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Title: An Analysis of Progress and Achievements in Regional Dehulling Projects.

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ABSTRACT

The paper characterizes two interrelated problems facing the SADCC countries and the inhabitants of the dry areas, and proposes two developmental objectives: maximum utilization of the potential of the dry areas, and attainment of household food security. Home dehulling of sorghums and pearl millets, important food crops for the dry areas, is one step in the primary processing which has presented a problem. The relevance of mechanical dehullers to the food systems of these drought-resistant grains is set out. The evolution of small scale dehulling technology is described; and the programme of its development and field testing, leading to wider dissemination in Sub Saharan Africa, is summarized. The experiences of that programme of research support for processing and utilization, aimed toward rural benificiaries, are brought out by examining the question: what has changed in, and what has been learned about, the post production systems of sorghums and millets. The main issues which arise from that experience are identified and briefly discussed. Priorities for future work in the region, and on sorghum and millets for human food, are recommended.

The opinions expressed in this paper are those of the author and do not necessarily represent the views of the International Development Research Centre.

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AN ANALYSIS OF PROGRESS AND ACHIEVEMENTS IN REGIONAL DEHULLING PROJECTS

INTRODUCTION

A substantial portion of SADCC's 70 million inhabitants live in dry areas where rainfall is less than 750 mm per year and occurs erratically or not at all in many years. These human beings, mostly subsistence farmers, face major additional constraints: poor soils, degredation of land, increasing population pressure leading to the use of even more marginal lands, uncertain land tenure, long distances from sources of agricultural input and markets for their produce, infrequent visits from extension agents, limited options for food production or cash income with which to buy food.

A related set of problems can be defined at the national level: uncertainty whether enough food for all will be harvested; insecure or inadequate levels of foreign exchange earnings with which to buy the food to compensate for production shortfalls; stated policies which desire the maximization of food sufficiency, with the practice of the policies often negating the intent; an infrastructure unable to quickly and reliable move food from areas of surplus to areas of deficit; well-developed marketing, processing and distribution systems and established policies which favour maize, but not the indigenous drought resistent cereals; an increasing dependency on cereal imports, with spiralling foreign exchange costs.

Two key developmental objectives for the dry areas emerge from the above problem sets:

-to achieve food security for households of the poor, i.e., access to adequate amounts of food of adequate nutritive content;

-to fully exploit the opportunities and limitations presented by the agro-climatic realities of the dry areas for food production.

The droughts in Southern Africa in 1982-85 have focussed the attention of national policymakers on the strategic importance of the drought-resistant grains to both national and household food security. This has led to renewed attention to the inhabitants of the dry areas, and until new and more advantageous systems of food production, and more cost-effective techniques of land utilization are discovered for the dry areas, it seems logical to emphasize indigenous foods, and full utilization of the food for human benefit at lowest cost.

The presentations and discussions of this meeting, organized to focus on component technologies, will have to be interpreted in the context of the two goals if the knowledge is to become useful to the inhabitants of the dry areas.

BACKGROUND

The vast majority of producer/consumers of sorghums and of pearl millets face the daily task of manually decorticating and pulverizing the grains before preparing the daily meal. Women and children labour hard and long to dehull these grains:

-to remove the outer layers which contain primarily fibre, the presence of which affects the cooking quality and taste/ mouthfeel of the final product;

-to remove sources of bitter taste which are often found in the outer layers of the grain.

It was initially thought that the provision of small dehullers to the rural areas would primarily alleviate a home labour bottleneck, and would directly lead to increased consumption and utilization of sorghums and millets. This analyis is not wrong, but incomplete.

For instance, there seems to be no tradition of dehulling sorghum in the Rift Valley of East Africa which goes through Tanzania and Kenya. The commonly grown varieties are brown, contain tannin, and have an endosperm which is so soft that it pulverizes on impact from a pestle. Dehulling has not been possible. In order to reduce the bitter taste of the tannins, dried cassava flour is added to the pulverized sorghum--an indigenous use of composite flour cooking. Mechanical dehulling may be useful to remove the anti-nutritional portions of these sorghum varieties.

We also know that urban dwellers do not have easy access to flour from dehulled sorghum or pearl millet, though it can be found in small quantities in the informal spontaneous markets in high density peri-urban areas. But in Southern Africa packaged maize meal can be found everywhere. The potential of the urban demand for these flours from the drought-resistant grains is largely unexplored.

From experiences to date we can now conclude that dehulling machines can contribute to the following outcomes:

- to free woman and child labour for leisure or other tasks;

- to make high tannin cultivars of sorghum more palatable and nutritious;

-to generate a sustained urban demand for surplus production;

THE DEHULLING TECHNOLOGY

The International Development Research Centre (IDRC) was created in 1970 by an Act of the Canadian Parliament with two major mandates: to support research-for-development by nationals in Third World countries; and to help strengthen indigenous research capacity in the Third World.

Within IDRC's Agriculture Division the group dealing with food after harvest, Post Production Systems, began to support the work of African researchers on dehulling as early as 1972 in Nigeria. IDRC's strategy has been to support those research activities intended to benefit rural dwellers. Since very little of Africa's sorghum and millet production is handled by national grain marketing systems, the primary point of intervention with the dehulling technology began at the rural level, near the source of production.

The Hardware

The initial technical objective was to develop a simple mechanical device suitable to the needs of the producer/consumer of sorghums, pearl millets and grain legumes. The basic principle of the dehuller is a metal shaft on which a number of grinding stones, or abrasive discs, are evenly spaced about 2 cm apart. This rotor is enclosed by a semi-circular sheet metal barrel with a flat (or rounded) top. The barrel is partly filled with grain, and the abrasive material, spinning at 1500-2400 rpm, rubs against the individual kernels in the agitated mass of grain. The result is a progressive abrasion of the outer layers of the grain kernels. The length of time for which the grain is retained affects how much of the material is removed as abraded fines.

The first effective design resulted from the modification of an existing barley thresher. The work was done by the National Research Council of Canada's Prairie Research Laboratory (PRL), now renamed the Plant Biotechnology Institute. During 1974-76, the PRL dehuller demonstrated its technical effectiveness on the sorghums, millets, and cowpeas which were commonly grown in Maiduguri, Nigeria. It was also tried in Senegal in 1977 as part of a larger post harvest research project, but was found to be too large, and unable to dehull the small batches of grain brought for dehulling by individual women. The same design, by contrast, proved very successful in Botswana 1976-78, and provided the basis for further improvement.

During 1978-80, the Rural Industries Innovation Centre (RIIC) in Botswana scaled down the PRL dehuller and incorporated a trap door in the barrel, enabling the dehuller to deal with batches as small as 5 kg. An exploded drawing of the RIIC dehuller can be seen in **Figure 1**. It incorporates an aspirating system which simultaneously removes the dehulled bran. It is relatively large, suited to the daily dehulling requirements of 8,000-10,000 people, and has an economic break-even point of 1.5-2 tonnes per day. In continuous flow operation it can process up to 5 tonnes per eight-hour shift.

Given the sparse populations in many dry areas, the RIIC dehuller was seen to be too large; it would be underutilized, and thus not cost-effective, in many rural situations. Agencies in three countries modified and ruggedized a smaller dehuller, the MINI-PRL, which had been designed for laboratory use. The resultant

designs are smaller and simpler than the RIIC dehuller. Two of them do not have an aspirating system, and the woman customer has to hand winnow the grain to remove the abraded fines.

The Catholic Relief Services (CRS) in the Gambia are marketing the **MINI-CRS dehuller**, have developed a good understanding of the millet food system and how the dehuller fits into it, and are simultaneously developing the indigenous manufacturing capability so that the technology can be delivered on a sustained basis [5]. The Zimbabwean non-governmental organization, Environment Development Activities (Enda-Zimbabwe) have generated the **MINI-Enda dehuller** [6], and have now begun a dissemination campaign, financed by CIDA (Canadian International Development Agency), of this and a larger size of dehuller. For a variety of reasons, much remains to be learned about the nature of the small grains food system in Zimbabwe. The question of the volume of effective demand for dehullers and dehulling remains unresolved, and will have to be incorporated, up front, in the dissemination programme.

In Senegal, a joint activity between the parastatal equipment manufacturer SISMAR and the Institut Senegalais de Recherches Agricoles (ISRA) has generated the **MINI-SISMAR/ISRA dehuller** [7], and prototypes are being tested in ten villages for effective response to the rural home dehulling problem. The dehuller design incorporates the winnowing of the abraded fines, and has a smaller capacity than the RIIC dehuller.

The programme of research-for development

It is important to note that the hardware summarized above was developed with particular beneficiaries in mind, has been tested for comprehensive usefulness in the domain of the beneficiaries, and is in the process of wider dissemination in each of these countries. In addition, national scientists are using these designs in pilot introduction of technology projects in Malawi, Uganda, Ethiopia, Zambia, Tanzania, Mali, Niger, and other countries. The basic question being addressed by these interventions is: "in what way is this technology useful?" At the rural level, in small communities, the technology has tended to respond to a home labour bottleneck. At urban or peri-urban sites, the dehullers respond to a potential demand for flour, not previously available, from a drought-resistant grain. As part of the process of providing the hardware, the researchers are clarifying the nature of the food system into which the dehullers might fit. The applied research into utilization is complementary to the dehulling work.

This paper does not intend to present an Africa-wide chronology of successive research projects. That can be found elsewhere [1], but a list of the research projects supported in the SADCC region, and addresses of the institutions, can be found in the Appendix. The current theme of these "dehulling" projects might best be described as applied work on processing and utilization of sorghums and millets, leading towards their increased consumption and production.

PROGRAMME EXPERIENCES

The experiences of the national research-for-development projects on processing and utilization of sorghums and millets in Sub Saharan Africa have been varied. Let us consider what has changed in, and what have we learned about, the post production system of sorghum and millets as a result of dehulling interventions.

1. Substantial change in Botswana:

In the decade following 1975, the following rapid process of change took place: it was demonstrated that the off-the-shelf convenience of sifted maize meal was causing a shift in cereal consumption away from sorghum; using the PRL dehuller, the Botswana Agricultural Marketing Board (BAMB) showed that a demand existed, in both urban and rural areas, for flour from dehulled sorghum, capable of competing with lower-priced maize flour; the PRL dehuller was redesigned by the Rural Industries Innovation Centre; up to thirty small scale mills, incorporating the new dehuller, were established throughout the country as a result of the RIIC's efforts; the drought, in continuous presence since 1982, and the practice of small scale industrialization policy contributed to an altered use of the milling systems (intended as custom or service mills, many were converted to small factories which bought grain, and competed for consumer purchase of the processed flour by differentiating their brand with attractively labelled packages --however, two thirds of the mills are now severely underutilized, and are approaching economic non-viability); the club of mill owners, the Botswana Mill Owners Association, came into existence in 1983, in part to lobby government on policies relating to sorghum. A number of papers have sought to analyze and comment on the "Botswana experience" [2.3.4].

The achievements to highlight are: The RIIC has a proven dehuller design, has sold up to 70 dehullers to neighbouring countries, often through the mechanisms of aid agencies because the recipient countries have limited access to foreign exchange. Flour from dehulled sorghum is available in large quantities, and is readily purchased by consumers. A small scale processing industry has grown up. The original intent to provide service milling has in large measure been superceded by complete small scale factories (because of the persistent drought, families had very little to take for service milling). The existence of the mills, and evidence of reliable supply of an acceptable product, may have changed the producer's view of sorghum from a subsistence to a cash crop.

2. Useful hardware has been generated:

Four variants of a basic abrasive dehulling technology have been designed, tested and ruggedized under village conditions, and are in the process of wider scale introduction in many Sub-Saharan countries.

3. Food systems and needs differ from country to country:

The conditions which facilitated a swift process of introducing the dehulling technology to Botswana do not obtain in Zimbabwe, Zambia, Tanzania and other countries. The nature of the home dehulling problem is less clear cut, and the competition between maize and the small cereal grains still has to be better understood. It is not enough to merely make new hardware available. We need to understand the rural dweller's perception of her/his needs (if any) for dehullers, and responsive techniques of technology introduction have to be developed carefully.

4. A second point of intervention with dehullers for rural benefit:

The small scale producer of sorghums and millets can benefit from the deployment of dehullers at two separate points of intervention in the food system: small machines in the rural areas will contribute primarily to enhancing the quality of life of the producer/ consumer, though an increase of consumption may occur (Figure 2); larger machines in peri-urban or urban areas can satisfy the demand for flour of the urban dweller, the consumer who is not a producer, and can thus induce a sustained urban demand for surplus production of the grains which grow well in the dry areas (Figure 3). Adequate supplies of the raw material in the urban areas will depend as much on producer prices as on the maintenance of grading standards in the grain marketing system.

5. National research resources are being deployed for sorghum and millets:

The appended list of dehulling-related projects being supported in the region shows that a substantial number of scarce researchers have been attracted to work in the post harvest sphere of sorghum and millets. There is still a tendency for some of the applied researchers to be too technology-, rather than problem-oriented; some of the work done has been too limited, and the results have not made a real difference to the ultimate beneficiary. There is a need to strengthen the applied researchers' abilities to document their experiences effectively, and to direct the knowledge acquired to a number of targets: to the policymaker, to indigenous development agencies, to the specialist scientist, to the commodity improvement programmes, and to industry. Systems thinking is admittedly not easy, and has to be encouraged and practiced more widely.

6. Beginnings of inter-country collaboration:

The RIIC in Botswana has become a reference point, the "training school", for the dehulling technology. This inter-country co-operation is a welcome and useful outcome. Also of regional significance was the 2-6 June 1986 workshop, ambitiously titled "New and Improved Foods from Sorghum: a food strategy for the

semi-arid zones", organized by Sokoine University of Agriculture with funding from the British ODA (Overseas Development Administration). While in practice not very many new foods were described, the workshop did serve as an important forum for exchanging experiences on processing and utilization of sorghum and millets. The workshop proceedings are being edited for publication. The participants sought the undertaking of the SADCC Food Security Project dealing with the post harvest sphere, the Post Production Food Industries Advisory Unit, to co-ordinate this nascent network.

7. Interventions cause new problems:

There is an awareness of the new kinds of problems and opportunities which occur as a result of dehuller intervention. Upstream, the producer will seek to adjust her/his production system, planting patterns. Downstream, from the point of view of the eater, the consumer, the need to characterize food product quality and to relate it to varietal grain quality characteristics is becoming more evident.

8. Understanding the process of research-for-development:

One can identify the following stages in the process of successful research-for-development:

i. Identification or recognition of a wide-spread problem (or opportunity);

ii. Generation of a technology (by invention, adaptation or adoption) which is likely to solve that problem;

iii. Verification, in concert with the intended beneficiary, that the technology is technically sound, economically viable, and socially acceptable;

iv. Wide scale dissemination to bring the solution, the technology, into full utilization.

These are not discrete stages, and a good deal of iteration can be seen to occur. For instance, the experiences gained in field testing may cause the problem statement to be refined or amended, and require design changes before field testing can again be tried. I feel that this framework is useful for tracking the effectiveness of a strategy for executing applied research.

The more recent among the projects listed in the Appendix tend to be located at levels three and four, indicating some substantial progress by the applied researchers of the region.

9. Drawing in the international community:

Two recent events are important milestones for the coming of age of sorghums and millets, though not uniquely issuing from the dehulling topic:

Sorghum and millets featured prominently at an international workshop on Household Level Food Technologies for Improved Young Child Feeding, held in Nairobi 11-16 October, 1987, and co-sponsored by IDRC, SIDA and UNICEF. In addition to the vital technology of breastfeeding, the workshop examined the state of the art of two techniques of preparing supplementary foods: the use of lactic acid fermentation to produce the thin soured porridge, uji, and the use of flour from germinated cereals for dietary bulk reduction, from indigenous food crops.

The workshop was attended by paediatricians, nutritionists, food scientists, cereal chemists, and nutrition promoters. They also discussed nutritive, toxicological, and pathogenic contamination aspects. Recommendations focussed on further work, both basic and applied, for these technologies--uses for indigenous raw materials. The proceedings should be published during 1988, and will be of interest to the participants of this workshop.

An informal grouping of research and development donors, the Group for the Assistance with Systems relating to Grains After harvest (GASGA), at its annual gathering in June 1987 invited Dr. Muchena, Dr. Mosha and me to present a half-day symposium focussing on the small grains food systems in the SADCC region. This was followed by a three-day intensive workshop here at Matopos in mid-October, attended by scientists from Southern Africa and representatives of some GASGA members. The workshop's main objective was to jointly identify research and development areas with regard to sorghum and millets which needed further work. The proceedings of both meetings will be published shortly by GASGA (c/o Dr. Peter Prevett, Storage Department, Overseas Development Natural Resources Institute, London Road, Slough, SL3 7HL Berkshire, U.K) and, it is hoped, will lead to a clearer systems-related commitment by donors and recipients.

ISSUES

Based on the experiences of the dehulling projects, some general issues can be identified, and elaborated. The issues relate to both technology introduction and to the drought resistant grains.

Adoption rate:

The rate of adoption of this innovative technology has been slower in many countries, where the food systems are different, than it was in Botswana. This may be due in part to incorrect or incomplete characterization of the problem(s) of the target group and therefore an inappropriate intervention with a probably non-needed dehuller.

Reaching the target group:

The target group can benefit from interventions aimed directly, or indirectly at them. The small scale millers can deliver a dehulling service to the rural dweller, or use rural raw material to provide a processed product to a rural or urban consumer.

Continuous characterization of the problem:

Extreme care has to be taken that the real problem, not its symptoms, is identified. In the course of an intervention it is likely that other events occur in the environment, and that the problem has to be re-analyzed and redefined.

An innovation has to be evaluated in a broad economic context:

The introduction of dehullers may have benefits not only for the labour of the rural female, but for labour in general; income opportunities arise in several points of the food system. Consumers of processed products, millers, manufacturers of the hardware, are all potential beneficiaries of the new technology. Conventional calculations for return on investment have to take note of the droughty environment; the technology's profitability is affected by the presence or absence of localized droughts. It must also be recognized that every intervention results in losers and winners, and that detrimental results from a generally beneficial intervention must be ameliorated.

Need for complementary inputs:

A new technology, even if demonstrably needed, does not necessarily spread on its own; a system for the sustained delivery of the technology has often to be established and helped to grow (credit, business advice, manufacturing, repair and service capability).

Broader policy issues:

-is the grain viewed by the producer as food, as drink or as cash? Can a change in policy alter this view?

-do price and marketing policy make it advantageous for the producer to sell all the production, and to buy back a cheaper, subsidized, cereal?

-can policy be adjusted comprehensively to permit sorghums and millets to compete effectively, such as with the well-established and often subsidized maize system?

-does exchange rate policy favour the import of cereals over local production?

-dehulling can be the start of a rural growth point, leading to other activities; road development and transport systems to rural areas or easy access to larger centres can help or inhibit growth point development.

-does a policy exist for the promotion (and protection) of small scale food processing industry?

The technology as a permanent versus transitional intervention:

While the technology might initially be deployed as rurally located service mills, and have specific desired impacts, it is possible that later it may be relocated in larger groupings at district foci, and utilized in a different way. The Botswana precedent suggests that economies of scale apply in the distribution and marketing, and not on the processing side (several lines can be run in parallel for just the cost of the additional equipment).

The technology is useful for other grains:

As part of a sorghum utilization project, the Ethiopia Nutrition Institute installed a MINI-dehuller in a district town. After three months of operation, it had processed a substantial 4 tonnes of grains, but not one kg of sorghum:
barley, lentils, chickpeas, oats, faba beans, wheat, and field peas were brought by housewives for dehulling.

CONCLUSIONS AND RECOMMENDATIONS

The "regional dehulling projects" which I have been asked to review are filling an important gap, and will contribute to the increased use of sorghums and millets. I have not spoken to the very important priorities which have been developed by the SADCC/ ICRISAT Sorghum and Millet Improvement Programme: to work towards the differentiation of varieties for different potential end uses: secondary food processing, other industrial uses, and animal feed. Those will be covered by other papers at this workshop, and their realization should have substantial effect on generating a sustained demand for surplus production.

From my experiences, interacting with national researchers as they are doing the real work, I recommend the following:

a) Priorities for future processing and utilization work.

-define, and get widely used, simple measurements of grain kernel characteristics and measurements of the preferred quality parameters of the food end products;

-document and characterize the current traditional food uses of pearl millets, which have received far less attention than has sorghum;

-look at the nutritional intake from the total meal prepared and consumed, not merely the nutritional availability from the cereal component of the meal;

-the reduced bio-availability of proteins from cooked sorghum gruels appears to be an important problem to solve and ameliorate;

-an emphasis on practical utilization work: to find products from sorghums and millets which possess some of the convenience aspects of wheat-based foods; to improve the cooking and preparation procedures of indigenous food products such as sadza, ugali, uji, etc.

-develop and maintain stronger interaction between the specialized sciences and the practitioners of research-for-development.

b) Strengthen national systems:

The creation of national task forces for the promotion of sorghums and millets, with authority to define the changes desired and to effect implementation, would enhance progress. Such task forces would have an overview of the national production and utilization systems, and would chair annual meetings for review and goal setting. The proceedings from this workshop will provide national policymakers with a menu of practicable and feasible policy options.

c) Strengthen links between national and international systems:

This workshop on the Uses of Sorghums and Millets has the opportunity to define a strategy for widening and intensifying the discussion between the SADCC countries and the donor community in order to develop goal-oriented interaction and mutual collaboration.

APPENDIX

IDRC-supported research on processing and utilization of sorghum and millets in SADCC countries.

Botswana

Botswana Agricultural Marketing Board, Private Bag 0053, Gaborone.

-1975-77 Sorghum Milling (Botswana)

Rural Industries Innovation Centre, Private Bag 11, Kanye.

-1978-80 Grain Milling (Botswana)
-1982-84 Optimization of dehuller production (Botswana)
-1985-87 Improved Dehulling Systems (Botswana)

Lesotho

Division of Agricultural Research, Box 829, Maseru 100.

-1988-90 Marketing Sorghum Products, proposed

Malawi

Farm Machinery Unit, Chitedze Agricultural Research Station, Box 158, Lilongwe.

-1986-89 Grain Dehulling

Tanzania

Small Industries Development Organization (SIDO), Box 2476, Dar es Salaam.

-1979-82 Sorghum Milling I
-1983-87 Sorgum Milling II

Sokoine University of Agriculture, Department of Food Science and Technology, Box 3006, Morogoro, Tanzania.

-1981-85 Sorghum Utilization I
-1988-91 Sorghum Utilization II, proposed

Zambia

Small Industries Development Organization (SIDO), Box 35373, Lusaka.

-1987-89 Grain Dehulling

Zimbabwe

Silveira House, Box 545, Harare.

-1983-87 Sorghum Milling

Environment, Development Activities (Enda), Box 3492, Harare.

-1985-86 Mini-Dehullers I
-1987 Mini-Dehullers II

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Abrasive Disc Dehullers in Africa.
(Submitted for peer review prior to publication)
International Development Research Centre, Box 8500, Ottawa, Canada.

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An evaluation of the development of the sorghum milling industry in Botswana. (Draft)
Botswana Mill Owners Association, Box 438, Gaborone, Botswana.

3. Schmidt, O. 1987.
The sorghum dehuller: A case study in innovation.
Presented to 28-30 April, 1987 Conference on Sustainable Development
International Institute for Environment and Development
3 Endsleigh Street, London WC1H 0DD, England

4. Whitby, G. 1985.
Successfully Processing Sorghum.
J. Appropriate Technology 12(1)

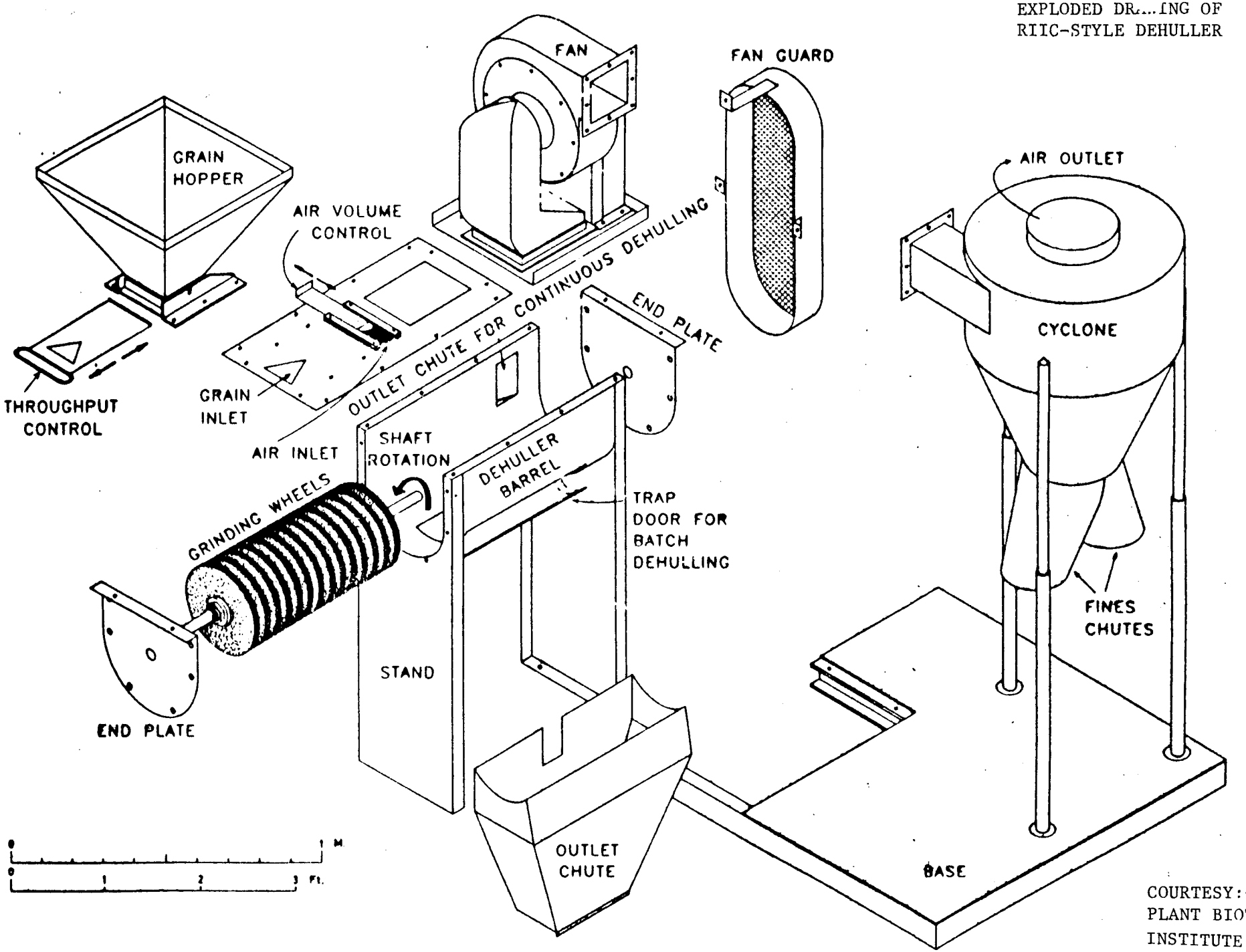
5. Nance, J. and S. Colley. 1985
Technical aspects of abrasive disc dehulling of staple grains in a rural village: results of two years regular operations.
Catholic Relief Services (CRS), Box 568, Banjul, The Gambia.

6. Anonymous. 1988.
Final Report to IDRC of Mini-dehullers (Zimbabwe).
Enda-Zimbabwe, Box 3492, Harare, Zimbabwe.

7. Mbengue, H.M. 1986.
Projet 3-P-84-0016 de Creation d'un Decortiqueur au Senegal: Situation des Travaux de Recherches au 31/08/86.
Centre National de Recherches Agronomiques (CNRA)
Bambey, Senegal.

FIGURE 1

EXPLODED DR...ING OF
RIIC-STYLE DEHULLER



COURTESY:-
PLANT BIOTECHNOLOGY
INSTITUTE SASKATOON,
CANADA

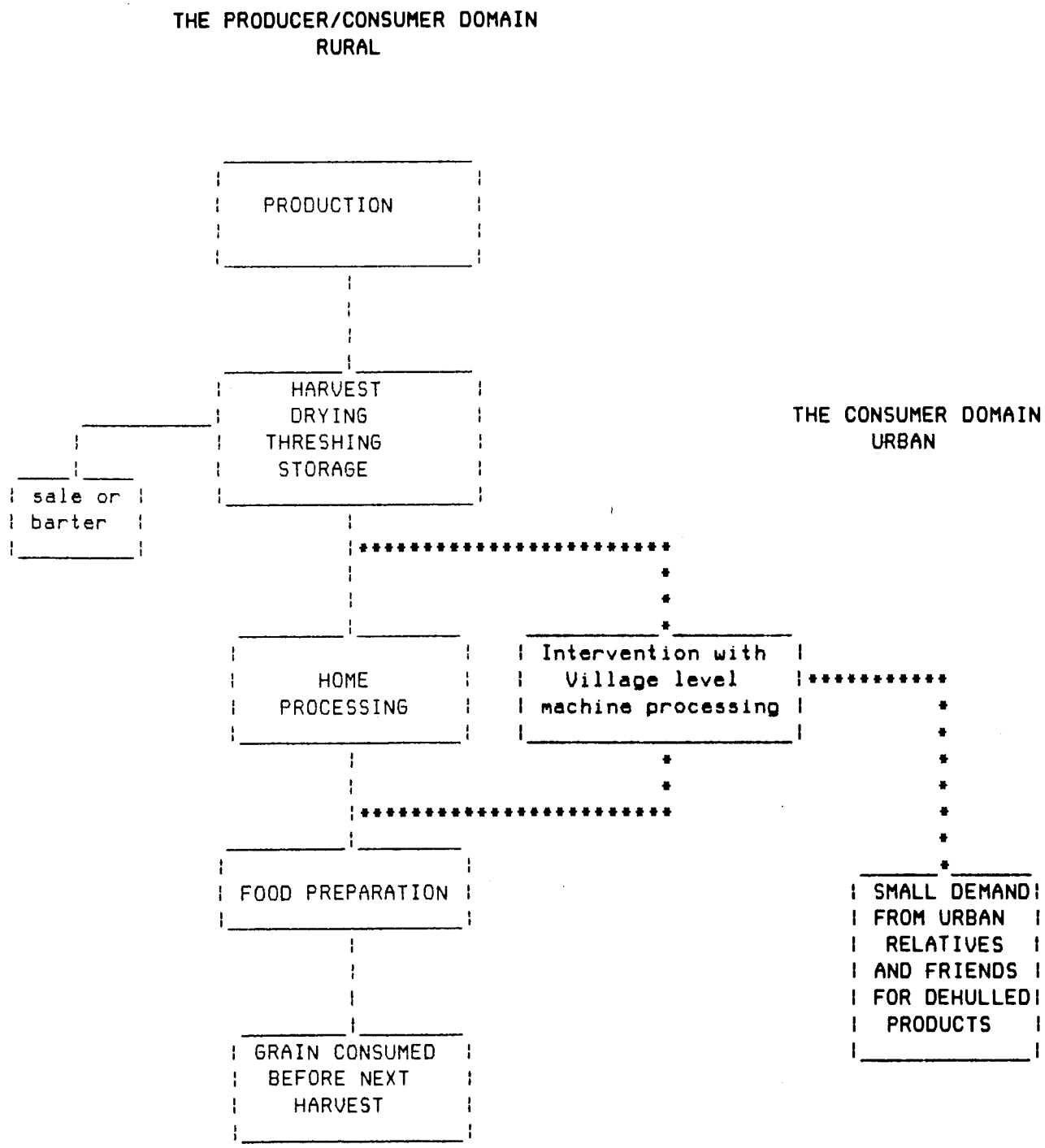


FIGURE 2

EFFECT ON FOOD SYSTEM BY INTRODUCTION

OF RURALLY-LOCATED DEHULLING MACHINERY

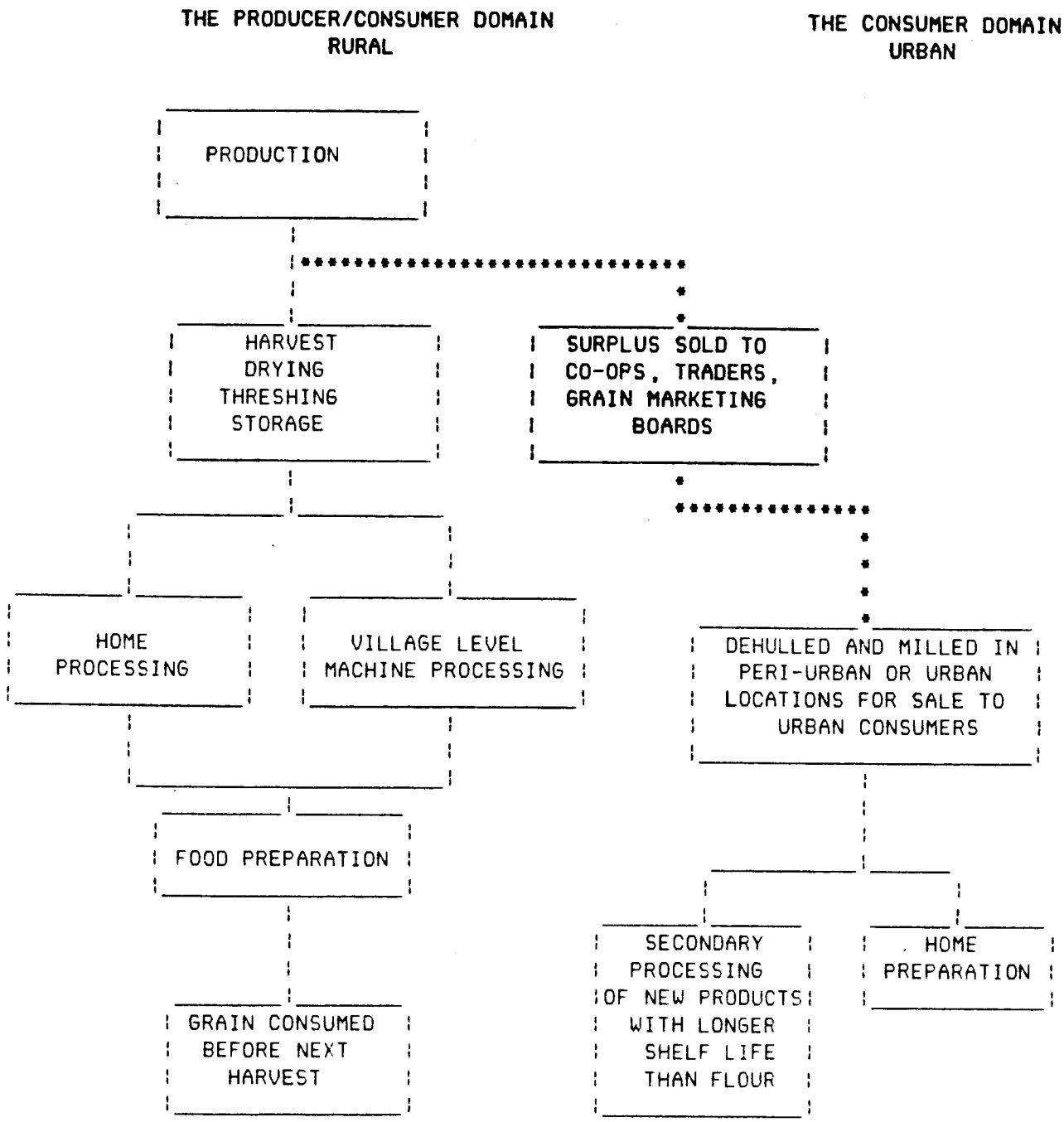


FIGURE 3

THE MATURE FOOD SYSTEM FOR

SORGHUMS AND BULRUSH MILLETS