of judgment which decides the machine to use from the range of those available. An informed judgment is assisted by a systematic review of machinery evaluations made formally and informally.*

Selection is a safeguard to investment. Procedures are likely to be less rigorous when the investment is small and for a well-established purpose, in which case farmers will usually make their decisions based on cost, experience and local knowledge, combined with performance trials or demonstrations of available machines and a critical physical examination of them — a form of quality evaluation. A more rigorous selection procedure is desirable to validate larger investments.

Chapter 3 Supply-side testing and its impact on the consumer

Potential customers for supply-side testing of agricultural machinery have been categorized in Chapter 2 as suppliers, regulators and advisers. These customers may operate within the private sector or public sector, depending on government policies and their implementation. Normally they request or require particular tests which they specify and the results are submitted to them, usually on a confidential basis in the first instance. Detailed test results may be published subsequently, at the discretion of the test's sponsors and in accordance with the policy and regulations of the testing station concerned.

3.1 TESTING FOR SUPPLIERS: MANUFACTURERS AND SALESPEOPLE

3.1.1 Objectives

When manufacturers submit their machines for testing they will generally have one or more of the following major objectives in mind:

- assistance to research, design and development;
- support for marketing and sales, either directly through publication of a favourable test report or award of a 'seal of approval', or indirectly through improvements to product quality ; and
- confirmation that the machine meets statutory requirements, including criteria for importation if necessary.

To achieve these objectives it may be necessary for specific tests and recommendations to be made on one or more items from the following list:

- **quality** of the design and construction of a developed machine;
- **functional performance** of the machine, to confirm that it reaches an acceptable standard in defined and repeatable circumstances, according to a relevant Test Code if any;
- **product development,** to suggest ways by which the machine might be improved in design, quality or manufacture;
- **field (or workplace) performance** to confirm that the machine performs to an acceptable standard in a representative range of field or workplace conditions (absolute or comparative performance: single-machine or comparative tests);
- **acceptability to the consumer** as expressed in a test report which, if favourable, may be used in promoting sales;
- **compliance with regulations**, confirming that the machine's construction, functioning and field performance meet the statutory regulations of the country of manufacture and other countries into which it is to be sold;
- **suitability for import licensing** (when required by regulations) to gain government approval for the machine's importation; and
- **credit potential** to gain an approved status for particular forms of support from government and/or financial institutions, e.g. eligibility for loans to assist purchase by farmers.

3.1.2 Review

Testing services have generally responded more positively to supply-side customers than to consumers (demand-side customers). Supply-side customers, as individuals and as groups, are

relatively well organized, influential and able to interact comfortably with testing station staff at a technical level, particularly in engineering matters (research, development, manufacture). Manufacturing and marketing are relatively high profile activities in comparison with agricultural production, attracting higher levels of attention and investment in most developing countries.

Most manufacturers, at all scales of production spend some of their time and money on developing and testing their products. Even one-person village businesses, such as that of the village blacksmith, usually work closely with their customers in developing and testing products which are directed at satisfying the customers' perceived or stated needs. This interactive relationship between manufacturer and purchaser may persist into local manufacturing businesses operating on a larger scale and supplying over a wider area.

Local manufacturers will often vary the details of their design to suit the demands of individual users in different parts of the area which they supply. Local variations of this nature should not be discouraged since they often lead to innovative developments which are subsequently taken up by larger manufacturers at regional or national level. When supplier and user cooperate in such a close working relationship there is very little need for involvement by a testing agency.

As the scale of production grows machinery sales and distribution are managed increasingly by agents and dealers rather than by manufacturers, making it more difficult for them to keep in touch with the varied needs of farmers in more distant areas having diverse crops, soils and climates. Some manufacturers respond by building up interactive relationships with individual farmers managing a variety of farming enterprises in different localities, using them as advisers on equipment under development. Others may turn to testing stations for advice and assistance in the design and development of new or improved equipment. Expanding markets may also encourage new entrepreneurs to enter agricultural machinery manufacturing, working in conjunction with testing stations to make up for their own lack of expertise in the development of new products.

Testing for manufacturers is usually undertaken on a confidential basis at a fee which covers part of the costs involved, in accordance with the policy of the testing organization and its source of funding (usually government). Development tests on prototype machines are primarily for the manufacturers benefit and their results normally remain confidential. Manufacturers may submit production machines for test in order to obtain an independent authoritative review of their construction and technical performance to assist in marketing. The manufacturer is not obliged to publish the report but, if published, the testing organization normally requires that it must be published in full, including any critical comments.

3.1.3 Linkages between manufacture, testing, agricultural and industrial development

Industrial development is generally seen as having a significant role to play in improving the economies of most developing countries and the welfare of its people, who are usually engaged predominantly in agricultural production. In these circumstances the manufacture of agricultural equipment is likely to play an important part in the development of both agricultural and industrial sectors.

Professional staff of active testing stations will be well placed to give constructive guidance on product selection and product development in relationship to quality, design, manufacture and innovation, taking account of the potential local market for agricultural machinery. Such activities are related to industrial extension. Testing stations should be able to act as specialist centres for extension advice in product selection and manufacture, particularly with small and medium scale enterprises. However, even the best of advice cannot be acted on if the manufacturer is faced with shortages of

suitable materials, equipment and skilled artisans.

When materials, equipment and artisanal skills are in good supply industrialization will be able to progress, leading to the emergence of component manufacturers using specialist machinery and techniques, such as casting and factory-scale forging. These developments enable manufacturers to improve the range and quality of their products and to extend coverage of their potential market. Testing stations may expect a greater demand for development and product testing.

3.1.4 Impact on consumers

Benefits

1. There can be little doubt that an independent testing service for manufacturers has, in many cases, contributed to the development of better quality and better performing machines, even though it is difficult to quantify its effect.

2. Authoritative information is available on those machines for which test reports have been published, supplying useful information on their construction, adjustment, performance and quality. The reports may draw the attention of potential users to particular machines which they might otherwise have overlooked.

3. Tests can provide objective assessments of performance claims made by designers and sales people, in advance of user experience over an extended period of time. For example the uniformity of fertilizer distribution from an oscillating spout spreader was investigated soon after its introduction, enabling a comparison to be made with that of the better-known centrifugal spreader which had been in use for many years previously.

4. A 'seal of approval' may be awarded for machines reaching specified levels of quality and performance. A recognized seal of approval awarded by a competent and impartial organization provides a selling point for salespeople and reassurance to customers.

Shortcomings

1. Test reports provide only a small proportion of the total information needed to evaluate the suitability of a machine for an individual consumer in his or her particular circumstances. Much information which is relevant to machinery evaluation and selection, such as the effectiveness of local repair and maintenance services, is not a specific function of the machine itself and can only be checked locally.

2. Test reports are not readily accessible to most consumers. Even if they can find out which machines have been tested they often have difficulty in obtaining reports on them.

3. Reports are often written in terms which consumers have difficulty in understanding. Tests may have been conducted in conditions which are markedly different from those of the particular farmer. Agricultural extension services often lack the mechanization expertise to explain their relevance to the farmer.

4. Manufacturers are not obliged to publish the reports on tests which have been made on their machines. Unfavourable reports can be withheld from publication and it may not be possible to find out whether this has happened.

3.2 TESTING FOR SUPPLIERS: IMPORTERS

3.2.1 Objective

Importers of agricultural machinery into developing countries are sometimes subject to controls applied by government on a short-term or long-term basis for one or more of the following purposes:

- to prevent the importation of equipment which is not suited to use in the country;
- conservation of foreign exchange;
- protection of local industry from competing products; and
- standardization of imports to one or a few models of a particular machine.

3.2.2 Review

From the time when tractors became widely available in the late 1940s, most countries have encouraged the increasing use of tractor-powered mechanization. This has been seen as a key to improved productivity and profitability in the agricultural sector, combined with a reduction of human effort in farming. Many countries, especially those with a record of increasing industrialization, have achieved a welcome degree of success. Others have been burdened by high costs, of which one symptom has been the inability to maintain imported equipment in good working order, resulting in additional losses of production and profitability.

In some countries the high proportion of tractors and other equipment which is either out-of-action or in poor working order has been blamed variously on its unsuitability for use in local conditions or the inability of importers to maintain an adequate supply of the replacement parts needed for effective maintenance. Attempts have then been made to refuse the importation of equipment until an official acceptance test has endorsed its suitability and an extensive selection of replacement parts is imported with the machines. Alternatively governments have tried to 'standardize' on specific makes of tractor, often produced in local government-supported factories, *e.g.* the production of Steyr and Fiat tractors in Nigeria. Neither policy has achieved general success. Rodriguez (1992) suggests that a solution is more likely when importation of machinery and replacement parts by entrepreneurs is allowed to develop freely in response to customer demand.

3.2.3 Impact on consumers

Benefits

1. Unsuitable imported machinery is eliminated from the market place (but see shortcoming 2 below).

Shortcomings

1. Consumers do not have the opportunity to judge for themselves the suitability of imported machinery. The range of machinery available to the consumer is restricted.

2. Some imported machines escape testing for suitability, notably that sponsored under some bilateral assistance agreements and through loans provided by donor agencies. The quality of design, construction and/or workplace performance has in some cases proved scandalously poor.

3.3 TESTING FOR REGULATORS: ENFORCEMENT OF LEGISLATION

3.3.1 Objectives

The application of government regulations for agricultural machinery is generally overseen and enforced by inspectors appointed for that purpose. Regulations may require machines to be tested for one or more of the following reasons:

- to safeguard the health and safety of operators and the public;
- environmental protection; and
- to ensure compliance with relevant Standards for machinery and components.

Such tests are usually paid for by manufacturers or importers.

3.3.2 Review

Health and safety regulations are usually concerned with safety for the operator and the public at large and must be observed. Some products, particularly tractors, are subjected to rigorous functional tests to ensure compliance with internationally agreed Standards relating to, for example, the provision of safety frames for roll-over protection of the operator, fitting guards to belt and shaft drives, and restriction of noise and pollution to environmentally tolerable levels. Such tests may require expensive facilities but, because they usually refer mainly to quality and function, it is not necessary to repeat them locally. It is commonly the responsibility of manufacturers or importers to ensure that their products have been tested and approved as meeting relevant regulations.

Machines made by small-scale manufacturers often escape inspection and their installation is often faulty, *e.g.* a grinding mill driven by an electric motor may not be fitted with guards for the drive belt and electrical regulations may not be complied with. Such omissions are regrettable but difficult to deal with.

3.3.3 Impact on consumers

Benefits

1. The health and safety of the machine operator is protected to some degree.

2. The functional performance of machines and equipment is assured.

Shortcomings

1. Local manufacturers may not be able to obtain high grade materials or afford advanced production techniques necessary to ensure that Standards are complied with, thus reducing the availability and increasing the cost of replacement parts.

2. Non-Standard machines and components may be driven off the market, even though consumers like them, if Standards are rigorously enforced.

3. Standards provide little or no assurance of good performance for a machine, when used in the consumers own farm or workplace.

3.4. TESTING FOR REGULATORS: PROVIDERS OF FINANCE

3.4.1 Objectives

Testing undertaken for financial agencies has one principal objective:

- to reduce the risk involved in providing consumers with loans for purchase of machines (particularly small-scale farmers with virtually no collateral assets).

3.4.2 Review

Small-scale farmers seldom have working capital readily available for the purchase of equipment and supplies, or suitable collateral assets to negotiate a loan through normal banking channels. In the past governments have tried to relieve this problem by making direct gifts of equipment and supplies or by subsidizing their cost but the effectiveness of such arrangements has long been questioned and is looked upon with increasing suspicion and disfavour. In many countries governments are making alternative arrangements with banks to provide loans to farmers on special terms, for the purchase of labour saving and/or profit generating equipment.

It is difficult to install fully effective safeguards for special loans to small-scale farmers. One method adopted to reduce risks has been to tie loans to the purchase of equipment which has been tested and approved for quality and performance at an official testing station. Tests will often be made at the request of manufacturers, in the expectation of increased sales for credit-worthy machines.

3.4.3 Impact on consumers

Benefits

1. It is easier to obtain a loan for machinery purchase.

Shortcomings

1. The consumers' freedom of choice may be restricted to specified machines which are not necessarily the best for their purposes and which they would not select if a free choice were available to them.

3.5 TESTING FOR ADVISERS

3.5.1 Objectives

The main duty of mechanization advisers is to provide valid mechanization advice to consumers, including advice on machinery selection. In this context the main objective of testing is:

- to assist advisers in providing consumers with valid information and recommendations on mechanization and machinery matters.

3.5.2 Review

Most mechanization advisers are employed by government extension services, sometimes as subject matter specialists, or by private producers of specialist crops such as cotton, who often give extension advice to individual farmers growing their crops under contract. Some expatriate advisers

may be working in technical assistance programmes.

Advisers are essentially substitute consumers, putting themselves in the place of actual consumers and going through the same procedures of system selection, machinery evaluation and machinery selection as farmers would do, but bringing additional knowledge, insight and experience to the process. The information which advisers hope to gain from machinery testing is therefore very similar to that needed by the consumer.

Many expatriate advisers arrive with their own preconceived ideas of suitable machinery. Favoured machines should be subjected to a formal local test, whenever possible, before endorsing their use in local circumstances. Locally published test reports should constitute an important source of information on the potential performance of machines in local agricultural systems.

In some countries journalists are active in sponsoring tests or in organizing field days and demonstrations. Usually a range of machines of a particular type is tested on a comparative basis in realistic field conditions. Manufacturers are encouraged to show their products in competitive action in the field or workplace. Results and comments, *e.g.* from farmers attending the demonstrations, are subsequently published in journals having widespread distribution.

3.5.3 Impact on consumers

Benefits

1. The adviser can provide expert assistance on the methodology of machinery selection and its application to the consumer's particular circumstances.

Shortcomings

1. Many farmers have only limited access to expert advice, including extension services. It may be difficult to get advice at the time when it is needed.

3.6 THE IMPACT OF SUPPLY SIDE TESTING ON THE CONSUMER

3.6.1 Impact on evaluation and selection

Farmers planning for improved or increased mechanization need information to help them formulate suitable production systems and to evaluate and select the machines needed to put them into effect. Supply-side machinery testing should be able to supply at least part of the information needed. To what extent has this happened?

Supply-side testing is concentrated on single-machine functional tests, sometimes supplemented by field tests in a limited number of locations chosen to represent a range of typical, but often idealized, local conditions. Some manufacturers and salespeople try to ensure that reprints of satisfactory reports are made available to potential buyers, but on its own this information is not usually sufficient for evaluation and selection, which has to deal with specific operating conditions and should review the complete range of available machines. Comparative tests for a range of machines and conditions would provide a more reliable data base but they are rarely commissioned by supply-side customers.

To summarize, the contribution which supply-side test reports can make to machinery evaluation and selection may be limited for a number of reasons:

1. **Information is not comprehensive, and often not accessible.** Test reports will not usually be available for all of the machines to be evaluated. Not all machines will have been tested. Reports may not have been published on some of those which have been tested — does this mean that the results were not good enough to merit publication? Some test reports may be out of date or the tested machines may have been superseded by new models. It is often difficult for the 'ordinary' consumer to obtain or consult published reports and they may be difficult to understand.

2. **Information is not comparative.** Supply-side tests are biased towards single-machine functional testing, perhaps including a limited number of field tests in conditions which are not standardized and may not correspond with those in the field or workplace where the machine is to be used. It is difficult for farmers to predict performance in their own fields and to make valid performance comparisons between machines based on these tests.

3. **Tests may limit the consumers' freedom of choice.** Importation may have been refused, or a machine may not have been considered credit-worthy, on grounds with which the consumer might not agree if he or she had been or were to be consulted. A machine may have been banned from the market for failing to comply with regulations or Standards which the consumer might consider unrealistic or unnecessary.

3.6.2 Impact not directly related to evaluation and selection

Supply-side testing does not necessarily help directly in machinery evaluation and selection but it may benefit the consumer indirectly in other important ways:

1. **Product improvement.** Supply-side testing normally results in product improvements which benefit consumers. It is difficult to estimate the contribution of testing to the process of product development but it is probably very little in the case of local small-scale manufacturers and only slightly greater for medium-scale and large-scale manufacturers, most of whom do their own development work. On balance the consumer will have benefitted from testing which has ensured compliance with regulations for construction quality, performance, health and safety.

2. **Quality assurance.** Some testing stations award a seal of approval for high quality products and give the manufacturer or importer permission to advertise the award by putting a distinguishing mark on approved machines. Such arrangements provide the consumer with some assurance of quality and general performance and the manufacturer with an aid to marketing. General criteria for award of a seal should be published by the testing station, which should also publish a report on each approved machine indicating its potential for use in a variety of local farming systems.

Chapter 4 Consumer-responsive testing

4.1 EXPERIENCES IN DEVELOPING COUNTRIES

4.1.1 The need for consumer-responsive testing

The fundamental purpose of consumer-responsive testing of agricultural machinery is to inform users of the relative merits of different machines, as an aid to evaluation and selection of the most appropriate machine from those available. Such information should therefore relate as closely as possible to the specific needs of the individual farmer. An additional purpose may be to help farmers in formulating new or improved mechanized farming systems, possibly involving the use of alternative power sources.

The supply-driven approach to mechanization which has been used extensively in the past has been shown to have significant shortcomings. Many 'aid' programmes have been built around the introduction of technically competent machines whose use has proved viable in other circumstances, but which have failed to achieve sustained productive use in new situations. Many research and development programmes, often conducted with external technical and financial assistance, have been devoted to the production of machines which have not been taken up by local farmers. Farmers themselves are generally aware of the resources available to them and adapt their demands accordingly so that a sensitive response to farmer demand is likely to be the best foundation for progress. Consumer-responsive testing should be designed as a service to provide farmers with information in a form which they can use for successful identification and satisfaction of their needs.

4.1.2 Review

Until now most machinery testing organizations have been set up by government, usually within or in close relationship with the Ministry of Agriculture, but with wider responsibility to serve both the agricultural and the manufacturing sectors. From the start, or over a period of time, they have tended to become increasingly technology driven, as typified by ESCAP whose main objective is stated (RNAM 1983) as:

> *... the identification, testing, development, manufacture, popularization and use of appropriate agricultural tools and equipment and technology so as to enable small farmers to attain higher levels of productivity and increase incomes."*

These objectives indicate a well-intentioned but essentially supply-side approach so that most of the information available to consumers from machinery testing (usually in the form of test reports) is the result of supply-side initiatives, either by manufacturers or salespeople requesting single-machine tests on their own products or by the institute itself testing its own products developed 'in house'. The reports which are made available to consumers usually present a technical analysis written in a form which the machinery user cannot readily understand and utilize.

Direct relationships between machinery users and testing services have not featured strongly in past arrangements. In many cases it has been left to agricultural extension services to articulate the needs of farmers, even though mechanization expertise is often poorly represented with few, if any, specialist staff. Generalist advisers are inclined to put forward their own perceptions of the farmers' needs rather than formulate them through discussion.

Some non-government organizations have undertaken tests in direct response to consumer demand, *e.g.* the privately financed ART in Zimbabwe and the Institute of Agricultural Research

(IAR) at Ahmadu Bello University, Nigeria, which is actively involved with farmer-responsive research and extension activities. Some comparative testing has resulted from such arrangements.

4.1.3 Impact on consumers

Consumer-testing of agricultural machinery has made little impact in developing countries — a consequence of the neglect it has suffered in the past.

Many of the agricultural machinery institutes which have been set up to promote the development of mechanization have concentrated on machinery research, design, development and manufacture, with the result that their machinery testing activities have developed a strong supply-side bias. Advisory services to users have suffered, being limited mainly to spin-off from supply-side machinery testing, with little hard evidence that farmers have benefited from the availability of new machinery.

4.2 A FUTURE FOR CONSUMER TESTING ?

Funding for institutions involved in agricultural machinery development and testing has declined in recent years. The quantity and quality of equipment and staff have suffered in consequence. An upsurge of consumer demand could reverse this trend, if matched by reorganization to ensure a positive and professionally competent response, backed up by adequate funding.

A continuation of past and present arrangements is unlikely to stimulate consumer demand having failed, for the majority of farmers, in generating and disseminating useful information on power and machinery. Effective consumer testing must be directed at benefitting farmers, not suppliers, by emphasizing mechanization (*i.e.* the use of machinery) rather than engineering. For a viable future, consumer testing must contribute to a comprehensive information and advice service on mechanization matters and play a significant role within it. The service must be effective in stimulating and maintaining an active demand from farmers, aided by prompt and effective responses to requests made by them.

4.2.1 Objectives for the future

Overall aim

The overall aim of consumer-responsive testing is to ensure that farmers and other machinery users are consulted and provided with all necessary information and advice on the selection and efficient operation of power and machinery, according to the opportunities and constraints of their individual mechanized farming systems (existing or proposed).

Objectives

To meet the overall aim it will be necessary for the testing unit to work with, or as part of, a comprehensive consumer-responsive information and advice service for farmers and other machinery users. The detailed objectives of the consumer testing unit will be determined by the allocation of responsibilities between or within the organizations involved but are likely to include the following as a minimum:

- ensure that farmers and other machinery users are consulted, and agreement reached on machinery testing needs and procedures to accomplish them;
- undertake comparative performance testing of groups of machines, in a form which will

allow potential users to make direct comparisons for a range of farming conditions;

- test the performance of individual machines as picked out in discussion with potential users, using procedures which will allow meaningful comparisons to be made with similar machines;
- encourage manufacturers to submit their machines for user-orientated testing;
- ensure that the results of all tests are presented promptly in user-friendly format allowing meaningful comparisons to be made of quality, performance and other relevant factors; and
- ensure that potential consumers are aware of all published test reports and that the reports are readily available to them.

Additional objectives might include:

- establish a 'seal of approval' scheme to designate machines of commendable quality and performance;
- classify existing local farming systems, identifying their potential for improved or additional mechanization;
- undertake surveys which will provide data to help the consumer evaluate non-performance factors such as user experience, machine life, availability of replacement parts, maintenance costs, *etc*;
- organize field demonstrations of competitive machines;
- ensure that users are informed of mechanization opportunities by all possible means including extension services, displays at agricultural shows, field days, demonstration farms, television, radio, journals *etc*;
- encourage widespread reporting of test results in consumer accessible media (journals, radio, television etc.); and
- maintain contact with consumers by visiting and discussing with them in their workplaces, as well as with consumer organizations and extension service personnel.

4.2.2 Review

The objectives above show that consumer-orientated testing is markedly different from supply-side testing, with much greater emphasis on comparative testing. Although suppliers and users have a common interest in testing for machine quality and function, farmers will usually look for additional information on machine adjustment and performance in-field. A different emphasis is needed when reporting results to supplier and user groups — most farmers will not be interested in the exposition of fine engineering detail and may be confused by it, but they do need a clear explanation of its implications on machinery use, in qualitative rather than quantitative terms.

For developing countries especially, a healthy consumer-responsive testing service must be integrated with a broader information and advice service dealing with mechanization development. It must interact with machinery users and respond to their identified needs. It may be necessary for government to act as originator and facilitator of such a service but entrepreneurs may also find a role to play. For example specialist farming journals in many industrialized countries regularly present comparative tests of different types of machines, often based on results obtained from a testing organization, interpreted and presented in farmer-friendly format.

4.2.3 Potential impact on consumers

It is probable that machinery testing can have a significant impact on the development of mechanization, but only if involved staff are prepared to work more closely with consumers than has

happened in the past, responding to consumer demand rather than trying to promote it. Reform and revitalization of consumer testing depend on a clear definition of its overall aim and contributing objectives. Some suggested objectives are set out above to promote discussion, not as a definitive statement.

Potential impact on the consumer will depend on the validity of the agreed objectives and on the effectiveness of their execution, determined by the quality, commitment and initiative of staff involved.

4.3 PROCEDURES FOR CONSUMER-RESPONSIVE TESTING

Consumer-responsive testing requires a different approach from the supply-side testing which has by now become firmly established in many testing organizations and formalized in most of the published test procedures. It would be tempting to add to existing procedures, incorporating additional items in an attempt to satisfy consumers as well as suppliers. Such an approach would make existing procedures more cumbersome and costly when the real need is to make them more direct, flexible and cost-effective. A comprehensive rethink is essential.

The Annex puts forward some comments and suggestions on a consumer-responsive approach to the testing of power sources and machinery. It is hoped that these might initiate the joint involvement of consumers and testers in developing effective procedures to meet the needs of local consumers — an ongoing process which must be responsive to changing circumstances.

Chapter 5 Standards and their relevance to the machinery user

5.1 BACKGROUND

The fundamental purpose of most Standards is to provide consumers with an assurance of the 'fitness for purpose' of the component or product which they are buying, including safety and environmental aspects. They also provide manufacturers with a product specification which must be achieved if they are to meet the reasonable expectations of consumers. Thus Standards serve as a reference point against which various features of a product may be compared.

Features which are commonly the subject of Standards are:

- **dimensions** of components in widespread use to ensure fit and interchange ability, particularly of wearing and replaceable parts;
- **quality** of materials, heat treatment, construction and finish to ensure serviceability of the product;
- **health and safety** requirements for protection of the operator, the community and the environment;
- **product design**, leading to general similarity of the overall product, irrespective of the manufacturer; and
- **test procedures** for assessing functional characteristics and field performance to ensure that the machine meets such performance criteria as may be specified and to provide general information on a machine's 'fitness for purpose'.

In most industrialized countries Standards serve to coordinate the best existing design and construction practices. This is usually achieved with the agreement of interested parties representing consumers, manufacturers and suppliers of the products involved. Standards should reflect the best existing practices without attempting to get ahead of them.

5.2 REVIEW

5.2.1 Dimensional standards for machine components

Basic machine components in widespread use, such as bolts, nuts and bearings, are generally manufactured in accordance with international Standards, whether they are made locally or imported. Agricultural machinery components which are liable to wear or damage, such as cultivator points, tines and disks, are also widely standardized. Parts made by specialist manufacturers in developing countries often conform dimensionally with a foreign Standard, usually of a country from which imports have previously been made, although it may not be possible to achieve comparable quality of materials and heat treatment. Further standardization is largely unnecessary at this stage because repairs, other than replacement of bought in components, are generally carried out by the original producer who will be able to manufacture other replacement parts and fit them individually according to the needs of his own craftsman-made machine.

Additional standardization becomes more attractive as the scale of production increases. However it is necessary to bear in mind that when a component is standardized the design process has effectively been brought to an end. It is a matter for judgment whether it will be more advantageous to keep open the opportunity for design innovation or to freeze the design through standardization.

Lack of standardization is often blamed for difficulties experienced in obtaining replacement

parts for agricultural machinery. Comparisons are often drawn between the availability of replacement parts for motor vehicles and for agricultural tractors. Closer examination suggests a more valid distinction is between private and public ownership and supply. Government ownership of vehicles and tractors is often associated with bureaucratic procedures for purchasing goods and services, which make dealers reluctant to supply. Shortages of replacement parts for agricultural machinery can often be traced to government control of importation, production or assembly facilities. Standardization cannot overcome problems caused by poor customer/supplier relationships or by poor supply and distribution arrangements.

5.2.2 Quality standards

The aim of quality Standards is to ensure that high grade materials and techniques are correctly used to produce a reliable product with a good service life.

Although a high quality product is obviously desirable, product quality is not an end in itself. An improved product made from high quality materials will nearly always cost more. The extra cost has to be justified by a consumer faced with a low family income and competing urgent demands. If consumers can buy two locally made spades for the price of one imported one, it may well be more convenient and cost effective to spread the investment. There will also be an advantage from a national viewpoint in terms of foreign exchange requirement and in promoting the development of local industry.

Local manufacturers will generally use high grade materials if they are readily and reliably available from local suppliers at reasonable prices. This may require a policy decision by local steel mills to promote the production and supply of higher grades of materials or by government to ease the import barriers which often exist for more specialised material inputs. If special materials are needed it is best to arrange for their supply through normal marketing channels in collaboration with existing entrepreneurs. Overseas aid projects do not help in the long run when they provide 'one-off' importation and supply of special steels under arrangements which cannot be sustained into the future.

Improved production techniques are generally necessary to take full advantage of higher quality materials. Available techniques depend on the level of industrialization within a country, including installed equipment and the training and skills of the workforce, which will in turn depend upon the country's industrialization policy and its implementation. A systematic approach to the introduction of quality Standards must take account of the local supply of high grade materials and the availability of workpeople with the necessary skills and equipment. Arrangements will vary from country to country, depending on the industrial, economic and political realities of each.

5.2.3 Health and safety requirements

Many countries have enacted regulations to ensure that machinery operators and the community at large are protected physically and psychologically from unwanted effects of machinery operation or accident. Such regulations set Standards which the machine must meet. They may be assessed in conjunction with a particular machinery test code, for example the OECD tractor test requires that the engine noise is measured. Use of the tractor may be prohibited in some countries if the engine noise is excessive while its use may be allowed in other countries where regulations are not so strict.

In some cases, such as spraying machines, functional standards must be reinforced by a user's 'Code of Practice' to ensure that the machine is operated in a way which will minimise environmental (or other) damage.

5.2.4 Standards for product design

Standards can act as incentives or a constraints to manufacturers. One incentive is a potential commercial benefit if their products reach or exceed a defined minimum standard. But Standards can also stifle attempts to develop and introduce innovatory products or improvements. This danger is probably greatest with 'product design' Standards.

A particular Standard, for example, specifies the design of a manually operated rotary paddy weeder. Subsequently the International Rice Research Institute (IRRI) has developed a 'double cono-weeder' which is claimed to do the same job twice as fast. Should the design specified in the Standard be discarded in favour of the new design? Should both designs be included in the Standard? Such Standards obviously discourage the enterprise of local manufacturers, who will be placed at a disadvantage relative to importers of more productive machines. The Standard should be withdrawn leaving consumers to decide which machines suit them best, in conjunction with local manufacturers.

It may be noted that 'product design' Standards are usually confined to simple machines, including a number of hand tools such as spades, forks, hoes and weeders. Such Standards are usually unnecessary and can inhibit innovation even for the simplest tools.

5.2.5 Testing Standards (Test Procedures or Test Codes)

Test Codes are generally concerned with single-machine testing of those functions which can be examined in repeatable conditions. Standard procedures are desirable to ensure comparability although it may be difficult to devise tests which take account of the complex influences which the farmer has to face, such as the variable condition of soils or crops. The problem is illustrated by an Asian country Standard for manually operated maize shellers which attempts to define the maximum permitted proportion of unshelled and broken kernels. Such damage is greatly influenced by crop variety, moisture content and method of drying — variations in these factors serve to obscure the effects of differences due to machine design, so that expert guidance may be necessary to avoid misleading comparisons. Nevertheless, existing standardized test procedures are generally sufficient to satisfy the needs of supply-side customers.

Machinery users, however, would like more information to help them with evaluation and selection of machines for use in their particular conditions, which might differ from those used for standardized tests. They will want to know: 'How does this machine perform in comparison with others? Which would be the best machine for me to buy?" Comparative tests aimed at answering these questions might be encouraged if suitable procedures were established, including guidelines to user-friendly reporting aimed at giving the reader positive assistance in machinery evaluation and selection.

5.3 STANDARDS IN DEVELOPING COUNTRIES - HELP OR HINDRANCE?

Standards undoubtedly act to the ultimate benefit of the consumer. For example it is extremely difficult to visualize a situation today where linkage dimensions for tractor-mounted implements were not standardized, but it is worth recalling that no such standards existed when Harry Ferguson designed his first mass-produced tractors incorporating the linkage. His linkage design was 'standard-setting' — it was widely copied by other manufacturers, adopted as a National Standard in many countries and eventually finalized as an International Standard (ISO 730 04.90).

This case illustrates the point that Standards are formulated almost invariably to ratify and consolidate existing design practice. Standards which do not conform with existing practice are likely to be rejected by the user. In one Asian country, for example, farmers have not accepted the officially

promulgated standard for a hitch pin for single-axle tractors (Senanarong, 1992). A top-down approach does not work with Standards, just as imposed innovation has been unsuccessful in establishing the use of equipment against the better judgement of the farmer.

Local manufacturers in developing countries at the early stages of industrialization are usually involved with small-scale production, hampered by non-availability or shortages of required raw materials at reasonable prices, of equipment and of high-grade trained and skilled labour. In these circumstances it is unreasonable to expect product uniformity to a high quality level — the first priority must be to overcome shortages rather than set Standards which cannot be achieved. For example experience in Thailand, which is relatively advanced in its manufacturing capabilities, has shown that:

> *'Some published Standards ... are too high for Thailand at this period. Only a few manufacturers can produce the machines to meet the requirements of the Standards and the cost of machines may be increased. ... Therefore, Thai government policy does not force agricultural machines to be in conformity with the Standard ...* " (Senanarong, 1992).

This arrangement recognizes that machinery purchasers usually deal directly with small-scale local manufacturers/suppliers who are able to repair any defects which might arise in their products. At this level of industrialization the main case for standardization is for widely used replacement parts such as cultivator points and grinding plates, which are usually produced by specialist manufacturers with a personal interest in evolving a standard form for their products.

As industrialization progresses the case for formal Standards becomes stronger. Additional standardization will generally arise informally through a process of evolution and natural selection, becoming ripe for formal adoption as the scale of production increases and manufacturers become more capable of making high quality products to close dimensional tolerances. It will usually be expedient to adopt Standards which have evolved locally or select from those already existing in other countries.

5.3.1 Summary

Testing Standards

Standardized test procedures already exist for many types of agricultural machinery. They are generally orientated to functional testing of single machines from a supply-side viewpoint. There is a need to develop testing and reporting procedures which are more consumer-orientated. In particular:

- standard procedures should be developed for comparative testing;
- test reports should be more user-friendly, presenting descriptive assessments which the average user can understand rather than undigested arrays of tabulated numbers;
- tests should aim at producing a feature by feature evaluation of machines in uniform descriptive terms, allowing comparisons to be made between machines even if they have been tested on a single-machine basis; and
- test reports should provide positive guidance on a machine's suitability for local farming systems with an objective assessment of probable benefits and shortcomings.

Manufacturing Standards

It is suggested that dimensional, quality and product design Standards for locally manufactured equipment have only a very limited positive role to play in the early stages of industrialization and

their imposition and enforcement from above may indeed be counter-productive. Efforts should be concentrated on building up manufacturing capability (materials, equipment, skills), not regulating it and thereby delaying the advance of industrialization.

Standards may be justified to encourage improvements in selected products when a variety of manufacturers have reached the stage of medium- or large-scale batch production, particularly for exported products. Quality criteria should be carefully set to ensure they can be attained by a good proportion of indigenous manufacturers, as demonstrated by existing products.

Health and safety standards

Health and safety Standards are obviously desirable, particularly to safeguard the physical and physiological wellbeing of the operator, the public, plant and animal life.

General

Standards are costly to formulate and administer. Over-zealous manufacturing Standards may cause marked increases in product cost or drive products off the market even though the original product was acceptable to the consumer.

Consumer-orientated procedures for machinery testing and reporting are in need of development. Consumers and manufacturers must be involved at all stages of formulation and subsequent execution and review.

Standards should develop from the bottom up, not be imposed from the top down, with the possible exception of health and safety Standards.

Chapter 6 Machinery evaluation for users

6.1 THE MACHINERY USERS' EVALUATION NEEDS

6.1.1 Evaluation and machinery choice

For many farmers in developing countries the supply of potentially suitable machinery is very restricted, often to a specific machine which is promoted by extension services or aid agencies. The user's choice in such circumstances is limited to accepting or rejecting the offered machine, evaluation procedures could be helpful in reaching the final decision but are unlikely to be used.

Systematic evaluation procedures become more important as the range of available machinery increases, allowing consumers a measure of real choice. Evaluation is also important for services provided by extension and aid agencies which have professional and moral obligations to collect all available information for making a rational evaluation and selection, in active co-operation with the user group.

6.1.2 Items for evaluation

A comprehensive evaluation will attempt to assess the strengths and weaknesses of each available machine against specific items as decided by the user. Most of the items may probably be included under the major headings:

- **machine quality** — materials and construction;
- **technical performance** — functional and in-field;
- **costs and benefits** — including economics of operation;
- **user friendliness**; and
- **operational support** — needs and availability.

6.1.3 Quantitative and Qualitative Assessments

Evaluation is made easier if assessments can be made in quantitative, rather than qualitative, terms. Scientists and engineers concentrate on making quantitative assessments in absolute terms by measuring various physical machine characteristics (dimensions, power, throughput, *etc.*), but they are often reluctant to make qualitative judgements which farmers treat as everyday matters. A scientist or engineer will try to devise a method for describing seedbed quality in terms of the characteristics of soil aggregates, such as size and distribution, moisture content, *etc.* Farmers find it easier to understand judgements of quality based on experience and this must be a preferred format in consumer-responsive testing.

The problem may be resolved if qualitative assessments are expressed in quantitative terms. One method is to assign scores to different levels of quality, *e.g.* from 1 = poor to 5 = very good. Consistency in scoring may be helped by making assessments on a comparative basis. Quality scores should not be regarded as second-rate assessments. Experienced machinery users (farmers in most cases), will generally agree on what constitutes good quality work.

6.1.4 Who should undertake the evaluation ?

Farmers, whether in industrialized or developing countries, are accustomed to making their own evaluations, often by observing neighbouring farmers who are successfully using alternative

machinery or techniques in similar circumstances to their own. This age-old method is simple and very effective, but is limited to machines and techniques already in local use.

For innovatory machines and techniques farmers will generally benefit from expert assistance in evaluation and selection . Necessary expertise may exist in government extension services, universities, machinery testing centres, research institutes, agricultural colleges and in the extension departments of the larger commercial companies dealing with particular cash crops.

6.2 EVALUATION PROCEDURES FOR MACHINERY USERS

6.2.1 Evaluating machine quality

Most farmers have to strike a balance between machine quality and cost. A machine (from handtool upwards) may have a low build quality in terms of materials, precision of construction, quality of welding or quality of components but the user may still decide to go ahead and buy it if he/she considers its performance to be satisfactory, its cost to be acceptable and it can be repaired locally. Farmers are generally aware of the balance between cost and quality and must be allowed the freedom to make their own choice.

Nevertheless informed assessments of quality are valuable to the consumer. The seal of approval awarded by some testing stations may reassure the consumer on the value for money of what might appear to be a high cost machine and may help him/her to obtain a loan for its purchase. All machines should be assessed for quality, reliability, ease of repair *etc.* Items for assessment may include:

- manufacturer (artisan/factory);
- quality of materials (good/acceptable/poor):
  - wearing parts (specify, *e.g.* tine points, grinding plates);
  - structure;
- quality of construction:
  - accuracy of metal forming;
  - accuracy with which parts fit;
  - quality of welding;
  - quality of joining (alignment and fit of bolts and nuts, use of locking devices *etc.*);
- components (bearings, drive chains, pulleys, *etc.*):
  - quality;
  - availability (local manufacture, imported, *etc.*); and
- maintenance and repair:
  - reliability (estimated frequency of breakdown);
  - level of maintenance (simple, training needed, specialist workshop);
  - estimated frequency of breakdown (rare, occasional, frequent).

The list is not comprehensive. Items should be added or deleted as necessary.

6.2.2 Evaluating machine performance

A distinction is commonly made between functional performance in standardized test conditions (usually in the laboratory) and performance in the field. The distinction is helpful for the machine's designer but less so for users. For users it is the field performance which is of decisive importance, preferably related to the particular conditions existing on the farm or in the workplace where they intend to use the machine.

Users will normally be concerned with:

- quality of work;
- rate of work:
  - maximum rate of work;
  - realistic average rate of work;
- ease of adjustment and operation; and
- reliability.

The ideal basis for field performance evaluation would be a consumer orientated comparative test report covering the full range of locally available and potentially suitable machines. Regrettably such reports are rarely available.

In developing countries it will usually fall to extension services to supply machinery users with information to help them evaluate machines which are available and potentially suitable for their use. Some supply-side reports may have been published but it is seldom possible to collect comprehensive up-to-date information on the field performance of the whole range of machines. Farmers' contacts with extension services are usually with field staff who may have little training or experience in mechanization matters and, because extension services often have no subject matter specialist to deal with machinery queries, they may not have access to the required information.

In this situation it may be hoped that extension staff would be able to arrange a competitive working demonstration on a representative farm or at an agricultural show, where local machinery dealers could demonstrate their machines and farmers could make their own judgements on performance and overall suitability.

There may be other useful sources of machinery information such as journals, trade leaflets, advertisements and, possibly, farming programmes featured on radio and television. However the information they provide arises sporadically and cannot be relied upon to be available when needed.

6.2.3 Evaluating costs and benefits

The costs and benefits of mechanization cannot all be measured in financial terms. Reduction of drudgery, for example, is often quoted as one benefit. Such benefits must be treated subjectively — is it worth incurring an additional cost (or forgoing additional income), in return for expending less physical effort? Is the same cost worthwhile if it is somebody else's physical effort which is being spared? Possession of particular machines is often regarded as a status symbol — how much is that worth? Such questions should not be ignored, but they can only be answered by the individual. Assessments of costs and benefits must therefore be made objectively in financial terms in the first instance, with subjective adjustments to take account of non-commercial factors at the farmers discretion.

Cost of purchase

It is usually easy to determine the prices of machines from the manufacturer or supplier. In many cases assistance for purchase is available from informal sources, or from formal sources such as agricultural credit banks having responsibility for loans to small-scale farmers. Formal sources of finance may wish to protect their loan by requiring that a particular approved machine is bought. This approach may be over-cautious, imposing an unnecessary limitation on the purchasers freedom of choice — a factor which should be taken into account when evaluating machinery.

The cost of machine purchase is an obvious obstacle faced by farmers. A full analysis of continuing costs and benefits will be necessary when seeking a loan and is a vital part of the evaluation process.

Operational costs

Much attention is given to the initial cost of a machine, usually considerably less is given to running costs and working capital which may be needed from time to time to keep it in operation. Such costs are a continuing burden for the user — over the working life of a machine they may amount to several times the initial purchase price. It is important to ensure that running costs will be covered by corresponding savings (*e.g.* on the employment of casual labour) or by increased income.

Operational costs include:

- cost of ownership (fixed cost);
- cost of use (running cost); and
- reliability.

To evaluate operational costs it is necessary to know:

- initial cost;
- cost of borrowing money (interest rate);
- expected machine life and usage per year;
- cost and availability of replacement parts; and
- cost of repair and maintenance over the life of the machine.

Machinery evaluation must provide information on each of the above items as a preliminary to calculating operational costs. Of the items listed it is probably only the purchase price and interest rate which are reliably known, making it difficult to estimate operational costs with any certainty. Reliable information on the life of the machine is needed to calculate the fixed cost while data on usage, repair, maintenance and replacement parts will be needed to calculate the running costs. It should be possible to establish the cost and availability of replacement parts by making a survey of dealers and of the local markets. AGS Bulletin 110 includes a section on the economics of machinery operation, including calculation of costs and benefits.

Reliability is essential, particularly for innovative machines. Farmers are very sensitive to the need to keep risk to a minimum and will quickly lose interest if time and production is lost by breakdown. In addition, repair costs make unexpected demands on working capital which may be minimal or non-existent.

Reliability is a function of the frequency of breakdown (due to distortion, breakage etc.) and of the down-time (time taken for repair). Frequent breakdown is made more tolerable if the machine can be repaired quickly, which is more likely with locally made equipment. A structured survey of representative users could give valuable guidance on the reliability and down-time for machines which have been in use for a number of years. For machines newly introduced to the market a provisional estimate of reliability could be made by specialists, based on a combination of experience and detailed examination of the machine.

Operational benefits

There is no incentive for the farmer to buy and operate machinery unless sufficient benefits

arise in return. Benefits are generally counted in terms of additional profit after covering the costs of machine operation, although associated benefits such as the often quoted 'reduction of drudgery' may presumably be considered adequate justification for machine use even with no net financial return.

Financial benefits might arise from:

- increased crop output due to:
  - enlargement of area farmed;
  - improved yield per unit area farmed;
  - increased cropping intensity;
- value added on-farm by:
  - processing;
  - storage to benefit from higher prices;
- growing higher-value crops;
- labour saving (reduction of paid labour costs); and
- alternative employment opportunities for the farmer:
  - paid employment during time saved by faster work rates;
  - undertaking machine contract work for other farmers.

These benefits are notoriously difficult to quantify in advance and many mechanized farming projects, from very small to very large, have failed (often dramatically) because expectations have not been fulfilled. This is particularly true of expected increases in crop yield per unit area and expected increases in cropping intensity.
Many studies quoted by Rijk (1989) pp 20-23 lead to one emphatic conclusion which must not be ignored:

Mechanization alone does not increase crop yield per unit area or give rise to increased cropping intensity

Financial benefits are most likely to arise from enlarging the area farmed (where land is available) and from undertaking contract work for neighbouring farmers.

Partial budgeting (cost/benefit analysis)

Partial budgeting is an established technique aimed at assessing the economic viability of changes to a farming system, such as those arising from the introduction of new crops or new machinery. The technique is outlined in AGS Bulletin 110.

If the only change to the farming system is the introduction of a new machine the main cost will be that of machine use. Methods for estimating machine costs are well established and widely known but resulting predictions are often over-optimistic due to the use of data relating to substantially different circumstances, *e.g.* in developed countries with long established support services. Problems arising include:

- depreciation of equipment and interest on invested capital is insufficiently provided for, particularly on items provided under 'aid' agreements;
- machine life (years) is over-estimated;
- annual usage (hours of work) is over-estimated; and
- costs of repairs and maintenance are under-estimated.

Over-optimism is also common when predicted benefits are being calculated. Expected increases in crop yields, improvements in crop value, reduction in labour costs, machine productivity (area covered) *etc.* often fail to materialize.

Realistic assessment of economic viability is hard to achieve due to lack of basic data, the innate optimism of human nature and the desire to put forward a good case for change. One method which might help to alleviate this problem is to make two sets of calculations based on 'best case' and 'worst case' scenarios. This should at least make the analyst think about those things which might go wrong.

6.2.4 Evaluating user-friendliness

User-friendliness is probably one of the most important factors in acceptance or rejection of an innovative machine. User-friendliness is a function of:

- confident use of the machine — training may be necessary;
- ease of adjustment;
- working effort needed;
- operator safety and comfort;
- a well-written and illustrated instruction manual;
- frequency and ease of maintenance; and
- social and cultural acceptance.

A number of these factors are listed for evaluation in existing test procedures; it may be necessary to add the others and to ensure that full assessments are made. Ergonomic procedures can help in making the assessments but at present they tend to orientated towards research and development, so that test reports give little realistic information on ergonomic matters. A check-list is required giving guidance on ergonomic factors to be included in machinery assessments, preferably made on a comparative basis .

There is an obvious case for strong farmer participation in evaluating user-friendliness. Testing centres should develop consultative procedures which ensure that representative and realistic farmer assessments are made and incorporated into test reports. Until this is done farmers will have to rely upon the experiences of their neighbours and acquaintances. These may be backed up by their own intuitive assessments gleaned from observation and any opportunities which may come their way to handle the machine at agricultural shows and demonstrations.

Training may be desirable or essential for particular machines if they are to be used to best advantage. If this is the case the evaluation should note who will give the training (manufacturer or dealer), where it will be given (on-farm, locally or at a distant centre), duration and cost (if any).

6.2.5 Evaluating operational support services

The growth of mechanization is linked with the quality of support services available to the farmer. Requirements will change as mechanization develops. Evaluation of support services should take account of both current and foreseen needs. It is likely that support will be needed in:

- training and advice;
- maintenance and repair; and
- finance.

Training and advice

Training and advice are particularly important in the start-up period when new machines and new techniques are being adopted and their use consolidated. Given enough time most operators will develop optimum working methods to suit their personal priorities, although these might not coincide with the priorities of their employer. Both operator and employer must be aware of:

- realistic targets for machine performance and output, together with factors affecting their fulfilment, including capabilities of the power source;
- machine adjustment and operational techniques for optimum efficiency; and
- care and maintenance of the equipment.

In addition to advice the operator will benefit from practical training in machine adjustment, operation and maintenance. Such advice and training should preferably be given on-farm by the machinery supplier at the time of delivery, with periodical follow-up visits. It is in the interests of the supplier, as well as the user, that the machines they sell are used to best effect. Evaluation should be made of the supplier's policy on customer training. The availability of training from other sources should also be noted.

It is generally acknowledged that an operator's manual should be provided with all but the simplest equipment. Evaluation of the quality of the manual is specified in many machinery testing procedures. It should give information on machinery operation, adjustment and maintenance in an appropriate form for local users; a mainly pictorial presentation with text in a widely-used local language is generally recommended. A list of replacement parts, with clear diagrams enabling them to be recognized easily, should be included in the manual, together with information on stockists and ordering procedures.

Maintenance and repair

The responsibility for maintenance and repair, including fitting replacement parts, is shared between the user and the supplier of the equipment. When collecting information for evaluation purposes the following machinery support services should be considered

- on-farm care and maintenance;
- guarantees;
- supply of replacement parts; and
- overhaul and repair, on or off-farm.

On-farm care and maintenance is mainly the responsibility of the operator, guided by the operator's manual for the machine and advice from the supplier. The on-farm equipment needed to support effective maintenance (spanners, grease guns, special tools, *etc.*), should be noted for evaluation purposes.

Evaluation should include assessment of the guarantees provided by the manufacturer and/or supplier. It is reasonable to expect a guarantee that machines will be maintained and repaired as necessary free of charge for at least one year, except for normal use of wearing parts such as ploughshares.

The supply of replacement parts is a well-known problem which can have a decisive influence on the sustainability of machinery use, yet is still a long way from solution. Local small-scale manufacturers ideally have a close working relationship with the user so that replacement parts, if not immediately available, can be made and fitted without delay. Imported equipment can give rise to

more complicated problems. The supply of replacement parts may be impeded by government imposed import licensing procedures and currency restrictions, while import duties sometimes make them unduly expensive. Further confusion may arise from cumbersome purchasing procedures (as operated by many government agencies) and shortage of funds, so that parts cannot be bought even if they are physically available.

Information on the availability and cost of replacement parts is essential to full machinery evaluation. Rodriguez (1992) suggests that replacement parts may be categorized as:

- consumables — needed for routine servicing and regular replacement due to wear (oil filters, tires, ploughshares, *etc.*);
- predictables - items for which replacement can be expected from time to time during the life of the machine (drive belts, batteries *etc.*); and
- erratics — items which should normally last for the life of the equipment but which may need replacing for random and unpredictable reasons such as accident.

Information for evaluation should be concentrated on the local availability of consumables and predictables, which are probably responsible for at least 85% of sales for replacement parts (AGS Bulletin 72). It is unrealistic to expect erratics to be stocked locally, although they should be available quickly from a central store.

Supply of replacement parts is rarely given systematic attention, although AMTEC recognizes the problem in one of its objectives, *viz.*:

To set standards in evaluating spare parts and after-sales service capabilities of firms engaged in sale and/or distribution of agricultural machinery in the Philippines."

Efforts towards meeting this very desirable objective have been hampered by lack of staff and funds (Gayanilo, 1994). However it is not necessary to wait for standards to be established — it is possible to make a quick survey of dealers in a particular area to assess the availability and cost of replacement parts.

After-sales service is particularly important for more complex machines, whether made in-country or imported. Reputable manufacturers are aware that long-term sales depend on a reputation for efficient after-sales service and take care to build up a network of high quality local dealers. Farmers generally prefer to buy from a dealer who is known to provide good after-sales service and this is often reflected in a high concentration of that dealer's machines in the locality. The information may be easier to evaluate if farmers are asked to make comparative judgements on their experiences with different dealers.

Finance

Credit facilities for machinery purchase by small-scale farmers are well provided for in many countries, in principal if not always so readily in practice. However financial support may also be necessary from time to time after purchase when the farmer is faced with large bills to keep the machine in use, *e.g.* for major repairs or for buying expensive wearing parts such as tires. Loans to provide working capital for dealing with these items are not usually available from formal sources and it may be difficult and/or expensive in terms of interest to borrow the money elsewhere. In making machinery evaluations it will be wise to take account of the possible incidence of large lump-sum running costs of this nature and try to ensure that sources of finance will be available.

Chapter 7 Machinery selection

7.1 SYSTEM REVIEW: AN ESSENTIAL PRELIMINARY TO MACHINERY SELECTION

The process of machinery evaluation and selection is time consuming and costly. Before starting on the process it is advisable to review the farming system within which the machine is to be used to ensure, as far as possible, that the machine and the system are mutually compatible. The system must be capable of sustaining the costs of machine operation, while use of the machine should bring benefits to the system. Some benefits may be quantifiable in financial terms while other benefits are less easy to assess financially, for instance improvements to the status or conditions of employment for its workforce, but must not be allowed to push the system into debt.

Machine selection follows from a desire to change to a system of production which is more profitable or less demanding. The main options are to:

- replace an existing machine;
- increase the level of mechanization (employ new power sources); or
- increase the extent of mechanization (mechanize additional operations).

7.1.1 Replacing an existing machine

When a machine wears out or breaks down the most straightforward decision is to replace it by one which will do the same job within the existing farming system. The costs and benefits of using that type of machine will be well known and direct replacement will generally involve minimum risk provided that the replacement machine operates as effectively and at the same cost level, or lower. The farmer can go ahead immediately with evaluating whatever machines might be available to do the required job and selecting the most suitable.

Alternatively, rather than finding a similar machine to provide a direct replacement it may be worthwhile for the farmer to consider a different machine, possibly using a different power source. For example, rather than replacing an animal-pulled plough, the farmer might consider hiring a ploughing contractor who is using tractor power. Some basic decisions relating to the extent and level of mechanization are discussed below.

7.1.2 Increasing the level of mechanization

The advance of mechanization is not solely a function of machinery selection, however efficiently conducted. The justification and potential for new sources of power and new machinery must be established with reasonable certainty, otherwise efforts put into testing, evaluation and selection of machinery will be wasted. Very broad guidelines have emerged from studies made by Giles (1975), Binswanger (1984), Pingali *et al.* (1987), Rijk (1989). If mechanization is to be sustainable the cost of all inputs, including the costs of power and machinery, must be paid from income received by sale of the crops produced.

Total available power may be estimated by taking the power developed by human labour as 70 W per person, by draft animals as 300 W per animal (cattle) and by a tractor according to the maximum rated power output of its engine and the number of farmers sharing in its use. For farmers in the lesser developed countries the total power available comes mainly from human labour and draft animals and is usually less than 0.5 kW per hectare. Some operations may be undertaken by tractor-owning contractors, representing shared use of the tractor's power. Any additional power

beyond 0.5 kW per hectare can only be justified by crop yields above 2.5 tonnes per hectare.

It has to be emphasized that the use of additional power and machinery is only justified when assured crop yields are sufficient to sustain the extra costs arising. In itself the use of additional power does not provide any such assurance. However, Binswanger and Rijk provide some guidance on directions which might be taken.

7.1.3 Increasing the extent of mechanization

Binswanger undertook a historical survey which examined how mechanization had progressed when new power sources were introduced into existing agricultural production systems. In the early stages of their introduction new power sources have been used first for 'power-intensive' operations such as transport, water lifting and primary cultivation and only at a much later stage for 'skill-intensive' operations requiring judgment and sensitive handling, such as transplanting seedlings and harvesting most fruit and vegetable crops. It has evidently been more profitable for larger-scale farmers to hire out their new power sources to undertake power-intensive work for neighbouring farmers, who could not justify ownership of the new power source for themselves. In return the smaller-scale farmers have often undertaken skill-intensive operations on the larger farms, to the benefit of both parties. This pattern of events occurred when human power was supplemented by the introduction of animal, engine or tractor power and when animal power was supplemented by engines and tractors.

7.1.4 Changes to farming systems and the development of mechanization

Pingali *et al.* emphasize the need to consider the development of mechanization in relationship to the development of farming systems. The intensification of farming systems (the evolution from forest-fallow through bush- and grass-fallow to permanent cultivation, in response to population pressure) encourages a move from human labour to animal power and subsequently to tractor power. Such changes may facilitate the introduction of more profitable cropping systems incorporating higher value crops, possibly in response to local developments such as increased demand for oil seeds resulting from installation of a village scale oil seed processing mill.

The transition from animal power to tractor power is affected by a complex array of factors (including labour cost, farm size, size of tractor and intensity of use) but can occur rapidly without government intervention thus:

> *Where the transition to the tractor is profitable, rapid adoption of tractor power often takes place with minimum government involvement. Supply-side constraints are not a bottleneck in their adoption. Repair and service facilities follow demand — where they are not restricted by government policy — and privately operated machines typically have long lives and high rates of utilization."* (Pingali *et al.*, 1987)

7.1.5 Guidelines for profitable mechanization

The concepts outlined above provide guidelines for the introduction and expanding use of new power sources and machines. Mechanization is a consequence, not a cause, of increased crop yield per unit area or increased cropping intensity. Hence the use of power and machinery must be restricted to levels which can be justified by achieved yields. Power intensive operations are the first to be mechanized in viable production systems, followed later by skill intensive operations.

The progress of mechanization is linked with the development of farming systems — the financial effects of changes must be assessed using suitable economic techniques such as partial budgeting (AGS Bulletin 110). At this stage calculations will be approximate and must be revised after selecting the actual machine and power source to be used.

The process of machine selection is fundamentally invalid unless the basic conditions for the development of mechanization have been satisfied. Much time, effort and money would have been saved in the past if these guidelines had been understood and received due consideration.

7.2 PROCEDURES FOR MACHINERY SELECTION

Selection implies choice according to criteria set by the potential user. Freedom of choice is often limited because government, a testing organization or aid agency, may already have decided to offer one particular machine which it wishes to promote, without consulting the prospective user. The whole process of evaluation and selection is redundant in such cases, even though the machine may be offered on advantageous terms (gift or subsidy).

When genuine choice exists, even if limited, machinery selection goes hand in hand with evaluation. If choice is limited to only a few machines it may be possible to make a selection based simply on a rather intuitive evaluation of such information as may be available without any formal processing. In more complex cases the information gathered must be arranged in a form which facilitates a systematic feature by feature comparison of available machines.

There are no acknowledged procedures for selection of farm machinery but it will generally be convenient to use the same headings as were put forward when considering evaluation, *viz.*:

- machine quality;
- technical performance;
- costs and benefits;
- user friendliness; and
- operational support.

Individual features may then be compared under each heading, on a machine by machine basis, in as much detail as desired, subject to limitations of the information gathered. Comparison is best made in tabular form. An example is shown in Table 7.1, where assessments are made of four machines for a number of features under the 'machine quality' heading. Each machine is awarded a score for selected items under this heading, the scores ranging from, say, 0 (bad) to 4 (very good).

Table 7.1 Example of evaluation and selection of four machines under the general heading of 'machine quality'

Item	Weighting	Machine			
		A	B	C	D
Quality of materials (general)	1	1	1	3	2
Quality of materials (wearing parts)	3	1	2	3	3
Quality of construction	3	2	3	3	3
Quality of components	2	2	3	3	2
Availability of components	3	3	1	1	2
Reliability	3	1	3	4	3
Weighted total	60 (max)	26	34	42	39
Weighted total out of 60 (max) (*i.e.* divide by 60):		0.43	0.57	0.70	0.65
Weighted total on scale 1 to 4 (*i.e.* multiply by 4):		1.7	2.3	2.8	2.6

Note: 1. Each feature is scored: 0 = bad; 1 = poor; 2 = satisfactory; 3 = good; 4 = very good

2. Each feature is weighted: 1 = limited importance; 2 = moderately important; 3 = important; 4 = very important.

3. The table is constructed as a hypothetical example. Scores and weightings are for example only and may be varied according to the individual's opinion.

The next step is to award each item a weighting ranging from, say, 1 (limited importance) to 4 (very important). This must be done by individual farmers since the importance of each item will vary from one to another. Reliability, for example, will be less important for farmers who have quick and easy access to good repair facilities. Weighted scores, *i.e.* score multiplied by weighting, may then be totalled to give an overall weighted evaluation for each machine which may be used to calculate an overall assessment on a scale from 0 to 4 as shown. The procedure depends upon the availability of reasonably reliable data, including the results of tests, and the ability to make balanced judgments on particular features, perhaps making use of professional advice. Comparative test data is particularly valuable.

A similar process is undertaken for the features under each of the other headings. The economics of operation may be calculated using the methods shown in AGS Bulletin 110 making any adjustments necessary to deal with local circumstances, especially those relating to costs of machinery repair and maintenance, which may vary considerably from country to country.

The evaluations made under each of the headings may then be collected together to give a comprehensive final assessment as shown by the example in Table 7.2. Selection may be based on addition of the unweighed scores or, as shown, the scores may be weighted at the discretion of the user according to his/her opinion on their relative importance. In the example shown machine D is the first choice, subject to final review.

Consumer testing organizations in many countries conduct their own item by item analysis of domestic goods under various headings corresponding to those suggested above for agricultural machinery, using information collected on competing products including the results of tests specially made. Assessments made under each heading are then presented to potential users, together with explanatory notes when thought necessary, so that consumers may make their own judgements on the relative importance of each heading and make their selection accordingly.

Table 7.2 Example of scores leading to final selection from four machines

Heading	Weighting	Machine			
		A	B	C	D
Machine quality	2	2	2	3	3
Machine performance	3	2	3	2	3
Economics of operation	3	3	2	2	2
User friendliness	4	2	3	2	2
Operational support	4	3	1	1	3
Weighted total (max)	64	39	35	30	41
Weighted total out of 64 (max) (*i.e.* divide by 64):		0.61	0.55	0.49	0.64
Weighted total on scale 1 to 4 (*i.e.* multiply by 4):		2.4	2.2	2.0	2.6

Note: 1. Each heading is scored 0 = bad; 1 = poor; 2 = satisfactory; 3 = good; 4 = very good.

2. Each heading is weighted 1 = limited importance; 2 = moderately important; 3 = important; 4 = very important.

3. The table is constructed as a hypothetical example. Scores and weightings are for example only and may vary according to the individual's opinion.

7.3 THE POTENTIAL FOR SYSTEMATIC MACHINERY SELECTION PROCEDURES

There are no generally recognized and adopted procedures for machinery selection — those outlined above are not (as yet) in general use. This is unsatisfactory as the considerable effort put into machinery testing in the past has been largely wasted for lack of a clear definition of the information which is important to the machinery user and a methodology for presenting and considering it.

Lessons may be learnt from organizations which have been set up to help consumers with selection of domestic goods. They take a range of competing products and make informed assessments of each under a number of carefully chosen headings. Results are presented in user-friendly format, reviewing the relevance of particular features but leaving the consumer to make the final selection according to individual priorities. Agricultural machinery is required to operate in a wide range of circumstances, so it may be desirable to set up evaluation procedures which are more location specific. Local farmer groups, manufacturers, machinery suppliers, specialist advisers and machinery testing units should be involved in discussions to determine information needs and methods for obtaining and publishing it. Results must be subject to regular monitoring, review and refinement.

Chapter 8 Selection services for machinery users: the institutional framework

8.1 THE MACHINERY USERS' NEEDS FOR INFORMATION AND ADVICE TO ASSIST MACHINERY SELECTION

From time to time farmers and farm managers involved with machinery selection are likely to need information and advice on:

- the potential for better and/or increased mechanization;
- the potential performance of power sources and machinery which are available to them (by purchase, hire, loan, *etc.*), including a realistic assessment of costs and benefits arising in their particular circumstances;
- the relative advantages of hire or ownership; and
- efficient operation and management of selected equipment.

Information and advice services should be:

- readily accessible when needed;
- responsive and reactive — allowing interactive discussion to assist the user in formulating and implementing a clear action plan to take advantage of identified mechanization opportunities;
- comprehensive — providing information on all aspects to be evaluated, preferably from a single source, *i.e.* a 'one-stop shop';
- objective and impartial; and
- prompt in providing requested services.

Most farmers would no doubt welcome the opportunity to discuss their choice of machinery with specialist staff in an advisory service, although the final decision on which machine to buy should be the farmer's.

8.2 INFORMATION AND ADVICE SERVICES AVAILABLE TO MACHINERY USERS

Even when no specialist service is available there are other sources of information and advice which are potentially available to farmers interested in purchasing a machine. Some of the sources are interactive, *i.e.* the user is able ask questions of them and discuss their answers. Other sources, for instance radio and television presentations, provide information which may be interesting and useful but may not be recalled accurately and must be followed up from other sources.

Some of the main sources of information and advice which are generally available to farmers in developing countries are listed in Table 8.1. An attempt has been made to assess their relative usefulness to farmers seeking comparative information on a range of machines. They are judged, using a scale from 0 to 3, against the criteria shown, to give an overall assessment of their usefulness, as explained in Table 8.1.

Table 8.1 Evaluation of agricultural machines: sources of information available to the farmer and assessment of their relative usefulness (example only)

	Information criterion						
Information source	ACC	UND	INT	APP	REL	COM	Overall
neighbouring farmers	3	3	3	3	2	1-2	36-39
newspapers, journals	0-2	2	0-1	1-2	2	1	0-16
radio, television	0-1	2	0	1	2	0-1	0- 6
agric shows and demonstrations	0-1	2	2-3	1-2	2	2	0-11
extension services:							
government	1-2	2-3	1-3	2-3	2-3	2-3	9-30
company	3	2-3	2-3	3	2-3	0-1	27-39
universities	0-1	1-2	1-2	1-2	2-3	0-2	0-11
research institutes	0-1	1-2	0	0-2	2-3	0-1	0- 8
suppliers	1-2	2	1-2	2	2	2	9-20
testing services	1	1-2	0	1-2	3	2-3	7-10

Notes: 1. Information criteria:
ACC/essible; UND/erstandable; INT/eractive APP/licable; REL/iable; COM/parative.

2. Gradings for source of information:
O = unhelpful; 1 = limited; 2 = good; 3 = very good.

3. Overall rating = (UND + INT + APP + REL + COM) x ACC

4. This table is presented as an example of how information sources may be ranked for effectiveness. Obviously the ratings will vary from country to country and (to a lesser degree?) with the opinions of the assessor. If the concept is acceptable the scores and scoring system may be adjusted to taste.

The gradings shown are hypothetical ones made by the author for a 'typical'(?) developing country. Readers are invited to make their own judgements for a real country. Gradings will vary, for example, many government extension services have no machinery specialists, so that their effectiveness may differ; newspapers and journals will be more or less accessible depending on geographical location and literacy of the farmer; radio and television programmes may not be available to many farmers in rural areas where there is no electrical supply.

The two best sources of information, based on the gradings awarded, are neighbouring farmers and extension services, particularly those run by commercial companies which provide advice for farmers growing cash crops under contract. These are followed in order by dealers and leaflets, periodicals and newspapers, test reports, demonstrations and agricultural shows, radio and television.

8.2.1 Institutions which might provide information and advice on machinery selection

Most countries support a range of government funded institutions which might have relevance to machinery selection. Agricultural extension services are usually provided, although their expertise in mechanization is rather variable. Some crop research institutes may be involved with particular mechanization problems. Machinery testing centres have been set up in many countries, often as a unit within the Ministry of Agriculture, perhaps within an Agricultural Research Council, or sometimes in conjunction with a university. Other government institutions engaged in machinery design and development (including testing) might be able to contribute relevant information.

Within the private sector there are various ways by which valuable information on mechanization matters is provided to farmers. Commercial organizations involved with cash crops such as sugar beet often award production contracts to farmers and find it beneficial to provide them with specific information and advice, including advice on mechanization and machinery. Agricultural societies, trusts and producer associations often provide information to their members on machinery use and new developments, sometimes including specialised machinery testing and advice services.

The list below gives only a very few examples of institution(s) in the categories mentioned:

- government extension services — are provided by most governments, run on national or regional (state) basis;
- crop research institutes:
  - International Rice Research Institute, Philippines;
- machinery research institutes:
  - Farm Machinery Institute, Islamabad, Pakistan;
- testing institutes or units:
  - Agricultural Machinery Testing Unit, Nakuru, Kenya;
  - Agricultural Engineering Division, Ministry of Agriculture and Cooperatives, Thailand;
- combined research and testing institutes:
  - Institute for Agricultural Engineering Research, Harare, Zimbabwe;
- universities and university-linked units:
  - Institute for Agricultural Research, Ahmadu Bello University, Nigeria;
  - Agricultural Machinery Testing and Evaluation Centre, Los Baños, Philippines; and
- private associations:
  - Agricultural Research Trust, Harare, Zimbabwe.

8.3 EXISTING INFORMATION AND ADVICE SERVICES: PROBLEMS AND POSSIBILITIES

The assessment of information sources, as made in Table 8.1, suggests an order of effectiveness approximately as follows:

- high impact:
  - neighbouring farmers;
  - private sector extension services;
  - public sector extension services;
- medium impact:
  - suppliers;
  - testing services;

- moderate to low impact:
  - universities;
  - research institutes;
  - agricultural shows and demonstrations; and
  - media (press, radio, television).

Although the list is obviously not definitive and will vary from country to country, the sources are considered below in the order shown.

8.3.1 Neighbouring farmers

Neighbouring farmers are highly rated on all aspects of information except for comparisons with alternative machines and methods. For the machines of which they have had experience, whether good or bad, they will no doubt continue to be a valuable source of information into the future. Regrettably it is quite common to find that insufficient attention is given to farmer experiences in official circles — there is a tendency to reject farmer judgments as uneducated. Arrangements must provide for a fully interactive approach between advisory organizations and farmers, so that each may benefit from the lessons of their experiences.

8.3.2 Private extension services

Private companies involved with the purchase of specialist crops may provide comprehensive extension services to contract growers, including advice on mechanization. Hire services may also be provided for some mechanized operations. Such services are usually of a high technical standard, but available only to the company's client farmers.

Considerations of commercial competition make it difficult to predict whether private companies might cooperate in making their expertise more widely available. It is worth investigating the possibilities, which will no doubt vary from company to company and from country to country.

8.3.3 Government extension services

The governments of most countries maintain an agricultural extension service aimed at providing direct and practical support for farmers. A well run service is accessible, with close contacts between farmers and extension officers. The service should therefore be in an excellent position to deal with requests from farmers for information on matters relating to mechanization and machinery selection.

Two major problems may arise. First, it is much easier for extension services to adopt a top-down approach by promoting preselected information and training to farmers, rather than listening to and responding to problems as perceived by the farmers themselves. Second, only a few extension services have enough well qualified and experienced staff, backed up by information systems and equipment, to offer well founded information and advice on mechanization and machinery options. Subject matter specialists in mechanization are one of the rarer members of the species.

Nevertheless extension services are set up to maintain good contacts with farmers. They should be well placed to supply the farmers' needs for information and advice on mechanization and machinery selection, provided that they are prepared to interact with farmers rather than merely transmit messages to them. In many cases significant reinforcement of mechanization staff and facilities may be needed. A two way flow of information and experiences is essential to a healthy extension service.

8.3.4 Machinery suppliers

Established machinery suppliers generally provide verbal or printed information on the machines which they offer for sale, but of variable quality. Sales literature from manufacturers and dealers is sometimes backed up by reprints of reports on officially conducted tests, underwriting the validity of claims made by the supplier, particularly those relating to machine quality and performance.

Suppliers should be encouraged to publish information on:

- addresses of local stockists of machines, with prices and availability;
- addresses of stockists for replacement parts with details of:
  - parts held with guaranteed instant availability;
  - costs of replacement parts needed for routine maintenance;
  - costs of replacement for the main wearing parts such as ploughshares, plough discs, cultivator points, milling plates; and
- service facilities:
  - location;
  - costs of routine maintenance operations.

This information should be collected from all suppliers, coordinated and published regularly, *e.g.* quarterly, to provide essential information for users, and for potential users, in making their evaluations. Such competitive procedures should encourage machinery suppliers to improve their services. Validity of the information should be monitored by spot checks.

8.3.5 Machinery testing organizations

Agricultural machinery testing units have been set up in many developing countries with the intention of providing a testing service for machinery manufacturers, suppliers and consumers. Consumer testing has generally suffered from conflicts of interest which occur when it is mixed with higher profile activities such as supply-side testing and the development of innovatory products in the name of 'research and development'. Most such attempts have resulted in expensive failures. It is now widely accepted that nearly all public sector institutions engaged in machinery research, design, development and production have a poor or bad record of commercial achievement when compared with corresponding entrepreneurial activities in the private sector and when related to the investment consumed.

Thus supply-side testing has diverted attention from the field testing of machinery and other in-country investigations of value to the consumer, for example: conditions for profitable machine use; machinery evaluation and selection; machinery operation, repair and maintenance and techniques of use.

There must be some doubt whether machinery testing units which have been dominated by supply-side testing for a long time, and sometimes also by machinery research and development, will be able to adjust to supplying services which are responsive to consumer demand. A different philosophical approach is needed for consumer testing and suitable test procedures must be established.

User-responsive machinery testing is probably best located with an independent institution whose work is orientated towards the application and operation of machines on the farm rather than towards machinery design and development. Design, development and manufacturing activities should

be discontinued if the institution is to build up and maintain effective user-responsive test programmes.

The case for maintaining supply-side machinery testing should be considered as a separate issue. If supply-side testing is a viable activity in its own right it would be sensible to avoid duplication of facilities used for functional tests which are of common interest to suppliers and to users, although with differences of emphasis. Such facilities might be used for work commissioned under contract arrangements, as needed.

8.3.6 Universities and university-linked units

Universities have a long association with agricultural machinery testing starting with Nebraska in 1919 and followed by Oxford in 1924. The tradition is maintained at many universities throughout the world, which are hosts to government funded machinery testing organizations or have set up integral units for specialist activities, including mechanization research and/or extension, machinery development and testing.

Machinery development and testing activities at Universities have, in general, focused upon a particular subject area constituting a specialised research interest, such as spraying technology, rice production or processing of oil palm fruits. Such areas of expertise often involve an integrated broad-spectrum approach which includes machine design, testing and in-field trials backed up by a valuable blend of theoretical and practical skills in agriculture and engineering. Equipment levels and technical support facilities are usually good.

When a university has built up specialist testing facilities to a high level of excellence it will be wasteful of resources to attempt to duplicate them. Their use should be incorporated into an overall strategy for mechanization development, including the evaluation and testing of machinery, according to the specialist interests involved in the university's training and research programmes.

8.3.7 Research institutes

Research institutes have been set up for many specialist crops (rice, sugar beet, cocoa, maize, *etc.)* and disciplines contributing to agricultural production (soil science, entomology, *etc.*), usually on a national basis but sometimes internationally. Specialist machinery development and evaluation units have been established within many of these institutes, for example the Engineering Division of the Nigerian Institute for Oil Palm Research has developed equipment for village scale oil extraction. Such institutes should be formally associated with a national machinery evaluation and testing service so that their expertise and facilities may be available as and when needed.

8.3.8 Private institutes

Privately financed agricultural organizations (societies, trusts, institutes *etc.*) have been established in some countries for many years and have frequently been involved with mechanization matters, including machinery evaluation and testing. The Agricultural Research Trust in Harare is a notable example. Among other activities it tests machines such as combine harvesters, which are used by a minority of farmers and consequently are not high on the government's list for priority testing. Tests are usually done on a commercial basis, paid for by the machine's manufacturer/dealer, and are highly respected by dealers and by members of the Trust *i.e.* the potential users.

Private institutes involved in machinery testing will probably always work in closely defined areas in accordance with their customers' demands, paying particular attention to customer satisfaction

by the competence of their work and by prompt publication and circulation of reports. Their expertise will be capable of making a significant contribution to a national strategy for machine evaluation and testing. Governments should avoid costly duplication of their facilities, recognizing that such institutes can make a cost-effective contribution to machinery testing.

8.3.9 Agricultural shows and demonstrations

Agricultural shows provide an opportunity for manufacturers and dealers to exhibit their products and for farmers to compare them — assisted sometimes by working demonstrations in-field so that potential users can make their own comparative judgements by observing machines working side-by-side in realistic conditions.

Demonstrations or 'field days' may be arranged independently of agricultural shows, allowing more flexibility in frequency, timing and location. Extension service officers sometimes arrange such demonstrations, possibly in conjunction with publishers of farming journals, who will subsequently publish assessments of machine performance and other relevant features, on a comparative basis. Products of particular interest to local farmer groups may be targeted, *e.g.* crop spraying machines, and presented in competitive demonstrations.

Field days are best organized as demonstrations of competing machines. Farmers have a good opportunity to observe performance, exchange information and also to meet local dealers, rather than national ones, to check up on their after-sales service arrangements. Farmers may provide valuable feedback to the organizers through carefully designed questionnaires.

8.3.10 Media coverage

The media are generally open and available to those individuals or organizations having something to communicate, if it is judged to be of interest to the public or an identified specialist group such as farmers.

The electronic media — radio and television — sometimes run regular agricultural programmes which may be used to draw attention to profitable machines and methods, whether traditional or innovatory. However the impact of such reports is short-lived unless followed up in other ways, for example by ensuring that a written version of the information transmitted is available to listeners or viewers, quickly and easily. This need must be taken into account when planning the programme.

The printed media — newspapers and journals — are more permanent than the electronic media, but may not be so accessible to farmers in developing countries. Daily newspapers circulate most intensively in urban areas and are unlikely to carry user-orientated articles on agricultural mechanization. Some specialist journals are aimed at agricultural or agribusiness interests, but their circulation in rural areas is generally low. As with the electronic media, it is important to ensure that readers are told how to get additional information.

8.4 SUGGESTED INSTITUTIONAL ARRANGEMENTS FOR ASSISTING MACHINERY SELECTION BY FARMERS

8.4.1 The need for a Mechanization Information and Advice Service

Effective machinery selection depends on the availability of potentially viable machines and the systematic evaluation of all relevant information on them. It is clear that farmers in developing

countries need help and advice in the collection of information, its processing for evaluation and in making the final selection. Existing institutions are not meeting the farmers' needs. Available information is inadequate for the purpose of effective selection, its flow to the farmer is seriously defective and farmers are inexperienced in its evaluation. Can this situation be remedied using existing institutional arrangements or must they be changed?

It will be instructive to hypothesize an ideal institution which would fulfil the farmers' needs and examine the extent to which existing institutions are able to supply the necessary expertise, or could be adapted to do so. For this discussion the ideal institution will be called a Mechanization Information and Advice Service (MIAS). Its objectives and duties must be expressed, after which it should be possible to consider the extent to which these can be met by existing institutions and what new arrangements might be desirable. The exact solution will obviously vary from country to country.

8.4.2 Objectives and functions of a Mechanization Information and Advice Service

The principal objective of a service to meet farmers needs on machine selection in a wide mechanization context may be expressed as a single aim:

> *To inform and advise farmers wishing to enrich their livelihoods through the introduction and/or improved use of power and machinery on their farms and associated enterprises."*

Related functions are:

- **classifying farming systems:**
  - build up and keep under review a methodology for classifying farming systems according to their mechanization potential;
  - establish guidelines for farmers wishing to draw up a mechanization strategy for their farms;
- **machinery selection:**
  - build up a database enabling the characteristics of an individual machine or power source to be compared with others in its class, for the purpose of evaluation and selection, according to:
    - quality;
    - technical performance;
    - costs and benefits;
    - user friendliness;
    - operational support requirements;
  - provide information and evaluation guidelines for farmers wishing to select machines for specified tasks;
  - review the farmer's choice of machine in discussion with her or him;
- **machinery testing:**
  - establish user-orientated procedures for comparative testing of different classes of machines, in discussion with machinery users;
  - undertake or arrange for performance testing of different classes of machines according to priorities agreed with machinery users;
- **undertaking surveys:**
  - undertake, or arrange for, surveys relevant to machinery evaluation, *e.g.* prices of machines and frequently needed replacement parts, training requirements and provision, *etc.*;
- **identifying sources of finance and credit:**
  - collect information and advise farmers on sources of finance;

- **training:**
  - provide appropriate training for subject matter specialists, mechanization advisers, machinery demonstrators, testing staff, survey enumerators, *etc.*
- **publishing:**
  - vigorously publish and publicize, in user-friendly format:
    - ¤ guides to mechanized farming development;
    - ¤ guides to machinery selection procedures for farmers, including testing and evaluation;
    - ¤ evaluation and performance test reports, in comparative format, for different classes of machines;
- **demonstrating:**
  - promote and arrange, or cooperate in arranging, machinery demonstrations at agricultural shows, local field days, demonstration farms, *etc.*, providing an information and advice service at them.

8.4.3 Establishing a Mechanization Information and Advice Service

In many countries some of the objectives of a comprehensive MIAS as outlined above are already provided for, at least nominally, but probably spread amongst a number of separate organizations. It might be possible to establish a MIAS as a new, independent and separate institution by collecting existing activities into it, with additional responsibilities as needed. This is likely to be a high cost option to be approached with great caution.

Alternatively the MIAS might be run as a Centre for coordinating the work of existing institutions, building up responsibilities within them to deal with activities not already represented. To be effective the Centre must be provided with the necessary authority and funding, combined with strong leadership and practically orientated but innovative and dynamic staff. Such an arrangement might provide an effective option at relatively low cost.

Whatever solution is adopted it will be necessary to examine linkages with existing institutions such as machinery testing organizations, extension services and universities.

Linkages with machinery testing organizations

Most existing machinery testing organizations have shown little interest in developing procedures for comprehensive evaluation of machinery from the farmers' viewpoint. Their work has generally been dominated by supply-side activities. A Machinery Information and Advice Service has a broader brief and must be the senior partner in any association with a testing unit. If machinery testing units are to achieve credibility to consumers as providers of independent advice they must forego major involvement in machinery research, design, development and manufacture.

If existing machinery testing units are to respond adequately to consumer demands it will be necessary for most of them to undergo profound changes in outlook. Such changes are essential if they are to form effective links with a MIAS

Linkages with extension services

Extension services might be considered as suitable organizations for providing a machinery evaluation and selection service. They are heavily engaged in information flow and generally have excellent contact arrangements with large numbers of farmers. However most extension services tend to adopt a 'top-down' prescriptive approach, putting across various messages which they perceive as

important according to the current stage of the crop production cycle.

A Mechanization Information and Advice Service must adopt a more investigatory approach by listening to farmers needs, helping them to formulate the questions which must be answered to deal with their problems effectively and then researching and developing solutions in which farmers have confidence and which they are willing to try. This work is different in character from conventional extension services. If a MIAS were to be established as a component of the extension services structure it must be as a separate and autonomous unit with freedom to approach and cooperate with other institutions as deemed appropriate.

Linkages with universities

Agricultural faculties in many universities already operate outreach or extension programmes which complement and cooperate with government extension services, or sometimes substitute for them. Such arrangements are of long standing and acknowledged effectiveness, *e.g.* in the United States of America and in Scotland. Similar arrangements are in operation at the University of Peshawar, Pakistan, and Ahmadu Bello University, Nigeria. A Mechanization Information and Advice Service has similar investigative duties, suggesting that association with a university may be a beneficial arrangement. A major advantage would be that mechanization (of which machinery selection is a key component) is a neglected research area at the present time and would benefit from the enquiries and insights which a university stimulates.

If there is only one national university an MIAS might be located on or close to its campus. Countries having more than one university with an agricultural faculty might set up a number of MIAS units, each in a distinctive ecological zone, with one of them designated as the coordinating centre which should make use of existing 'centres of excellence' in specialised aspects of mechanization. Thus an institute with good facilities and reputation in spraying technology would be affiliated as a specialised consultancy unit to undertake investigations on a contract by contract basis, as necessary. Such flexibility would allow more dynamic and cost effective modes of operation than those of the large 'national' centres which were in vogue in the 1960s and 1970s.

Although universities are often thought of as 'ivory towers' the work of their agricultural faculties is usually farmer orientated, with research workers showing considerable concern that the results of their investigations are applicable in typical farming conditions. A progressive agricultural faculty with specialization in mechanization studies should be able to link effectively with a MIAS, with mutual benefits.

Linkages with the Ministry of Agriculture

The possibility of locating a Mechanization Information and Advice Service within the Ministry of Agriculture must be given due consideration. Units with strong farm machinery links exist in a number of countries, for example the Agricultural Engineering Division in Thailand. Most are, however, supply side orientated rather than user orientated and the general comments made on machinery testing organizations will apply to most of them.

8.4.4 Guidelines for locating a Mechanization Information and Advice Service

A consumer orientated Mechanization Information and Advice Service will be a new concept in most countries. A pioneering idea is best initiated by pioneering staff in a new environment, while financial realism demands that costs should be at the minimum needed to achieve effective results. The new service should not duplicate existing facilities.

A small dynamic unit having a coordinating role is indicated, located within or in close relationship to an existing progressive institution with related interests, where a stimulating interaction may be anticipated. Some possible locations are discussed above. Each is feasible, but their relative desirability will vary from country to country and must be judged according to circumstances within individual countries.

Some criteria which might be used in reaching a decision on the institution with which an MIAS might be most closely associated include:

- interactive involvement with farmers;
- compatibility and complementarity of interests;
- intellectual stimulation;
- progressive attitudes;
- good communications with other cooperating institutions;
- access to a variety of typical farming systems (geographical location); and
- costs of establishment.

The situation in each country will differ in detail and must be examined carefully to decide which is the preferred solution to match its own unique circumstances. From the above discussion it appears that a meaningful relationship might arise from close association with the Faculty (or Department) of Agriculture of a University, provided that it has strong interests and experience of mechanization development undertaken in collaboration with farmers.

The next most favourable association might be with an extension service which is prepared to undertake an investigative rather than a prescriptive approach to its work with farmers.

Location as a unit within the Ministry of Agriculture might be justified provided that it has autonomy with freedom to adopt an innovative approach and is not subjected to excessively bureaucratic committee and financial procedures.

The MIAS should not be located in conjunction with a machinery testing unit unless the unit is constituted, or reconstituted, to concentrate on consumer testing and evaluation in-field and in discussion and collaboration with farmers. Some testing facilities might be used in common with supply-side testing activities as necessary. The testing unit should become a constituent unit of the MIAS. Machinery research, development and manufacture should be regarded as a function of the private sector and discontinued as an in-house activity.

The size and diversity of a particular country might justify the establishment of several MIAS units located in differing ecological zones, based on technical rather than political considerations. One of the MIAS units should be designated as the 'lead' unit in such cases.

Notwithstanding their location, MIAS units must maintain strong professional, intellectual and working links with all organizations involved in agricultural mechanization in the agricultural, industrial and commercial sectors. Working links with farmer organizations and with individual farmers are the *raison d'etre* of the MIAS units and should be given priority at all times

8.4.5 Funding a Mechanization Information and Advice Service

Mechanization Information and Advice Service units should be responsive to the demands of machinery users. This will be the case if the Service works under contracts made with users and paid on delivery of specified work — an idealistic arrangement, but one which illustrates a principle.

More realistically it must be accepted that farmers as a group will not be able to pay for the services to be provide by the MIAS. Government must pay on behalf of the farmers using the service. However, government funds are derived indirectly from national wealth created in part by the agricultural sector and retained by government through taxation, or other less obvious mechanism, so in effect the principle is maintained.

A mechanism which might act to encourage accountability to machinery users would be to allocate funds to the Service to be used for work specified by farmers, or farmers' groups representing the interests of a particular category of farmers, for example maize growers or those using draft animal power. The Service should be empowered to place contracts directly with private or public sector organizations for work to be done by them, and to undertake work for them on a strict commercial basis.

Chapter 9 Conclusions

9.1 MACHINERY SELECTION IN CONTEXT (INCLUDING EVALUATION AND TESTING)

When a particular issue is highlighted for discussion it is necessary to stand back from time to time to assess its relative importance in a larger context. Discussion in this bulletin has led to suggestions for formal arrangements and procedures for machinery selection, including evaluation and testing, which might be of benefit to machinery users, culminating in proposals for establishing a Mechanization Information and Advice Service.

Proposals must be looked at in the context of other possible improvements to the mechanization of farming systems for small-scale farmers in developing countries. What is their importance relative to other activities which might contribute to this end? To what extent do they justify the investment of scarce and expensive resources compared with alternative investments? There are a number of alternative lines of action which should be given attention alongside, or even before, setting up a MIAS. In particular it appears that those developing countries in which mechanized agricultural production is making relatively rapidly progress are characterized by:

- relatively profitable farming systems;
- a relatively strong industrial infrastructure providing good support for local small-scale manufacturers and repairers of basic machinery, whether powered by humans, animals or tractors; and
- good access by farmers to privately run tractor-powered contracting services.

Programmes to develop these features must be examined alongside other possible developments to ensure the optimum deployment of scarce resources.

9.2 ALTERNATIVE AND COMPLEMENTARY PROGRAMMES

9.2.1 Changes to the farming system

Machinery selection is of little assistance to small scale farmers surviving on a marginal income. Until their farming systems have been made more profitable it may not be possible for them to afford the costs of power, other than family labour, or of machinery, other than hand tools. Improvements in profitability can only come from additional income derived from the farming system or by reduced costs of production.

Increased farm income may arise from:

- increased quantity of crops produced and sold at stable market prices:
  - increased area cropped while yield per hectare is maintained;
  - improved cropping index (crops per year), perhaps through irrigated production;
  - improved yield per hectare — crop varieties, fertilizer, pest control (including weeds), timeliness of operations, *etc.*
  - improved market access — transport and roads;
- improved crop prices at existing or improved production levels:
  - change to higher value crops;
  - prices guaranteed by government;
  - growing under guaranteed contract prices; and
  - crop value enhanced by on-farm processing.

Reduced costs of production may arise from:

- increased labour productivity:
  - more efficient working methods;
  - use of more productive equipment

Current policies aimed at reducing subsidies for agricultural products are largely a reaction to excessive subsidization in the past — in industrialized countries, not developing one. Subsidies were successful in rescuing agricultural production from years of depression, a situation which now exists in many developing countries where crop prices have been consistently low for many years. Low prices (cheap food) often represent a hidden subsidy to the non-agricultural sectors (industrial, commercial and public) and obstruct investment for agricultural development. A significant increase in crop prices may be justified to redress the balance for low prices paid in the past, to increase current farming profitability and help to provide for future investment in improved production practices, including mechanization.

Priority must be given to improving farm profitability when it is low. Additional mechanization, and hence the need for machinery selection, only becomes viable (in the absence of subsidies) when it can be paid for from increased profits.

9.2.2 Improving the supply of machinery

Procedures for machinery selection, however well devised and executed, are of no value until there is a good range of machines available from which to make a choice. Local availability with efficient after-sales service is essential.

Imported machinery

Any restrictions on the import of machinery should be kept under review. They limit the user's freedom of choice and should be lifted unless there are compelling reasons otherwise. Machinery importers must set up an effective distribution and service network for their machines to ensure that they are truly available for purchase by the farmer.

Locally manufactured machinery

Locally manufactured machinery of good quality is available in many Asian countries, but African countries lag behind, particularly the majority of those south of the Sahara. One notable difference between the two groups of countries is in the supply of steel in a range of sections — angle, strip, plate, round and rectangular hollow sections, *etc.* — suitable for machine production. Manufacturing facilities set up in Africa with the help of foreign companies usually arrange privileged importation of steel stock, while local companies must rely on local supplies which are virtually non existent or unreliable at best. The steel industries — production plants and rolling mills — which should have been set up in some countries under long standing policies have been established only nominally, with massive delays, and are not delivering the required goods to local manufacturers. The supply of components such as bearings and drive belts also tends to be weak and unreliable.

Local manufacturers generally operate on a small (or 'micro') scale of production and are spread throughout the country, with little influence on government policies and their implementation. Their potential role and contribution to mechanization development is vital but is seldom adequately recognized in government policies. Local metal-working artisans can flourish only when they have access to a supply of good quality raw materials, production equipment, skills training and credit. It

is essential that government industrial policies should facilitate supply of these essential inputs, but they often fail to do so.

Governments must give very high, if not the highest, priority to arrangements which encourage and facilitate local manufacture of good quality machinery.

9.2.3 Access to alternative power sources

Hand labour is at present the only source of power for many small-scale farmers in developing countries. Additional power from draft animals is not feasible in many regions due to endemic disease such as trypanosomiasis or other cause. Farmers then have no alternative to hand labour unless they have access to tractor (engine) power, whether by ownership, hire or other arrangement. Early attempts to provide tractor power to small-scale farmers concentrated on government managed contracting or hire services, with consequences which would have been financially ruinous to any commercial venture.

Subsequent developments, particularly in Asia, have shown that private contractors are able to provide economically viable tractor-powered contracting services and it is now widely accepted that any remaining government-run tractor hire services should be closed down in favour of contracting services which are privately owned and managed. This policy has been adopted in many countries with varying degrees of success. In some countries government or state run services have been privatised only nominally and are still managed through a hierarchical structure dominated by public sector procedures, although sometimes devolved to local government level.

When reliable and efficient contracting services are available, small-scale farmers have more flexibility in selecting the most appropriate machinery to be used on their farms. Tractor mechanized operations do not necessarily involve tractor and machinery ownership.

9.3 THE ROLE AND IMPACT OF MACHINERY TESTING

The past impact of machinery testing services must be judged in relation to its contribution to the differing needs of supply-side customers and of consumers. Supply-side machinery testing has been undertaken quite extensively and may have benefitted farmers by helping to refine the design of some machines already in production by local manufacturers — a seal of approval is awarded to good quality machines in some countries. But in general supply-side testing has a relatively small role to play in developing countries until local manufacture takes off. Reports on supply-side tests have been largely inaccessible to the majority of farmers and they have contributed little to machinery selection.

Machinery selection becomes necessary only when a choice of machinery — whether manufactured locally or imported (or both) — becomes available. Machinery evaluation becomes important at this stage and consumer testing has a potentially significant role to play in contributing to evaluation procedures. Consumer orientated machinery testing is not well developed and farmers have had to select machines using information from other sources. In some countries they have done this with some success, so that mechanization has made good progress. In other countries mechanization has progressed more slowly. There is no suggestion that relative success has been the result of superior machinery selection, whether by the farmers or by others on the farmers' behalf.

A wider choice of machinery leads to a greater need for well informed machinery selection. Consumer testing assumes increasing importance, although in general it has received less attention than supply-side testing. Existing test procedures with their supply-side bias must be completely

rethought and reconstructed if the change to consumer testing is to be effective. However the change should not be expensive. Procedures for consumer testing should emphasize comparative in-field tests and demonstrations rather than functional tests. The need for expensive instrumentation will be much less.

9.4 MACHINERY EVALUATION AND SELECTION

Techniques for the evaluation and selection of agricultural machinery, particularly as related to the earlier stages of mechanization, are not well developed. Data requirements and methods of presentation and interpretation have not been precisely identified. Consumer testing must be related to identified needs as a specific aid to comparative evaluation and selection. Procedures to fulfil identified needs have not yet been adequately investigated and established. Applied research is needed, as with many aspects of mechanization, to clarify needs and procedures .

9.5 TOWARDS A MECHANIZATION INFORMATION AND ADVICE SERVICE

It has generally been assumed that the major objectives of agricultural machinery testing have been to improve product quality and to assist farmers in selection of the most suitable machinery for use on their farms. This document has examined both assumptions, concentrating on the second in accordance with the terms of reference implied in the title. It has also considered how machine testing fits into the overall process of machinery evaluation, as a preliminary to selection.

Farmers in developing countries have been very poorly served with information needed for proper selection of machinery and advice on its interpretation, in the light of their individual circumstances. Machinery testing has had virtually no impact on their selection decisions. Provision of comprehensive information and procedures for its evaluation have not been given attention. Farmers have made their own decisions with customary independence and, in most cases, a reasonable degree of success.

The problem of machinery selection has not been too urgent in many countries because there has been little choice of machines, local manufacture having been restricted because of shortcomings in the industrial infrastructure. As more machinery becomes available its selection becomes a more complicated process. If farmers are to be given the opportunity to make their own informed decisions they will need more information of direct relevance to their decision making, compared with the little which is currently available.

It is proposed that the work of providing farmers with information relevant to their machinery evaluation and selection needs, and advising on its use, should be undertaken by a Mechanization Information and Advice Service. The MIAS would have an interactive farmer-orientated role, coordinating on their behalf the collection, processing, presentation and interpretation of information available from a range of sources, and commissioning surveys, tests, *etc*, to fill any gaps.

Mechanization has been a neglected area of research for many years, despite the large investments which have been made in power and machinery. Evaluation and selection of agricultural machinery by users appears to be a substantially new concept which must be investigated with professional skill and imagination. There is a wide range of topics relevant to machinery selection as indicated in the list on page 61. Requirements, techniques and procedures must be worked out in discussion and cooperation with farmers representing the range of local farming interests and systems. Methods must be devised for collecting essential data and making it quickly and easily available to farmers, to ensure that machinery selection decisions are well founded. A wide range of institutions

must be consulted and cooperative working arrangements established, for example with existing extension services, both public and private, to explore and develop the role of relevant activities such as local infield machinery demonstrations.

A Mechanization Information and Advice Service must be responsive to farmer demand. Existing institutions and attitudes must be examined rigorously and, if necessary, they must be closed or reshaped according to needs which will vary from country to country and must be investigated individually. It is hoped that this bulletin has put forward ideas which will provoke discussion and positive action.

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Annex: Procedures for consumer-responsive testing

INTRODUCTION

Most published test procedures are technology driven. They are aimed primarily at testing for manufacturers and suppliers of agricultural machinery and at ensuring that equipment conforms with statutory technical requirements, *i.e.* they are supply-side orientated. In general the reports contain much technical detail which most farmers find confusing, and they give little guidance on how machines will perform in farmers' fields in comparison with alternative machines which might be available.

Attempts have been made to remedy this situation by undertaking comparative (series or group) tests. Comparative tests have met with some success in more industrialized countries, usually when commissioned, or interpreted in user-friendly format, by consumer-responsive services such as farming journals (*e.g.* Theißen, 1992). Such reports have usually dealt with complex and expensive machinery such as grain and beet harvesters.

If consumer testing of agricultural machinery is to make a real impact it cannot be treated as a spin-off from supply-side testing, which is markedly different in aims and orientation. Technology driven testing depends on instrumentation and procedures which consume expensive staff and financial resources. Farmers need information on how machines will performance in their own fields, in terms which they can understand. Tests to establish such information require skilled staff with a practical appreciation of farmers problems and needs, particularly with regard to machinery selection and operation, but they can be conducted effectively using simple equipment.

Consumer-responsive testing has been largely neglected, particularly in developing countries. Current procedures must be reviewed to judge the extent to which they meet farmers' needs. Obviously the review must be undertaken in consultation with farmers covering the whole range of local farming systems, but not dominated by any one group. Reviewers should be quite prepared to discard a large proportion of current procedures where they are irrelevant to consumer needs. In today's economic climate future consumer-responsive testing procedures must be streamlined and cost-effective to a degree which is, probably, now lacking in current technology driven supply-side testing.

REVIEW: TYPES OF TEST

Functional tests

Existing procedures for functional testing, although directed mainly to the needs of the manufacturer and other supply-side customers, will usually provide some information of value to the user. Test codes and procedures have been formulated for most major items of agricultural machinery. Many have been standardized on a regional or international basis in both industrialized and developing countries. RNAM has published a compendium of agreed test procedures for much of the machinery used in the tropics and sub-tropics (RNAM, 1983). The International Standards Organization (ISO) has achieved inter-country acceptance and legally enforceable status for many standards, particularly those relating to agricultural tractors. AGS Bulletin 110 gives examples of typical procedures and suggests methods for implementing them using relatively simple measuring instruments and techniques.

Functional testing provides users with an assurance on the quality and functional performance of a machine, although the terminology and manner in which the results are presented may be hard

for users to understand directly and must be interpreted into practical farming terms. The systematic and quantitative methodologies involved in functional testing generally appeal to the interests and capabilities of staff with professional engineering qualifications, which may have led them to overemphasis its role. In-field performance testing is the more important activity for consumers, with functional testing playing a valuable supporting role.

Functional testing is not usually location-specific, so that results from a test undertaken in one place will normally be applicable elsewhere or can be adapted using routine corrections such as, for example, the effect of altitude on the power output of engines. Relevant extracts from the original test may be presented (with due acknowledgment to their source) alongside the results of local in-field tests. Functional tests on machines such as tractors and combine harvesters require specialized staff using complex and expensive instrumentation and the extravagance of duplicated tests must be avoided.

In-field performance testing

Consumers generally have a better understanding of in-field performance testing compared with functional testing and pay more attention to its results. The most cost-effective and respected in-field testing is the informal kind undertaken by neighbouring farmers, thus:

> *'Most Thai farmers have a simple way of selecting their machines, i.e. to acquire the same brand as their neighbours.'* (Senanarong, 1992)

— but it is difficult for testing stations to emulate such a perfect model! Should they try?

Formal in-field performance tests will gain most respect from consumers when they are made in conditions of soil and climate which are similar to their own and in similar farming systems. It may be technically desirable for a testing service to set up a number of outstations to deal with a representative variety of circumstances but staffing, management and running costs escalate rapidly. It will usually be more cost-effective for the work to be undertaken in conjunction with collaborating organizations such as universities and research institutes already established in suitable locations, with local knowledge and contacts.

Assessments made during in-field performance testing are generally more subjective than those made when testing for function. Some objective assessments may be made, *e.g.* weed counts may be made before and after work when testing weeder performance, but in general most assessments will be largely subjective, depending on judgments made by skilled adjudicators. A panel of adjudicators may ideally be made up from experienced farmers, who should work independently in arriving at their judgments. Adjudication is made easier when the judgments required are comparative rather than absolute ones.

Machines for user tests will normally be selected from those which are readily available on the local market. Trading conditions (import licences, logistics of shipment, bureaucracy, foreign exchange regulations) may make it difficult to acquire machines even from neighbouring countries; there is little point in testing such equipment unless to serve as comparison with locally manufactured ones. To obtain a representative sample it is customary to choose a machine at random from stocks held by a local manufacturer or agent

Procedures for single-machine testing

For the user particularly, comparative testing has many advantages when compared with single-machine testing. A body of literature has built up on single-machine test procedures (*e.g.* AGS

Bulletin 110), but unfortunately comparative testing has received very little attention. Agreed guidelines for comparative testing would be helpful. Brief suggestions are given below.

A number of comparative assessments should be made in a range of conditions typical of those faced by local farmers. Preferably the assessments should be made by local farmers or appropriate users acting as adjudicators, guided by testing station staff who are experienced in running such tests and who are competent in statistical techniques for their conduct and analysis, with particular regard to replication and randomization of experimental plots. Even where no techniques are available to make objective assessments it is possible for farmers or experienced testing staff to rank them subjectively for quality of work.

Comparative testing should be reported in comparative form, with a feature by feature assessment for each machine together with a ranking between machines. An overall ranking is desirable as a summary, with discussion of the closeness of the results and the strengths and weaknesses of individual machines. Comparative testing is more flexible than single-machine testing and the results can be presented in a more user-friendly format.

CONSTRUCTING A CONSUMER-RESPONSIVE TEST PROGRAMME

Consumer testing requires that farmers, as machinery users, formulate a demand for machinery testing which is listened to, discussed, refined, agreed, carried out and reported on. This may sound like a new concept for most farmers yet, in essence, it corresponds to the interaction between the farmer and the village blacksmith or small-scale manufacturer with whom he or she might be negotiating for the supply of a modified handtool to meet a newly identified need. The novelty in the concept is that such a dialogue might be feasible with a testing service provided by 'government'. The first step in setting the testing agenda is to establish a mechanism which allows farmers to participate effectively in determining the test programme.

The overall aim and contributing objectives for a test programme must be agreed and clearly defined in discussion between consumers and testers. The nature of the tests needed to achieve the objectives may then be identified, leading to informed decisions on whether existing testing procedures are acceptable or whether they should be modified or rejected. Use of existing procedures will be convenient if they are, or can be, tuned to fulfil the defined objectives in whole or part, but they should not be followed slavishly. Many of the measurements suggested in existing test procedures are orientated towards research and development — the machinery user will find no use for them and they should be eliminated from the enquiry.

The agreed test programme and reporting arrangements may then be set down in detail, specifying the objectives, type, location, executing agency and reporting arrangements for each test and a realistic time and cost schedule for their execution.

Comments on testing procedures for power sources

Much effort has been expended on tests to establish the power available from sources which are commonly used for agricultural mechanization, *i.e.* humans, animals, engines and tractors. Such tests are particularly expensive in terms of staff and equipment. Their value to the machinery user must be examined carefully to judge whether they should be continued in existing or modified form or closed down.

The first point to note is that power sources have generally been tested in isolation from the machines with which they are to be used, while the farmer is concerned with the performance of the

power source and the machine in combination. The justification for testing must be viewed in this context.

Human labour

Human labour is characterized by limited power output, but this is compensated in great measure by the versatility and dexterity with which machines can be used and the judgement which can be exercised by the operator. The ways in which a hand hoe can be used for a wide variety of purposes is an excellent example of human adaptability and skill.

Rate of working, *i.e.* power output, is very much a matter of judgement by the man, woman or child doing the work. It ranges from zero, through a maximum sustainable level which can be maintained for a full working day, to bursts of power which can be maintained for only a very short period of time. For example the day-long sustainable rate may be doubled, but for about ten minutes only, or increased by 50% for nearly half an hour.

The proper operation of hand tools depends very much for on the manipulative skills of their user. The complicated movements involved make it virtually impossible to measure directly the mechanical work or power transferred from the operator to the machine although it is possible to assess this indirectly using heart rate or respiration measurements. Such measurements are not generally necessary because the human undertaking the operation is well able to express an opinion on the ease of handling of any implement being tested. It is a grave deficiency in the test procedure if such opinions are not asked for and listened to.

Hand-powered machinery should be tested over an extended period of at least four hours to obtain a true indication of the average work output — enthusiastic operators testing over a shorter period may adopt a brisk work rate which will exaggerate a machine's capacity. Measurements of time, area and depth of work plus visual assessments of work quality should be sufficient for testing most field equipment. Expensive equipment and techniques are not necessary for consumer testing of handpowered machines.

Animal power

Work animals are used almost exclusively to provide a draft force for pulling an implement or cart. The pull depends mainly on species and body weight but is also influenced by condition, temperament and training. In general the optimum pull for bovines is about 10 to 12 per cent of body weight and about 12 to 15 per cent for equines and camels. This knowledge, together with other well documented data, is generally sufficient to permit the design of user-friendly implements, of which one essential feature must be provision for easy and effective adjustment of implement draft to a level which can be sustained for a full working day.

The main concern of animal draft operators is to make the most effective use of the best animals available to them. This depends on implement selection, adjustment and use, together with full consideration for the animals' welfare. The actual pull capacity of the animal is of less concern than the ability to adjust and maintain the working load at an acceptable level. From the machinery users' viewpoint there is no justification for repeated or continuing performance testing of draft animals in isolation from the implement. The real need will be to investigate methods for adjusting harnesses and implements for optimum work and welfare, as part of a user-responsive testing programme for animal-pulled implements. Required information may be obtained by measuring the magnitude and inclination of the pull between animal and implement, depth of work and average speed. Necessary instrumentation comprises a suitable dynamometer (force-measuring instrument),

stopwatches and measuring tapes.

Sophisticated and expensive instrumentation and data-logging systems have been developed for research into energy expenditure, biomechanics and nutrition of draft animals. Such equipment represents a diversion from the true needs of consumer-responsive machinery testing which will be better served by the more robust and less resource-intensive equipment which has just been mentioned.

Engines

Some agricultural machinery testing stations are equipped with comprehensive facilities for testing diesel, gasoline and kerosene fuelled engines. The costs of the testing facilities grow at an increasing rate with rising engine power and become more difficult to justify. Consequently, in all but the largest establishments, facilities are usually limited to testing relatively low-power engines, up to about 15 kW (20 hp). This is a range of engine size which fulfils a number of purposes in the early stages of mechanization, for example to drive processing machines and for installation in single-axle tractors, so that their testing becomes an attractive proposition.

Small-engine testing as generally reported adds little to the information provided by the manufacturer, other than validating (or not) the claimed performance — usually the full-load figures for power output, torque and fuel consumption (total and specific) through the range of working speeds. Such tests may be useful to manufacturers but their content and presentation is of little direct value to users.

The requirements for consumer-responsive engine testing must be specified by the user but are likely to include factors such as robustness, reliability and maintenance requirements, together with the local suppliers record for supplying replacement parts and undertaking repairs promptly. Full-load fuel consumption figures for the engine are of little concern to users — most engines are operated at part load. Users are more interested in fuel consumption related to the overall performance of the engine and the machine which it is powering, *e.g.* litres of fuel needed to thresh out one tonne of grain, which is a matter for performance testing of the machine rather than the engine alone.

Engine performance testing *per se* has at best a marginal role to play in consumer-responsive testing and is unlikely to justify use of the scarce resources which it absorbs.

Tractors

Tractor testing is a high profile activity which probably absorbs, worldwide, a major proportion of the total funds available for testing agricultural machinery. Most tractor testing is undertaken in conformity with national or international test codes of which the OECD code is the most widely recognized. National regulations may require that the tractor meets specific safety and environmental requirements, *e.g.* for roll-over protection, for noise and vibration levels or for conformity with road licensing regulations. Some countries restrict tractor imports to those which have been tested satisfactorily to international standards. Nationally and inter-nationally recognized tractor test codes prescribe tests which are mostly functional and strongly orientated towards the needs of supply-side customers. There is no justification for repeating them for consumers.

It is reasonable to expect that tractors which have performed well in functional tests to international standards will be capable of satisfactory operation in the field. Nevertheless there is a case for consumer testing of tractors in local field conditions. The purpose of such tests should be to

identify the tractor's strong and weak points and provide guidance in techniques of adjustment and use which will enable operators to optimize field performance. For instance it may be found that the tractor's wheel track adjustment is not consistent with the row spacing for commonly grown crops — a modified production system might be suggested. Traction trials should aim at providing positive guidance on optimum tyre sizes, ballasting and inflation pressures to suit local soils and modes of operation. The tractor should be tested with implements which are commonly used or available in the locality to check their compatibility and performance, with recommendations on their adjustment and operation.

Tractor testing for consumers in developing countries must be tuned specifically to their expressed needs, avoiding duplication with supply-side tests already made. Details of local procedures must be worked out and agreed with machinery users themselves, to provide the information which they identify as important.

Comments on current testing procedures for machines

Most of the published test procedures for agricultural machinery deal mainly with functional testing and have been formulated in response to the needs of supply-side customers. Much of the factual information which they generate is of value also to potential users involved with machinery selection, subject to presentation of test results in a format which is more user-friendly than is generally practised. Quantitative results must be expressed in a descriptive form which farmers can understand. Test reports should be pruned to remove information which is not relevant to machinery selection. Surplus information will be of little or no value to users and its inclusion in consumer orientated reports will serve only to mystify or confuse most of the customers.

While functional testing has been largely standardized, in-field testing has proved less easy to manipulate and control. There is therefore a continuing challenge in tailoring in-field test procedures to match consumer requests. Comparative testing requires good organization to collect together a number of machines for simultaneous tests, but it provides the best opportunity for judging the relative performance of machines in realistic soil and crop conditions.

Most test programmes for consumers will probably be built up from a judicious mixture of functional and in-field testing. When appropriate it may be possible to use information from tests already made by other testing stations or for other purposes. AGS Bulletin 110 provides guidance on testing procedures, instrumentation and methods for a wide range of machines and will be a valuable work of reference for officials, students and technicians involved in the theory and practice of machinery testing. The procedures described are orientated towards functional testing for machine development and, as emphasised in the publication, they should be tuned to meet identified testing needs by deletions, modifications or additions as necessary.

PUBLICATION OF TEST REPORTS

In the past it has often been difficult for machinery users to get hold of test reports, even if they have been officially 'published'. A policy for publishing and disseminating test results must be established and actively pursued, with a clear definition of responsibilities if the work put into testing is to achieve its full potential impact. Reports must be:

- **published and publicised** — potential readers, particularly those at whom the report is directed, must be made aware of its existence. Press, radio and television coverage can help in bringing it to the notice of the target group;

- **informative and readily understood** by the potential user of the machine — results must be presented in a concise, clear, informative and unambiguous format. The presentation and style of writing must be attractive and appropriate to the target reader;

- **easy to obtain** — at reasonable cost from accessible, dynamic and reliable suppliers;

- **promptly available** — the value of the report will diminish with time, so that for maximum impact the report must be published within a short time from completion of the work (maximum two months?); and

- **attractively presented** — a recognizable 'house style' helps in establishing a good image, adding to the reputation and credibility of the testing station.

The importance of effective publication cannot be over-emphasised. Much valuable work has been lost because it has never been reported. A user-responsive testing service will only be effective if the results are published promptly and are widely available to the end customer, *i.e.* the user. Testing is not an end in itself but is only viable in the longer term when it provides a service to others.

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The selection of farm machinery and equipment is an activity undertaken by the user by applying the information obtained from a range of sources, including reports on machinery tests where available.

This document is, therefore, primarily concerned with machinery testing and evaluation from the user's viewpoint, although attention is also paid to testing for manufacturers. Machinery testing as commonly practised has been essentially a supply-side activity responding to the needs of machinery manufacturers and dealers. A different approach is necessary for consumer-responsive testing – one that can be undertaken mainly in farmers' fields without the need for elaborate instrumentation. However, machinery testing is only one facet of the information required by the individual farmer in order to make a full evaluation of a machine's suitability for sustainable and profitable use in his or her unique circumstances. Machinery selection and evaluation requires a more systematic and user-responsive approach than has been practised in the past. It is suggested that the task of making the necessary information and advice available to farmers should be the responsibility of a mechanization information and advice service which would be empowered to coordinate the work of relevant institutions. Where possible this service would work in close cooperation with institutions that have already been successful in helping farmers solve their agricultural mechanization problems.

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