Appropriate Technology for Grain Storage

by: Community Development Trust Fund of Tanzania
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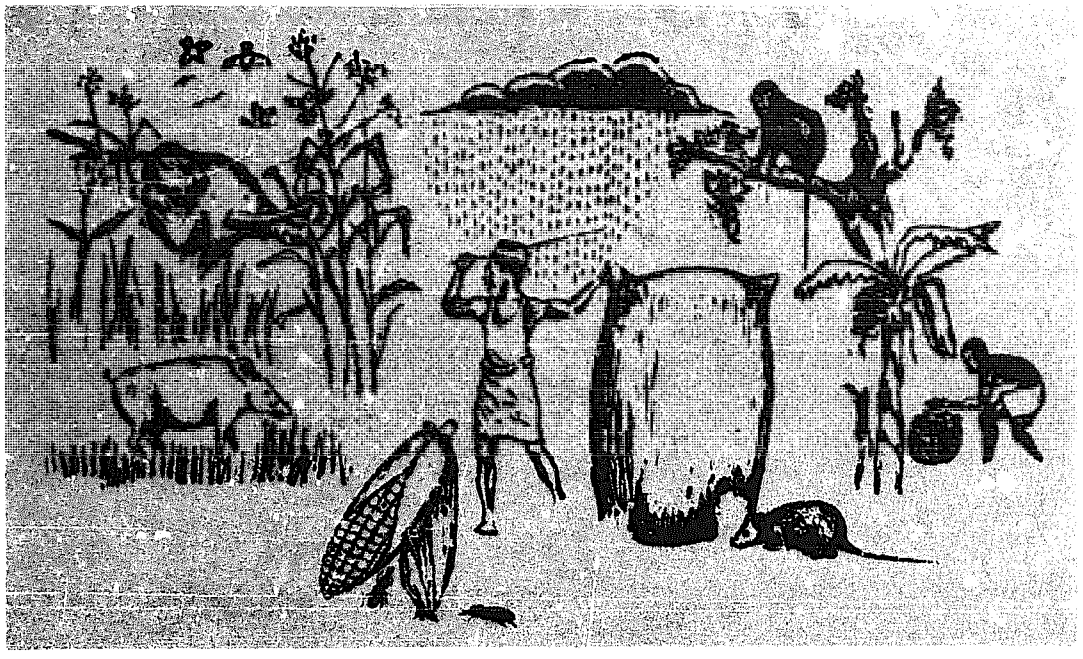
APPROPRIATE TECHNOLOGY FOR GRAIN STORAGE



Report of a Pilot Project

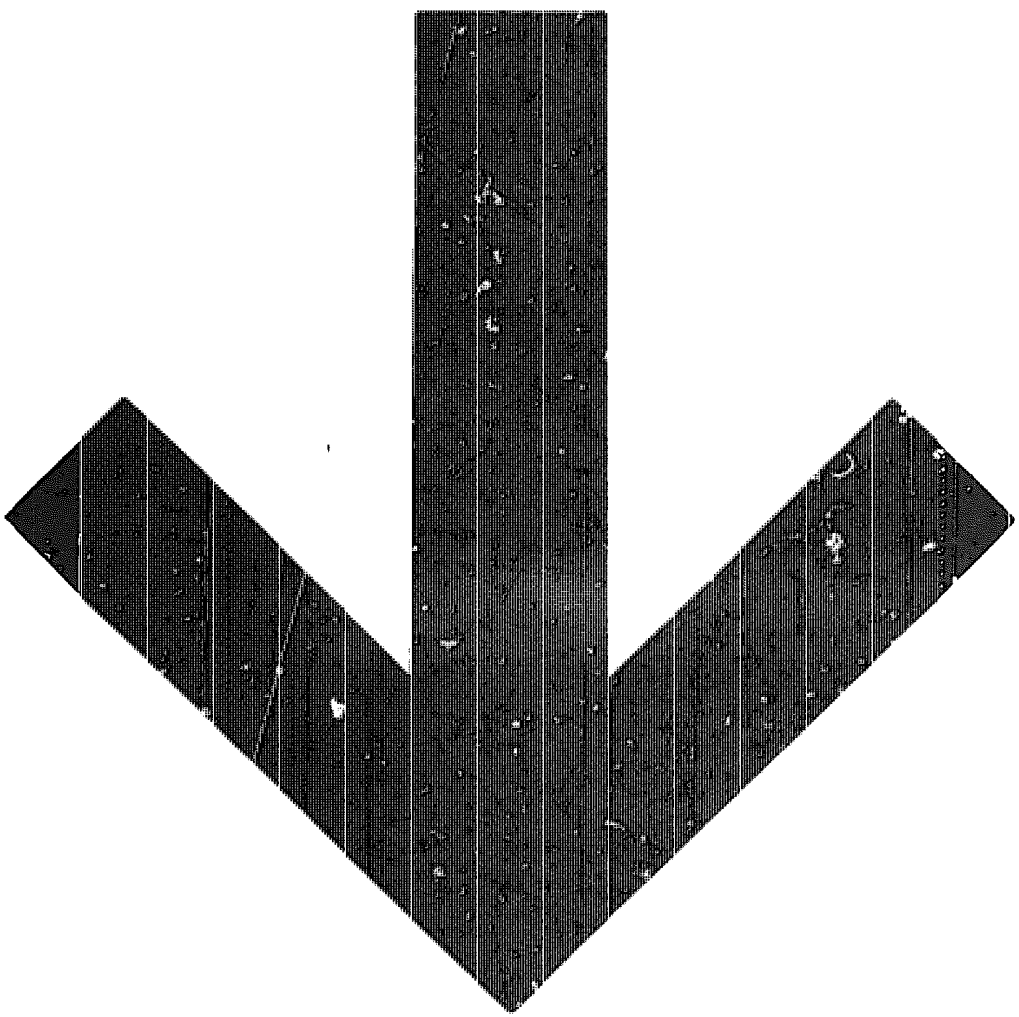
COMMUNITY DEVELOPMENT TRUST FUND
OF TANZANIA
IN COLLABORATION WITH
INSTITUTE OF ADULT EDUCATION

ECONOMIC DEVELOPMENT BUREAU

APPROPRIATE TECHNOLOGY FOR GRAIN STORAGE IN TANZANIAN VILLAGES

Report of a Pilot Project January, 1977

COMMUNITY DEVELOPMENT TRUST FUND OF TANZANIA



CONTENTS

APPENDICIES

MAPS

FIGURES

TABLES

ACKNOWLEDGEMENTS

The team which conducted the grain storage project on which this report is based received valuable contributions from many individuals and institutions. Specifically, we would like to thank Idrian [illegible]nick of the Economic Development Bureau and Simoni Malya of the Institute of Adult Education who participated in the project preparations. A.M. Mushi of the Ministry of Agriculture briefed the team on his research and findings on storage problems in Tanzania which were closely related to the work of the team. Jim DeVries and Brian Gerard of the University of Dar es Salaam, Faculty of Agriculture, both followed the project with interest from the preparation stages through the writing of the draft report on which they made insightful comments. With their assistance the team's liaison with the Faculty of Agriculture was very rewarding. M.S.Ndikwege, District Development Director of Morogoro, under whose authority the project was carried out, took a keen interest in the project and gave the team valuable support. P.O. Chikira of the Prime Minister's Office provided useful comments on both the project proposal and the draft report. Finally, we would like to thank the Dutch Government Ministry of Foreign Affairs which provided a special grant to cover the costs of the project.

Our acknowledgements would not be complete, however, if we failed to mention the villagers of Bwakira Chini who received us warmly and shared with us their wisdom and experiences about which this report is written. We sincerely hope that the comradely relations established with the villagers will continue to grow.

Dar es Salaam
January, 1977

Grain Storage Project Team

Figures 10, 13 and 14 were photographs in the original printing. These have been converted to drawings for clarity.

Illustrations on p. 44, 46, 49 and Figure 12 have been redrawn for reproduction in this edition. Artwork was done by Heather Tunis.

New Haven, Conn.
May, 1977

SECTION 1.

SUMMARY

The project described in this report for improving small-scale grain storage at village level was undertaken by a team composed of staff of the Community Development Trust Fund, the Institute of Adult Education and associates of the Economic Development Bureau. The work was carried out in the village of Bwakira Chini in Morogoro District. The goal of the project was to develop, in the course of discussion meetings with villagers, improved designs and strategies of grain storage appropriate to local conditions and to begin implementing these improvements.

1.1. Method of Approach

The efforts of the external team were from the start combined with those of a village ad hoc Storage Committee appointed by the Village Council. In the course of more than 20 formal meetings over eight weeks, clear lines of low-cost improvement of existing grain storage structures and methods emerged from the people themselves and were systematized by the Storage Committee. This process involved discussions with villagers concerning the nature of storage problems, their causes, dimensions and significance within the full range of food problems and priorities in the village. Existing village structures and methods of storage were elicited and discussed critically. Since the village is composed of many tribal groups, a rich variety of structures and methods existed, but had not necessarily been shared even by close neighbours. This existing range of storage technology was combined with inputs of low-cost storage technology developed in other countries such as Nigeria and Mexico. Further discussions ensued during which the 'foreign' technology was criticized, modified, and added to the stock of possibilities already known in the village.

1.2. Modifications

Three major streams of modifications were agreed upon by groups of villagers who started implementation under the supervision of the Storage Committee. The systems are:

(1) outside, sun-dried, insect-protected, rat-proofed, elevated storage—
The Improved Sun-Drying Crib;

(2) outside, fire-dried, insect-protected, rat-proofed, elevated storage- The Improved *Dungu*;

(3) inside, fire-dried, in roof (*dari*, and subsequent transfer to rat-proofed, insect-protected woven cylindrical storage (*kihenge*).

These three streams of modifications of existing storage systems correspond to the expressed needs of peasants having different socio-economic positions, resources and harvest sizes.

1.3. Benefits

Immediate benefits of the project include the construction of fifteen improved, rat-proofed storage structures with a capacity of 25 tons of food grains in this harvest season, and the use of insecticide by 25 peasant farmers on some 12 tons of grain. The value of crops saved from destruction by rats and insects through these improvements during the first six months is estimated to be as high as shs. 10,000/=.*

Medium range benefits include a greater awareness and understanding on the part of the villagers of the principles of grain storage and the technical and social variables which affect storage in their environment. In addition, the creation of the Storage Committee means that the village has a mechanism for evaluating and assessing the modifications made and a vehicle for the continued mobilization of villagers in incremental improvments of their storage systems. The Storage Committee could also become a permanent manpower resource for similar operations in the entire Division, as well as in the project village.

Long range benefits of the project include the development of methods of village dialogue and participation for use by several Tanzanian institutuins in training their rural workers and in running their programmes. Furthermore, the project's considerable documentation, including 25 hours of tape-recorded reflection by peasants on their own food and storage problems, is a rich source for the creation of post-literacy reading matter, radio programmes, and other educational materials.

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*The approximate value of ten tons of cereal grains.
"/=" is the English colonial notation for shilling.

SECTION 2.

RECOMMENDATIONS

This report is specifically addressed to those Tanzanian institutions which are in a position to deal with the pressing problems of food storage. Listed below are various courses of action open to these institutions which could contribute to the improvement of peasant storage facilities. The recommendations are not confined to a single institution since the nature and the extent of the storage problem in Tanzania demands a broad-based and co-ordinated programme of action. Some of the institutions concerned should be dealing with the short term follow-up of this specific project while others should be dealing with the long-term preparations of the Tanzanian peasants to exercise greater control over the storage of their produce.

A further question is whether any of the institutions listed below are in a position to replicate at least in some way this project in other places of the district, region or nation. The team feels that the approach of this project towards storage is not only worth repeating but is essential for the improvement of the village storage systems in Tanzania. Similar projects should be undertaken again guided by the experience of the Community Development Trust Fund and the Instutute of Adult Educatuion in this pilot project. Other Tanzanian institutions which are interested in promoting improved storage along the lines described in this report should participate together with the Community Development Trust Fund and the Institute of Adult Education in another joint project.* The biggest obstacle in the extensive replication of projects such as this one is the availability of trained and committed manpower. Yet the best way to train someone in the use of dialogical methedology is to have that person experience the practice of this approach. This is an additional reason why the project bears repeating.

The team makes the following recommendations for Tanzanian institutions:

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*See Appendix 1 for more detailed discussion of future storage projects.

2.1. Community Development Trust Fund should consider:

(a) training its field staff in the use of the dialogue methodology and building such an approach into selected small-scale, appropriate technology projects which it assists;

(b) sponsoring the repetition of this project in conjunction with other Tanzanian institutions during the next harvest season;

(c) continuing to subsidize the cost of construction materials for improving storage facilities in the project village and in other villages in the Division which have set up their own storage committees;

(d) financing the costs of running a seminar to be held in the project village for other villagers in the Division concerning the use of the dialogue methodology in improving village storage.*

2.2. The Institute of Adult Education should consider:

(a) creating post-literacy adult education materials (books, radio broadcasts, etc.) on the theme of storage from the materials generated by this project;

(b) preparing a seminar in the project village for other villagers on the use of the dialogue methodology in improving village storage.

(c) following the progress of the Storage Committee and similar committees established in neighbouring villages as important examples of village mobilization teams trained at low-cost by adult education methods;

(d) integrating the village dialogue methodology into its training syllabus for adult education workers;

(e) diffusing the village dialogue methodology in appropriate forms to institutions in Tanzania which undertake the training of village-level workers.

2.3. The Office of the District Development Director should consider:

(a) supporting continued diffusion of the project village's storage innovations both within the project village and among the other villages of the Division and the establishment of storage committees in these other villages.

(b) recognizing officially the Storage Committee of the project village as a mobilizing resource for at least the whole of the Division if not for the District and to consider supporting

* This seminar was carried out in November, 1976, sponsered by C.D.T.F. in co-operation with the Institute of Adult Education (See Section 8.6. for further details).

their further training and travel expenses to other villages in the Division District for the purpose of training other storage committees;

(c) studying the possibility of encouraging the establishment of credit machinery which would allow even the poorest families to make improvements in their crop production and storage systems;

(d) ensuring the availability of storage inputs such as insecticide dust and encouraging their distribution to the villages.

2.4. The University Faculty of Agriculture should consider:

(a) training its rural economy and extension students in village dialogue methods;

(b) encouraging staff to visit the project village to follow-up and assess the new structures and systems developed by the villagers.

2.5. The Ministry of Agriculture should consider:

(a) including the project village amont those where presently the use of malathion dust is under study by the Ilonga Research and Training Institute;

(b) putting greater emphasis on practical training in food storage for agricultural extension workers, especially in the application of insecticide dust;

(c) training its agricultural extension staff in village dialogue methods;

(d) testing various traditional storage structures and innovations at the Zonal Research Institutes.

2.6. The Ministry of National Education Primary School Division should consider:

(a) preparing a syllabus on grain storage problems for primary school science classes including practical experiments which the students can carry out.

SECTION 3.

INTRODUCTION

3.1. Project Background

The idea of conducting this project on grain storage began in May, 1975 when the subject arose in discussions held in Dar es Salaam between the Community Development Trust Fund of Tanzania and the Economic Development Bureau. These discussions centered on ways in which participatory methods could be used in the implementation of village development projects in Tanzania. In May, 1975 peasant farmers throughout the country were preparing for the first harvest of the *Kilimo cha Kufa na Kuponga* (Life or Death Farming) campaign whose objective was to increase the nation's capacity for self-sufficiency in food production. This campaign followed two disasterous harvest seasons which saw the country spending its entire foreign exchange reserves on the importation of food.

With reports indicating that a good harvest would be forthcoming from the first *Kufa na Kuponga* campaign, attention shifted towards the question of food crop storage. Would the results of this harvest be safe and properly looked after or would the efforts expended to increase production be negated by heavy storage losses? The extent of storage losses in traditional structures was said to be between 25 and 40 percent. C.D.T.F. Field Officers had seen these losses on their village inspections and they had often heard peasants mention crop storage as among their most pressing needs.

It was decided that the food grain storage problem needed urgent reviewing. The question was then how this enormous problem should be attacked. C.D.T.F. believed that villagers themselves can go a long way towards solving their own development problems (be they grain storage, domestic water supply or anything else) on the basis of their own skills and resources. It was proposed to attack the storage problem guided by this philosophy. Thus it was necessary to begin by looking st those existing storage structures and systems which were being used by peasants in Tanzania and to build improvements together with the peasants on this basis.

3.2. Project Preparations

Preparations for the project began some six months prior to the actual commencement of the project. These preparations in-

cluded the selection of the project site, collection of resource materials on storage and, formation of a working group. Although these preparations were spread over a period of six months, they probably did not add up to much more than 40 man-days labour imput.

3.2.1. Selection of the Project Site

Food grain storage problems are common throughout Tanzania though they vary in type and in degree from one area to another. Thus there was hardly any place in the country that could be excluded as a possible project site. After some consideration and consultations with the Institute of Adult Education, C.D.T.F. decided that the project should be located in Morogoro District. The factors which contributed to this decision are as follows:

(a) all the major food grain crops (maize, sorghum, rice) are cultivated in this area;
(b) the Faculty of Agriculture and the Ilonga Agricultural Research Institute which is the centre for storage research in Tanzania are both located nearby;
(c) communications with Morogoro from Dar es Salaam (headquarters of both C.D.T.F. and I.A.E.) are good; A great deal of travelling would have to be done and it was important that this take up only the minimum amount of time;
(d) it was felt that the District Authorities in Morogoro were sympathetic to the objectives and to the approach which the project proposed to employ.

It was left up to the District Authorities to choose the specific project village within Morogoro District. They chose a place where storage problems and the resulting losses were known to be great. Two preliminary visits were made to the project village to collect some basic data on the environment and crop production and to inform the villagers of the pending arrival of the team.

3.2.2. The Working Group

A working group composed of representatives of the Community Development Trust Fund, the Institute of Adult Education and the Morogoro District Authorities was formed prior to the start of the project. Together with the two Economic Development Bureau associates who joined at the beginning of the project, this working group formed the core of the team

which went to the village. The names of the team members and the roles which they played in the project are given in Appendix 2.

An attempt was made to stimulate a pre-project "dialogue" about both storage problems and the methodology to be used among the participating institutions and with other Tanzanian institutions concerned with food production and storage. The project proposal was mimeographed and dispatched to fifteen institutions in Tanzania. In addition, personal contacts were made and discussions held with most of these fifteen institutions. Out of these discussions emerged valuable information concerning the state of knowledge about traditional storage facilities used in Tanzania and the extent of losses incurred. People were also identified whom the project team could call upon for technical advice and consultation during the project time period.

3.3. Time Period

The team spent a total of eight weeks in the project village from the beginning of July, 1976 to the end of August. The months chosen for the project coincided with the harvest season in the village when interest in storage was at its height. It is doubtful that such great human resources could have been mobilized around the problem of storage at another time of the year. Though the villagers were rather busy, they were engaged in activities related to the issues being discussed in the project.

The period of eight weeks which was available had both advantages and disadvantages. Compressed into this short period the developments which emerged from the dialogue were visible and became part of the consciousness of all who participated. The villagers realized the possibility that they could make real changes and the impact and results obtained could be directly arrributed to the methods used.

On the other hand, the time constraint meant that the team could not always wait for the level of group consciousness to rise to a certain height of understanding about a particular problem before moving on to another one. The time allotted for identifying and examining in depth various storage-related themes for presentation to the discussion groups was insufficient and, therefore, may have affected the richness of the dialogue experience for the villagers.

SECTION 4.

THE VILLAGE DIALOGUE APPROACH

This project was as much concerned with the way in which to go about finding solutions to food storage problems as with the solutions themselves. The team felt that 'correct' solutions could only be found by using an approach which could stimulate the villagers own creativity. This approach was "village dialogue" which put the team in contact with the villagers' perceptions of the grain storage problem. The team aimed not to impose an alien analysis of the problem on the villagers but to work from the basis of their perceived and understood reality. In this section we shall describe village dialogue and how it was used in this project.

4.1. Village Dialogue

Tanzanian policy encourages mass participation in decision-making and the use of adult education as a vehicle for liberation (Hall, 1975; Mongi, 1976; Mbunda, 1976). The relationship among adult education, participation in decision-making and liberation has been acknowledged for some time by Tanzanian planners. In particular the discussion-group approach has been developed in Tanzania during such national adult education campaigns as "The Choice is Yours" (1970), "Man is Health" (1973), and "Food is Life" (1975). Such discussion groups provide the possibility for engaging in "the social act of naming the world" (Freire, 1971) through which individuals' awareness of their own reality increases as does their confidence that they can themselves improve their situation. When discussion groups are also action/implementation groups, the balance between reflection and action is obtained and it is possible to mobilize human energies on a vast scale. Tanzania has seen proof of this in the thousands of pit latrines dug by discussion-action groups during the "Man is Health" campaign.

The methods used in this project were grounded in the experience of the discussion group approach in Tanzania. The team attempted to elicit from the villagers in a series of discussion meetings their perception of the reality surrounding village food supply and storage problems. A special committee on storage was appointed by the Village Council to help conduct discussion meetings and sift through the mass of ideas thrown up by the discussion meetings. Such close liaison with a self-selected and voluntary committee of villagers was a vital check on the team's possible misunderstandings of the villagers' perceptions expressed

during the meetings as well as an invaluable contribution to the understanding of the problem in the context of village reality.

With the help of the Storage Committee the team systematized what the village meetings brought out and gave this back to later meetings in the form of visual summaries (codes)—large pictures drawn by a member of the team. Such codes are thought to help discussants to step outside of their immediate situation and to view it more objectively. They also serve to focus the discussion on a particular significant aspect of the village reality and thus help the villagers to unwrap it or de-code it and thereby gain a more critical understanding which forms the basis for action.

The team systematized and returned everything the discussion groups mentioned as ways which they use to protect grain and the reasons they gave for using these methods. In giving such knowledge back in systematic form the team hoped to build up the villagers' confidence in themselves. They were able to see themselves as possessing a concrete science and technology.

It was only at this point according to the dialogue methods that the team could begin to make contributions of science from outside the village. Having prepared carefully the villagers' awareness of the problem and aroused their confidence in their own resources, the Village Storage Committee together with the team could then present possible modifications or re-combinations of existing village technology. As a result of the preparation, villagers' reactions to the outside suggestions were in most cases critical. They were not overwhelmed by such suggestions and forced into passiveness. Instead they were able to pick and choose among the elements of their own and the other storage systems which were introduced. In this way the systems which they finally disigned were in fact their own systems and therefore easier to put into practice.

To summarize, the team together with the Storage Committee had the following functions in the village dialogue: (a) to examine the situation in the village and to identify storage-related themes; (b) to present these themes to the villagers in a dialogical manner; (c) to systematize the information gathered during discussions and return it to the groups; and (d) to participate in the action which grew out of discussion.

4.2. Formation of the Storage Committee

The first real step of the dialogue was the critical task of forming a Storage Committee in the village which could be inte-

grated together with the team. The Committee was chosen at an extraordinary meeting of the Village Council during which the team explained the aims and intentions of the project to the village leadership.

The selection process for the Storage Committee largely pre-determined its composition. The membership of the Village Council was almost entirely made up of the richer and more influential peasants with only token representation of the poor and of women. Given the task of selecting the Storage Committee from among its own membership, the Village Council inevitably appointed the rich or "progressive" farmers who were more aggressively interested in agricultural innovations (see Appendix No.3 for profiles of the Storage Committee Members). There was a danger, therefore, that the Committee might merely turn into a vehicle for these "progressing" elements to make storage improvements which were appropriate to themselves alone and not the broad base of poor peasants in the village. The team members were aware of this danger from the beginning and carefully helped to steer the Committee to the "mass approach" by continually emphasizing the need to hear from all types of villagers and to design improvements which would meet their varied needs. The political commitment of the team was extremely important on this issue as the content and direction of the dialogue depends on the political intent and input of those who identify the themes and lead the discussions.

The Storage Committee was an important vehicle for entering into the reality of the village. The Committee also worked closely with the team planning meetings, listening to tape recordings of discussion group meetings and screening the many ideas and designs that surfaced from the dialogue. The job of leading the discussion group meetings fell solely upon the Storage Committee. At first they tended to dominate the early discussions, but later as their appreciation of the method grew, their skills sharpened and their self-confidence increased, they learned to lead rather than dominate.

4.3. Organizing the Discussion Groups

For the purpose of conducting the dialogue, the Storage Committee divided the village into four distinct zones of settlement. This was an alternative to the original idea of conducting the discussions in the existing ten-family adult education study groups. The team had thought that these small adult education groups would have a higher level of co-operation than the larger,

less permanent zonal groupings and, therefore, a greater possibility of discussing and implementing real changes. The Committee, however, noted that discussions could not be held with all the small adult education groups in the short period of time available. They stressed that full coverage of the entire village was essential to our work. In the final analysis, the Committee proved to be correct. The full coverage provided by the larger zonal groups was important in understanding the village reality and preparing the "mass base" for the implementation phase.

The Storage Committee was disappointed by the poor attendance of villagers at some discussion group meetings. On occasion, they even went to the extent of "rounding-up" potential participants. When this happened it could be attributed more to poor organization and preparation than to lack of interest on the part of the villagers. In spite of the problems encountered, one can argue that attendance was in fact very good considering the time devoted to participation during the busy harvest season. The villagers put a total of some 900 man-hours into the formal discussion meetings alone during the project period. This represents a substantial contribution to the project by the villagers. It was only the dedication of the Storage Committee members which made this possible.

4.4. The Elicitation of Village Reality

Village life is a unity; its analysis requires consideration of the constituent parts in relation to the whole. In trying to identify home storage problems, the team was first led back by the villagers to the crop production system. Discussion groups told us, for instance, that any improved storage system must provide for home-drying of grain at least as efficient as that presently used. By why is home drying important? Because maize is harvested while it is still moist. Why is it harvested in this condition? Because farmers cannot protect the crop from destruction by wild pigs. But can nothing be done about the wild pigs? This requires a level of co-operation the villagers themselves say they do not yet enjoy.

Such an example highlights three important reasons why the dialogue approach places such a problem area as grain storage in the context of the total village reality. (1) The significance of some seemingly technical detail of a development problem can easily be misunderstood. For instance, well-meaning experts might have argued that farmers *should not* harvest their maize while moist; they *should* let it dry in the fields, and then store it in such and such a way. Such an unfortunately common 'outside'

app[illegible].ch would be bound to fail because it lays down rules for the farmers and takes no account of the reality of wild pigs. (2) The dialogue approach generates awareness of interrelated development problems that can be taken up in turn. For instance, the planning committee of the project village has already discussed block farming in relation to the problem of protection against pigs. While outside the specific scope of this project, the dialogue method produces village awareness of interrelated problems and is thus a useful tool in village-level development planning. (3) By pursuing problems back to their origins, discussion groups confront what are sometimes called 'limit situations', that is, points where they quite genuinely say, "Tumeshindwa!" ("We have failed!"). By defining and objectifying limit situations and then by focussing human energy on them, they are ultimately overcome. It is the experience of bursting through a previously limiting situation that constitutes the liberating effect of adult education. Later we will describe how villagers at first thought that rats, like pigs, were uncontrollable. The dialogue accepted and posed the villagers' experience of rats as a limit situation. The team did not simply contradict the villagers, saying, "Oh yes, rats *are* controllable. *You* may not know how, but *we*, the experts, do." Instead the Storage Committee discussed the matter with discussion groups at length until the villagers themselves realized that there existed in the village resources and skills that could be deployed in order to control rats.

4.5. Recording the Dialogue

The project intended to sustain and develop the village dialogue with the help of both audio and visual inputs. All formal discussions in the village were to be tape-recorded, transcribed and a summary of the analysis made for distribution to the team and Storage Committee members and for inclusion in subsequent discussion group meetings. This proved impossible to do on account of the large volume of recording which was taken and the fact that no experienced transcriber could be found.

The recording of the discussions was not abandoned and it proved to be a valuable input into the dialogue even without the transcriptions. Members of the team and the Storage Committee, either individually or in groups, frequently replayed the tapes of the preceding group discussions in order to sharpen their perceptions and deepen their understanding. In addition, members who had been unable to attend some meetings in the village could keep abreast of developments in the dialogue and add their own contributions.

Pictorial codes were drawn by the team's artist on the basis of discussions by the team and the Storage Committee on the progress of the dialogue. Wherever a theme in the dialogue needed expansion or clarification a code was designed by the team as a whole in order that future discussion group meetings could focus on that topic. This method proved to be very effective in drawing out the kind of information which the discussion groups needed in order to expand their knowledge to the point at which they were ready to come to terms with their situation. It also served to stimulate discussion when it seemed to be lagging by drawing out contributions from individuals who had difficulty relating to the otherwise exclusively verbal dialogue. In this way the breadth of the dialogue was expanded to include some people who were not accustomed to speaking at public meetings.

4.6. Role of Women

The attendance of women at discussion group meetings and their participation in those meetings which a few did attend was very poor. This was the situation in spite of special efforts made by the Storage Committee to get more women to come to the meetings and to speak. Seating at the meeting places was re-arranged so that women could have a place to sit as a group in the circle instead of their customary place outside. In addition, the Chairman of the meeting would intentionally try to direct questions on a particular topic in order to get the opinions of the women. All this was to no avail. The team even had to give up on its attempt to get a woman as a member of the Storage Committee.

This lack of participation by women is one of the major shortcomings of the project. For, while it is the men who are responsible for building storage structures, it is the women who look after the produce once it is placed in the store as part of their role of maintaining the household. Only the women have any idea what is the condition of the stored crops or even how much food remains in the store. Thus women stood to gain more from the dialogue in terms of controlling their environment than men.

The attendance and participation of women at the village's normal adult education classes was much better than at the discussion group meetings held in this project. This may be because the women viewed the discussion groups as formal meetings in which they customarily do not participate. The presence of a number of prominent village leaders as members of the Storage Committee might well have enhanced this impression and increased the women's reserved attitude.

4.7. Balance between Reflection and Action

Following the completion of the initial discussion group meetings during which the villagers discussed food and storage problems and their existing storage systems, the dialogue reached somewhat of an impasse both within the discussion groups and within the team itself. At the center of this impasse was the question of whether or not some concrete attempt to demonstrate a solution to the storage problems expressed should be attempted at this point. The villagers themselves became impatient, insisting that their expertise had been exhausted and demanding that they be told by the team what they should do.

Even within the team the opinion was expressed that it was the time to show the villagers that the team really did have some answers to their storage problems. It was questioned whether this was not a reversion to the tradtional "expert" role of outsiders mixed with an appetizer of discussions. It was decided that the team's contribution needed to be fitted into the framework of the dialogue which was emerging in the discussion groups and not superimposed outside of that framework where its effect would be anti-dialogical.

Right up to the end of the team's stay in the village, there was a constant dialectic on the balance between reflection and action. There was always the danger that premature action would be carried out in an authoritarian manner as the decision to act would be made by a few individuals and not through a consensus. Similarly, the dangers of inaction were great as they could stall the project's momentum and not produce fresh material for the discussion groups to reflect upon.

At the start of the implementation phase the question again surfaced of whether or not the Storage Committee should build a "model" structure at some public place in the village for everyone to see how to construct improved storage. The Committee argued for a long while but finally decided that its work was to produce *real, usable* improvements, however small, and that there was not one storage "model" which was applicable to everyone in the village. Therefore no models should be built, only improvements made on structures which would actually be used by farmers.

4.8. Evolution of the Dialogue

The sequence of actual discussion group meetings did not precisely follow a neat division among "analysis", "design", and "implementation". In practice, these areas of discussion very much overlapped with design questions leading to re-analysis of

the problems and implementation requiring re-designing of improved storage systems.

Discussion focused on a variety of storage systems which would be appropriate for the rich, middle and poor peasants in the village. (See Section 6 for an explanation of this terminology.) Rich peasants were more interested in a protected sun-drying crib; middle and poor peasants were more interested in a rat-proof, modified *dungu*. All groups generally embraced the idea of using insecticides on their stored crops.

4.9. Sharing Ideas and Experiences

Another important dimension of the dialogue method was to stimulate sharing of ideas among villagers many of whom did not knew what storage systems their neighbours were using. In general, there was a greater sharing of ideas and willingness to experiment among the richer peasants. The poorer peasants, with less ability to bear risks, were more suspicious and critical of proposed ideas; however, when convinced of the benefits of an improved system, they began implementing with as much enthusiasm as their neighbours (see Section 8 on Implementation).

The actual design process involved much detailed discussion between members of the Committee and villagers about the strengths and insect resistance of hardwoods used for constructing *dungus*, experience of rat behaviour, and prior experience with insecticide. This interchange of ideas and experience *among* the villagers in the course of a village engineering design process was perhaps the most mobilizing and enriching aspect of the project. (See Appendix 4 for a detailed sequence of events and the progress of the dialogue in the discussion group meetings.)

SECTION 5.

PERCEIVED PROBLEMS

Bwakira Chini lies in the Lower Mgeta River area of the Upper Ruvu Basin, just on the edge of the Uluguru mountains at an altitude of 450 feet (137 m.) above sea level (see Map 1). The average annual rainfall is probably between 960 and 1,060 mm. (38-42 in.) (Spooner & Jenkin, 1966, p. 4—see Appendix 1 for more detail on the environmental setting in a Tanzanian context). Over three-quarters of the annual rainfall occurs between the months of December and May. Figure 1 (below) shows the monthly distribution of rainfall at Bwakira Chini:

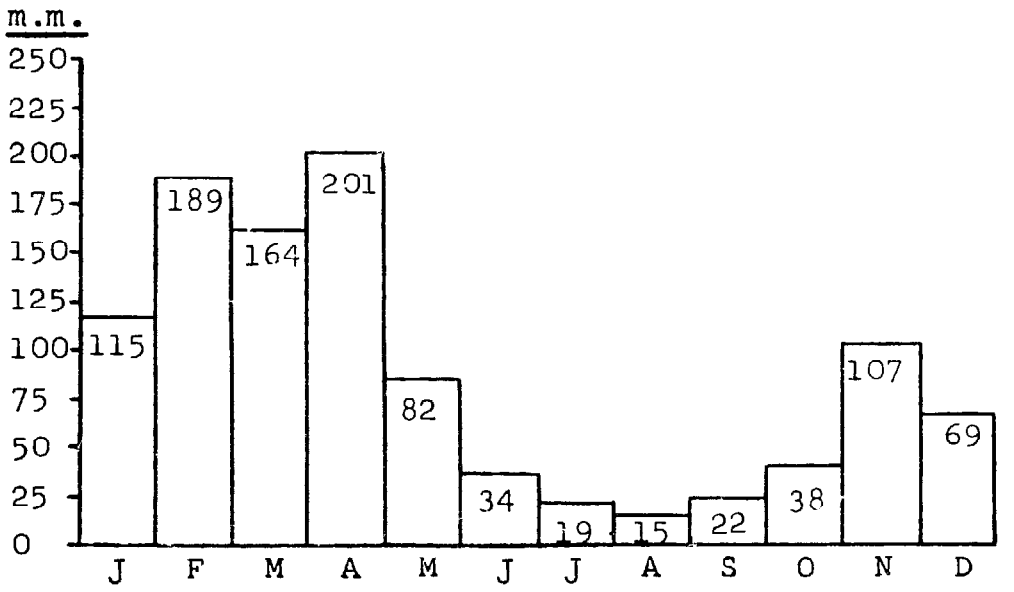

Figure 1: Bwakira Chini Average Monthly Rainfall* (1956-1963)

Some maize is planted in December and some in June, directly following the rice harvest in areas of alluvial soils. However, the major planting season is February, when maize, rice and sorghum are sown. Maize is therefore harvested between March and June, depending on both planting time and variety used; rice usually in June; and sorghum in August. Cotton is a major cash crop, planted in February/March and harvested in August.

*Source: Spooner & Jenkin, *The Development of the Lower Mgeta River Area*, 1966, page 5.

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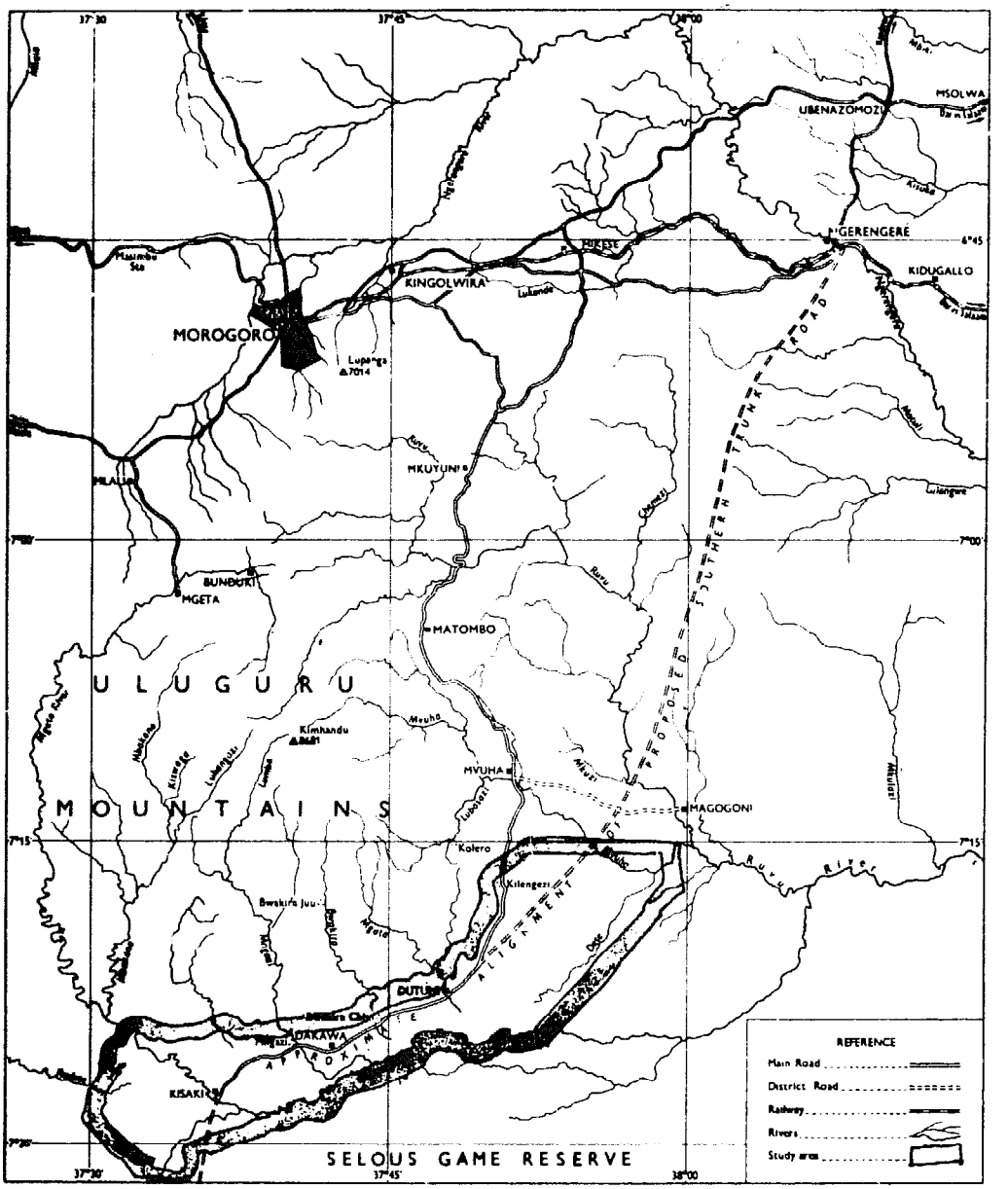
LOWER MGETA STUDY AREA

MAP 1



D.O.S. (L.R.) 3037D
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Soils are reasonably fertile ones of colluvial and alluvial origin. Yields of up to 20 bags of rice per acre have been reported; however the proximity of the Selous Game Reserve and large expanses of unoccupied land means that animal encroachment on standing crops is a real problem and a factor that can considerably reduce potentially high yields.

The problems which villagers raised in discussion meetings reflect the degree to which human use of this rich but challenging environment has so far been limited. The problems perceived by villagers can be divided into: (1) those dealing with the food system generally, (2) those dealing specifically with storage of grain; and (3) obstacles to solving either "1" or "2". The totality of these problems was captured in a pictorial "code" presented to the discussion groups (see Figure 2).

Figure 2. Code of Food and Storage Problems

5.1. Food Problems

The combination of a number of interrelated factors have created a food problem at Bwakira Chini similar to that experienced in many Tanzanian villages. Some of these factors are listed below.

5.1.1. Rainfall

The farmers in Bwakira Chini are dependent on rainfall; and the area has known prolonged droughts. In 1967 the participants in the Village Settement Scheme (since discontinued) were forced

to receive food from the World Food Programme due to failure of the rains. This year (1976) at Bwakira Chini the rains were late. Furthermore, the flooding of the Mgeta and Bwakira Rivers upon which some farmers depend for adequate irrigation of their rice lands is irregular. This year, for instance, the Mgeta did not flood sufficiently and the Bwakira shifted its stream-bed, innundating maize awaiting harvest!

5.1.2. Cash Crops

Food crop failure can rarely ever be attributed to a single factor such as lack of rainfall. Emphasis on export crop production at the expense of food crop production is a persistent problem in Tanzania. The cultivation of cotton at Bwakira Chini was pushed extensively during the Settlement Scheme period (1965-1969). The acreage cultivated at that time was so large that aeroplanes had to be called in to spray the crop from the air. Often more than half of the crop was left in the fields since the available manpower (including hiring labour) was not able to harvest it all. Later farmers began to reject cotton on account of its low return but presently cultivation of the crop is on the upswing again because of higher producer prices and increased pressure through minimum acreage laws.

5.1.3. Access to Land

Farmers try to balance reliance on rice, maize, and sorghum in order to insure an adequate food supply from diverse sources. However not everyone has access to good rice lands, nor to lands where the third crop (*mlau*) of maize is sometime planted in June. Villagers who were settlers during the Settlement Scheme still farm those lands which they acquried at that time, and these tend to be the better lands. Newcomers such as the recent immigrants to Makazi Mapya are presently only growing sorghum on lighter, stonioer soils. Although much fertile land is still available for cultivation, it is either difficult to prepare (perennial weed problem) or very far away from the settlement where the crops are most vulnerable to destruction by wild animals.

5.1.4. Field Pests

Villagers emphasized the problem of animal pests, especially wild pigs and monkeys, although hippos and elephants were also mentioned. Wild pigs can finish half a standing crop easily even if one stands guard at night while it matures, as many farmers do. While the pigs are active at night, the monkeys are at work during the day. Birds also destroy considerable sorghum and rice.

5.1.5. Production Relations

From discussion it would seem that at least one third, perhaps as many as two-thirds, of the 270 families in the village do not manage the harvest and store enough food to see them through the year. The team was told that it is common for the main maize crop harvested in June to be finished by November. Such families may or may not harvest sorghum in August to supplement their food supply. Those who are in this marginal food situation generally are the ones who also have the least rice.

For these villagers the alternative is to work cultivating the fields of wealthier neighbours beginning in November for the December planting. They weed for others and cultivate for others in January for the February planting. They weed for others in March. If these poor farmers have managed to find enough time to cultivate their own farms in December, by April they will have some maize. By June their own small harvest of maize planted in February will be ready to eat. However, they will not have been able to plant a large acreage because much of their labour will have been used for the sake of earning food to keep them alive, so their small harvest lasts only until November; and the cycle repeats itself.

The pay for such *mraba** agricultural labour is either in food or in cash (see Figure 3 for pictorial code). Some poorer farmers also pick cotton for cash during August and September. In November and December they do the difficult and dangerous work of harvesting kapok for the treeowners. Others work on the roads or do construction and other jobs. Any cash earned is generally used to purchase *bondo* (cassava flour), the least expensive staple food.

The payment for digging (ploughing) a *mraba* is now 2/= (approx. 40/= to 50/= per acre) or its equivalent in food.** The rate, however, does vary depending on the previous harvest season: following a poor harvest, wages tend to fall (i.e. the *mraba* gets bigger). The relationship between the land owner and the *mraba* labourer may also influence the amount of payment. Those who harvest kapok receive 40% of what they harvest as payment from the tree owner. Payment for other jobs such as latrine digging, house building, tree cutting, etc., is negotiated between the labourer and his employer. In all these cases it is

* *mraba* is a measured area of land (approx. 1/20 to 1/25 acre).

** The team was told that the *mraba* wage just a few years ago was 1/=.

generally the labourer who goes looking for work and not the other way around.

Figure 3: Code of Hired (*Mraba*) Labour

5.1.6. Insufficient Food

There is little doubt that a real food problem does exist in the village. The doctor in charge of the Health Centre in the next village estimates that from 3-6% of children under five suffer from acute malnutrition. One case of marasmus and two cases of kwashiorkor were encountered during the team's stay in the village. A Faculty of Medicine survey of the Division in 1973 found widespread signs of anaemia, which may have had a nutritional basis. There was no evidence that farmers exascerbated their food supply problem by imprudent sale of food crops, although some sorghum is sold or used for beer brewing.

It would seem that the allocation of land and labour resources within a set of reasonably old and established relations of production favours accumulation by the better established members of the community at the expense of the poor. This basic problem is compounded by the destruction caused by wild animals and post-harvest losses due to rats and insects. However, in view of the overall food problem—misallocated labour hence small harvests for the poor—the post-harvest losses diminish in significance, although they naturally play their part even at levels of production below one-half ton of maize.

5.2. Storage Problems

5.2.1. Crops Harvested with High Moisture Content

Rainfall seasonality, field pests, and seed variety combined to produce a storage problem consistently brought out in discussion meetings. As mentioned earlier, maize reserves can be exhausted by November. For such families it is essential that a December planting of maize is attempted. For this planting local varieties of maize are generally used. These seeds produce a mature crop in four months. This means that maize can be ready to harvest in April. But April is Bwakira Chini's rainiest month. Spooner and Jenkin (1966, p. 11) cite rainfall data from 1956-63 giving an average of 201 mm. (7.92 in.) rain in an average of 17 rain-days (see Figure 1). Furthermore fear of the real danger of destruction by pigs means that the farmer is not free to let his crops stand drying into May which in any case may have considerable rain. In addition, this December maize may have been intercropped with another crop such as sorghum in February. Thus, the crop must be harvested, and is invariably harvested wet. This wet maize is more vulnerable to mould, fungus and insect attack. Normal storage problems are complicated by the drying problem; this is a problem recognized widely by villagers. Their present solution is fire-drying in their homes, as will be described in the next section of this report.

Maize planted in February fares better. A June harvest date is generally drier, as are the months of July and August, the latter being the month when sorghum is harvested. Even September has only 22 mm. (0.85 in.) in an average of only 2 rain days. However, the pig problem is probably worse during these drier months because during the rainier ones flooding in the Mgeta area makes it more difficult for pigs to reach the fields. Fires in the game areas in the drier months drive animals closer to human settlement in search of food. Therefore, the tendency with the June harvest of maize is also to harvest when it is not adequately sun-dried in the fields.

5.2.2. Rats

Rats were named by the villagers from early in the project as the major storage pests. House rats are common, and there was evidence of considerable damage by rats in roof storage (*dari*) after only six weeks (the householder estimated that rats had consumed a paraffin tin's quantity of maize in that time—15 kg.). Villagers noted that around August/September when the fields around the village are cleared of food and often burned,

field rats from the lower areas also join the house rats and destruction of food increases. The extent of field rat infestation is cyclical while house rat infestation is constant. Damage to stored crops observed in November was severe and extensive when the infestation of field rats was reported as high.

5.2.3. Insects

Insect infestation in the village follows the typical pattern: the build-up is slow during the first month or so after harvest but then expands rapidly. As such it is not as readily noticed as rat damage by the villagers who do not regularly inspect their crops after they have been put in the store. Maize stored over a period of one year in jute bags without insecticide was inspected: it was completely decomposed into powder unfit for human consumption. The infestation was 100%—not a single grain was left untouched. The same result was obtained from a sample of sorghum also stored for one year.

The main primary insect pests in maize and sorghum are the maize and rice weevils (*Sitophilus zeamais* and *Sitophilus oryzae*) which increase their numbers very rapidly. Infestation of weevils was noted in the field and in the store both from crop residues and through cross-infestation. Crops attacked by weevils also contained numerous secondary insects of which the red flour beetle (*Tribolium castaneum*) was the most common. Sorghum was found to be infested from the fields by another primary pest, the angoumis grain moth (*Sitotroga cerealella*). When the sorghum is properly stacked, farmers say that infestation by both *Sitophilus* and *Sitotroga* is confined to the edges of the stack and does not penetrate to the centre.

5.2.4. Mould and Fungus

Mould and fungus on crops was found only in those storage structures which did not employ a fire-drying system. Since most people used fire-drying structures (either *dari* or *dungu*), there was correspondingly less awareness of mould and fungus as a problem, although when it occurred, it was very destructive. The presence of considerable mould or fungus increases the labour-time required for food preparation enormously as affected grains must be separated from clean grains either during shelling or during winnowing, or both. Also some fungi dangerous to health of humans and farmyard animals were observed; these were of the penicillium and aspergullus varieties.

5.2.5. Size and Space

Additional storage problems concerned size and space of storage facilities. Farmers are reluctant to sore maize and sorghum together since they are harvested at different times and mixing them will encourage insect infestation. Hence separate areas of the *dari* or *dungu* must by available; or separate *dungus* must be constructed. Since houses are generally not large the total space available above the cooking fire in the *dari* is not large. At present levels of production these spaces may be adequate, but they do not allow for expanded production of either maize or sorghum. Since various efforts are being made to increase production (introduction of improved seed, enforcement of minimum acreages), storage space may become a problem.

5.2.6. Rice Paddy Storage

Most villagers expressed satisfaction with present storage facilities for rice paddy, except that it too can be eaten by rats, though even this is less of a problem than with maize and sorghum. We saw no insect infestation of paddy whatsoever, and found only one case of mouldy paddy in the home of a wealthier peasant whose paddy had exceeded the number of jute bags available and had been stored in direct contact with his concrete floor.

5.3. Obstacles to Improvement

Discussion groups mentioned many obstacles to improving either the general food situation or storage situation or both. Many villagers noted that they had very little surplus cash or labour for making inprovements. It has already been described above where much of the families' labour goes. The lack of cash reflects low wage rates, low producer prices, relatively small acreages allocated to cash crops (125 acres of cotton per 270 families = 0.46 acre of cotton per family—and of course some families had no cotton), and high consumer prices for cloth, kerosene, etc. It is likely that planned obligatory minimum acreages of cotton (one acre per adult villager, block-farmed), if implemented, would ease the constraint on cash income, but can hardly have a favourable effect on the labour constraint.

Besides labour and cash, it was observed that credit is not available for some critical improvements. This last year a government tractor was stationed at Bwakira Chini and would plough an acre for the subsidized price of 45/=, cash in advance. Unfortunately there was no provision for credit, so the poorer farmers could not make use of the tractor to break out of the

vicious circle described previously.

In order to implement even the minimal storage modifications finally designed and approved by the Storage Committee and discussion groups, labour-time and small amounts of cash (perhaps 20/= to 30/=) will be required. At the moment one or more of these critical elements are missing for at least one-third of the villagers.

The question of constructing new or improved storage facilities met with the problem of permanence. The newcomers to the village as well as a number of the older settlers had not yet built permanent houses so the proposition of permanent storage facilities was not easy to put across. In addition, part of the village had not been surveyed and the survey in another part was the subject of some controversy: thus a large portion of the villagers were uncertain about their own plots.

Discussion groups also mentioned low level of co-operation as another obstacle to improving the storage and food situation. Former members of the Settlement Scheme (1965-69) recalled an attempted communal food storage system and co-operative efforts to fence block farms against incursions by pigs. Such activities were generally judged by villagers to be impossible at the present time. The large imflux of new settlers in the village had compounded the problems of co-operation. Last year the Divisional Bwana Shamba held meetings with ten-cells to try to generate enthusiasm for co-operative pig hunting. He made little progress, and villagers say it is not just that the predominatly Muslim villagers are reluctant to hunt pigs. At present there is no co-operative agricultural effort at all in the village, neither block-farming nor *ujamaa*. It was often said that it doesn't make sense to ask people who do not produce together to store their food together.

Jealousy and rear of theft were often mentioned as twin obatacles to particular storage improvments, especially those which involved outside storage in general or the use of sun-drying, air-ventilated systems in particular (see Figure 4).

5.4. Food & Storage Problems in the Dialogue

In the context of the dialogue, three distinct levels of limit-situations were identified:

(a) A limit-situation which the villagers felt that they could deal with and overcome at the present time. This was the problem of the control of pests in small individual family storage structures.

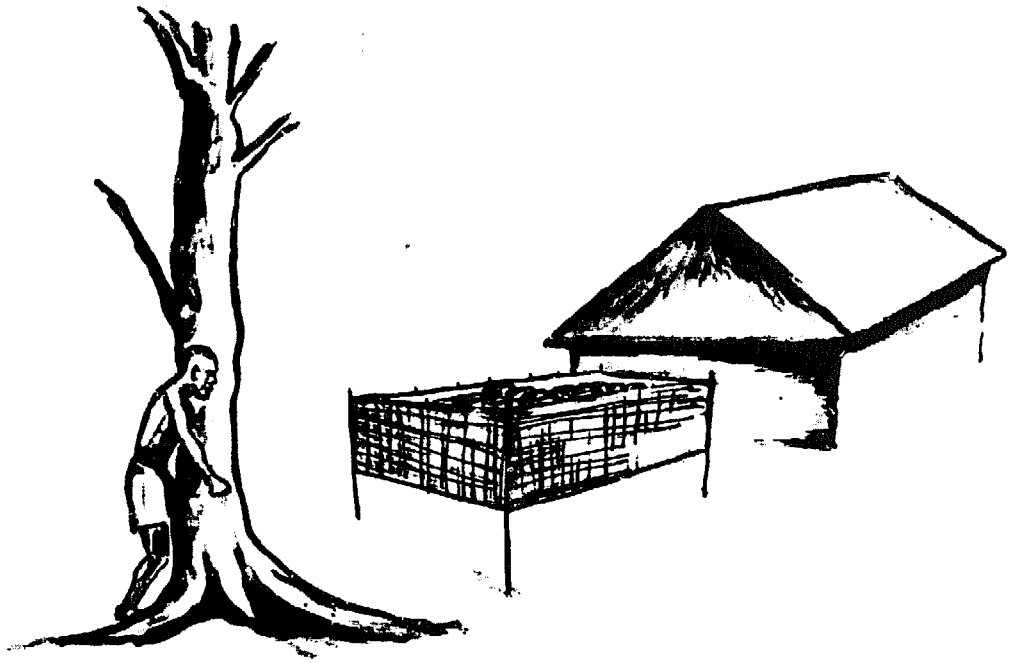


Figure 4. Code of Crop Theft Problem in Outside Storage

(b) A limit-situation in which the course of action necessary was recognized and it was felt could be dealt with over a period of time. This was the increased protection of standing crops in the fields.

(c) A limit-situation whose value was acknowledged but which could not be overcome under the present conditions in the village. This was the communal storage of produce.

Increasingly higher levels of village co-operation are needed to deal with each of these limit-situations. The villagers were able to identify these as short, medium, and long-term objectives— to put each limit-situation in its proper time perspective. They were able to state realistically that "this is what we can accomplish now and this is what we should do later."

SECTION 6.

EXISTING STORAGE SYSTEMS

Bwakira Chini is composed of peasant families with different levels of wealth. While there was no formal classification of rich, middle and poor peasants in the group discussions, these divisions and their membership became increasingly apparent to the team through observations and informal talks. The most important factor which was used to determine an individual's classification was the sale or purchase of labour power and purchase of other production inputs (such as tractor hire). The classification of the village members was essential for the consideration of a range of storage design modifications which could be applicable to all of the groups in the village. Each of the groups in the village already had different storage needs, and hence different storage systems.

6.1. Rich Peasants

There are a small number of families who harvest large quantities of all the three major grains. Quantities such as 2-3 tons of rice, 2-4 tons of sorghum, and 1-2 tons of maize would be typical of this group. This group uses family labour but also hires large quantities of labour from the poorest group of families in the village. These rich peasants also have the cash to hire tractorization of their land. They are generally, but not exclusively, families that were established in the area around the time of the Village Settlement Scheme (1965-1969)—though not necessarily Settlement Scheme members. Some newcomers also belong to this group such as government salaried workers who also farm.

The rich peasants have quite large storage requirements for the grains which they produce. Not only do they store their families' food needs for the year but also the crops which they will eventually sell. Very little food is sold immediately after harvest but rather is kept and sold later on when the price is high. Sorghum, for example, can be sold between January and March at a 50% to 100% increase over the price in September.

For these rich peasants the roof storage system (*dari*) is not appropriate. These peasants nearly all store considerable quantities of grain in jute bags in unoccupied rooms (often with concrete floors) inside their homes. In one case where a rich peasant's house with a concrete floor has been somewhat rat-proofed, space in his home was rented to other peasants who stored their crops there.

Some rich peasants make use of very large (½ to ¾ ton capacity) woven reed containers called *kihenge* for part of their rice harvest. The *dungu*, a free-standing storage house on stilts, ususlly with a small cooking fire below, and a shorter non-free-standing version called *upango* are also used by these richer families, especially for sorghum. Sorghum is temporarily stored in rough raised platforms in the fields while awaiting transportation to the home.

Several of these rich peasants have recently begun to experiment with open-air sun-drying cribs for maize built of locally-available trees, thin poles and sorghum stalks. These are of varying size, permanence, and effectiveness—as will be described later in this section. Given government stress on maize production, the present low level of production of maize as opposed to sorghum and rice, and potential productivity given moderate additional inputs, it is likely that maize production by this group of richer farmers will increase several-fold in the next few years.*

For this group of peasant farmers the priorities of improvement seem to be (1) improved home drying and storage of maize, (2) improved storage, mainly in the form of rat-proofing, for sorghum, (3) rat-proofing for rice storage.

6.2. Middle Peasants

These are the families who harvest up to a ton of rice, a ton of sorghum, and half a ton of maize. Many of these families also hire some labour from the poorest families, but they mainly rely on their own family labour. During the past season a number of middle peasants were able to hire a government tractor at the subsidized rate of 45/=per acre for ploughing during the limited time period when this tractor was in the village. Only the rich peasants and government staff could afford the private tractor hire of 90/= per acre. Many of the middle peasants were members of the former Village Settlement Scheme. Some forty of the original eighty settlers remain in the village up to the present time. These families may be slowly moving upward into the group of richer families, but the process of accumulation at this level is very slow.

*Bwakira Chini is one of the villages included in the National Maize Programme but implementation of the programme had not really begun there. Improved seeds (Ilonga Composite) and fertilizers were brought to the village last season. The fertilizer, however, was returned unused as it is not needed and uneconomic.

For this group the *kihenge* generally is sufficient storage for rice. There is some rodent damage, but when *kihenge* are plastered thickly with mud, it deters the rat, and rat entry points can be detected quickly. Such *kihenge* are generally kept in the sleeping room, and are therefore easy to inspect for rat attack. Sometimes they are covered, and often they have a top and bottom layer of rice-chaff as a buffer against rodent attack.

For this group the roof storage (*dari*) system for maize and sorghum is marginally sufficient. The level of production of this group represents the tipping point between perceived adequacy of the *dari* and the clear perception that a *dungu* is necessary. Hence, some of these families had *dungus*, some did not.

6.3. Poor Peasants

These are the families with little or no rice and who harvest less than one-half ton of maize and between one-half ton and one ton of sorghum. These are the families who provide most of the casual wage labour for the other families in the village. These poor peasants can be further subdivided into two groups. First, there are long-established families who provided wage labour for the alienated plantation as well as for the Government during the early phase of the Village Settlement Scheme (for instance, in 1965 the Government paid 302 casual labourers for work at Bwakira Chini). These same peasants continued to provide casual labour for the eighty settler families up until 1969, and continue up to the present in more or less the same economic relationship to the rich peasants. The process of accumulation among these poorer families is obviously very slow, and they are not expected to break out of their dependent position soon, nor are they expected for the same reason to expand their grain acreage dramatically within the next few years unless some direct intervention is made on their behalf by the Government and Party (e.g. special credit measures). Therefore, it is likely that their storage system and needs will remain more or less unchanged.

The second group of poor peasants consists of the most recent settlers. Some recent newcomers have entered immediately the middle group because they have in fact not moved from far away and because they retain some outside economic links with their former homes. However, at least 70 of the 80 new families who moved down out of the foothills of the Uluguru mountains within the past 15 months appear to have joined the established group of casual labouring families in this activity. This may only be a temporary situation as these new families integrate themselves in-

to the village and increase their economic activities. At present they farm only moderate acreages of sorghum and peas. Harvests of sorghum will probably not exceed one ton for most of these families. Hence in this season their storage needs relate exclusively to moderate quantities of sorghum. It is in this group however, that the greatest number of improved structures have been started in this project.

It is more difficult to predict this sub-group's future storage needs. They are not fully integrated into the *mraba* wage labour system, and have some small-stock (goats). They also engage in numerous other economic activities such as basket-making and communal pig hunting. Their sorghum commands a good price for beer-making locally, and they have knowledge and experience in the highland Uluguru trading networks. For these reasons this sub-group might accumulate investment surplus faster than the previously described, older group of poor. They probably also need Govenment and Party help in avoiding the vicious cycle of dependence, but have considerable community unity which is to their advantage. Therefore one might expect that some of the recent settlers will soon diversify into maize and possibly later, rice. As they do so over the next few years, their storage needs and systems will come more and more to resemble those of the middle group of villagers.

At the present moment all poor families share a common storage system. They rely exclusively on the roof system (*dari*). Maize is piled (not systematically stacked) onto the ceiling platform about head-height, usually above the kitchen fire. The maize is not husked because the smoke from the fire blackens the grains and makes them bitter. Sorghum is piled in a separate section of the *dari*. It is stored on the head. Individual maize cobs or sorghum heads are removed from time to time to be husked, beaten, and pounded as appropriate for preparation of the family food supply in quantities sufficient for three or four days.

In these poor homes little use is made of the *kihenge*, but small amounts of grain or seed for planting are sometimes stored in earthen pots (*chungu*) or sewn tree bark cylinders (*lindo*). Sometimes maize cobs for seed are chosen, husked, tied by their husks in small bundles, and hung directly over the kitchen fire from the bottom of the *dari* platform.

6.4. Cultural Difference in Storage Systems

Although the major underlying determinant of storage needs and systems in the village is the socio-economic position of the family, these differences are somewhat overlain by cultural dif-

ferences, usually influenced by tribal origin.

Since Bwakira Chini has historically been a meeting place of several tribal groups, one finds a mixture of people. The area has traditionally been inhabited by the Wakutu tribe but recently large numbers of Waluguru have moved into the area making these two tribes approximately equal in numbers. The other tribes which have a sizeable representation are the Wamawanda, the Warufiji, the Wangindo and the Wapogoro. There are also individual families of Wamakonde, Wangoni, Wazaramo, Wanyakusa and Wachagga origin.

The *dari* is used extensively by both the Wakutu and the Waluguru. The Waluguru also utilize large clay pots which are made in the Luguru mountains. The Wamawanda introduced the *dungu* into the area and they are also experts at weaving the *kihenge*. Manufacture of the *lindo* out of tree bark is a traditional Kutu skill which is being passed on to a considerably reduced number of craftsmen.

The Kutu and Mawanda seemed more commonly to mix ashes of trees into their smaller containers of seed for preservation until the next harvest season. And one Kutu woman spoke of burning a special leaf in the kitchen fire in order to produce a smoke particularly damaging to insect pests.

On the whole, however, in such a stratified and ethnically mixed community as Bwakira Chini, it was found that socio-economic position had far more influence on the type of storage used than culture.

Richer peasants were generally quicker to borrow storage systems across cultural boundaries and in general to experiment, as the Committee members experiments with sun-drier attest. Even at a level of fine detail the richer peasants were more open to new knowledge whether it came from a neighbouring tribe or from a research station. The Chairman of the Committee, for instance, had been planning to construct a new, improved sun-drying crib/store. He had already cut several posts when other members criticized his choice of tree, he took their advice and sought out the new trees. Such a diffusion process among the richer peasants seems to have been going on for some time before the project. The project sought to generalize such diffusion to the poorer peasants.

6.5. The Village Godown

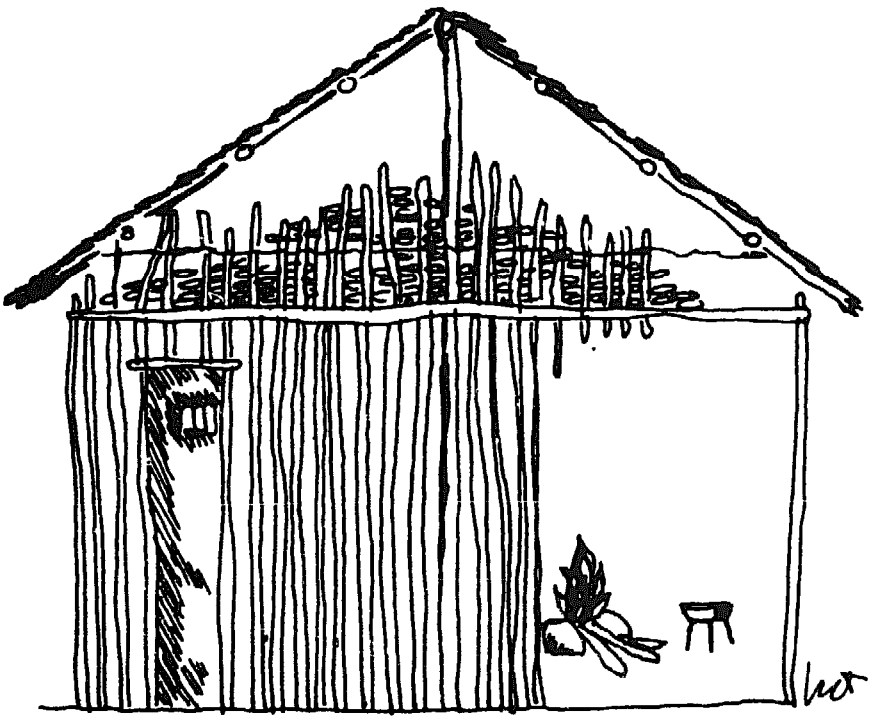
There exists a village godown which is used nearly exclusively for the marketing of cash crops (cotton, kapok and sesame) though small amounts of paddy have been marketed in the past. During last year's Life or Death (*Kufa na Kuponga*) farming

campaign, the resulting maize harvest of the old ujamaa group was collected in the village godown. Unfortunately, the floor had not been cleared of cotton seed, nor was the maize well looked after while it was in the godown. As a result losses to rodents were very high and the villagers are now even less favourably inclined toward communal storage than they were. The experience of this disastrous attempt to store food grains in the godown points up the necessity to review the villagers' godown management if this facility is to be used to market food grain surplus in the future.

6.6. Technical Features of the Structures

6.6.1. The Dari

Up to one-half ton of maize was observed to be stored on a platform of thin poles at about head-height above the hearth-stones of the kitchen area in homes. This platform generally was supported by the main beams of the house, above which rose the actual roof of the house. No special reinforcement structures were added.



Villagers perceived great benefits to their stored grain from both smoke and heat from the cooking fire. Many claimed that the smoke has insecticidal properties. Most villagers agree that the chief function of the *dari* is to dry grain which is harvested in a moist condition, as described above. In relation to the actual

drying effect of the cooking fire, fluctuations of wet and dry bulb temperatures were observed both inside and outside of a sample house. The relative humidity inside the house in the area of the *dari* was relatively constant throughout the day and night averaging 70% in the morning at 0600 hours, 54% at 1200 hours and 62% in the evening at 1800 hours. On the other hand, the outdoor variations during the same period were much greater showing a high average relative humidity during the night (87% at 0600 hours) and very low relative humidity during the day (46% at 1200 hours) which rose slightly in the evening (60% at 1800 hours). (See Appendix 8 for more detailed information on the data collected.)

Samples of maize examined after one month in the *dari* were quite dry with perhaps 12% moisture content or below, (testing was done by cracking grains with the teeth). This drying had been accomplished in some cases exclusively by the cooking fire under the *dari* since some farmers revealed that they had harvested their maize when quite moist and had not sun-dried.

On the other hand temperatures in the maize in the *dari* directly above the cooking fire are not likely to rise high enough to destroy the nutritional quality of the food. The fire is only used at full heat during cooking, when cooking pots are interposed between fire and *dari*. Afterwards only smouldering logs are left in place.

Structurally, the *dari* is part of the superstructure of the house. As such it is virtually impossible to protect against rats. Being elevated perhaps two metres above the floor, it is difficult for a woman to climb around in it in order to clean or to inspect in detail the condition of the grain. Also as part of the house superstructure the *dari* shares the ventilation properties of the house in general, which are not good. And, of course, the *dari* is subject to the same fire hazards as the rest of the house.

Hence the major advantages of the *dari* (perceived and acknowledged by the villagers as well) is its efficiency in drying and its ease and low cost of construction. Its major deficiencies are its vulnerability to rat attack and inaccessibility for cleaning and inspection. The *dari* system has also three other indirect health implications: (1) rat droppings and possibly contaminated broken grains, etc., can easily fall from the *dari* directly into the family cooking pot; (2) the *dari* system requires cooking to be done indoors, which means the house is almost constantly filled with smoke, an environmental contaminant of uncertain long-term health consequences for the family; (3) even the safest insecticidal

dusts (e.g. malathion, fenitrothion) cannot be dusted freely onto the stored grain because of fear that dust would fall from the *dari* into the family's food. A further consequence of fire drying is that maize must be stored unhusked to avoid discolouration and change of taste due to the smoke. Unfortunately, the unhusked maize provides a micro-environment more hospitable to insects than husked maize. Also insect infestation is more difficult to monitor if the maize is unhusked and insecticide application is ineffective.

6.6.2. The Dungu

The *dungu* is essentially a small storehouse raised on from one dozen to even two dozen stilts about 1.75 metres off the ground. The house itself is about 1 metre high and oblong (1.5 x 3 metres) giving a storage capacity of 1.3 tons of unshelled maize or 1.6 tons of head sorghum. The roof is generally grass thatch. The sides are made from closely arranged sorghum stalks, reeds or bamboo. With air circulating underneath and around the sides, the *dungu* is better ventilated than the *dari* which is inside a house with mudded walls and a thicker thatched roof.

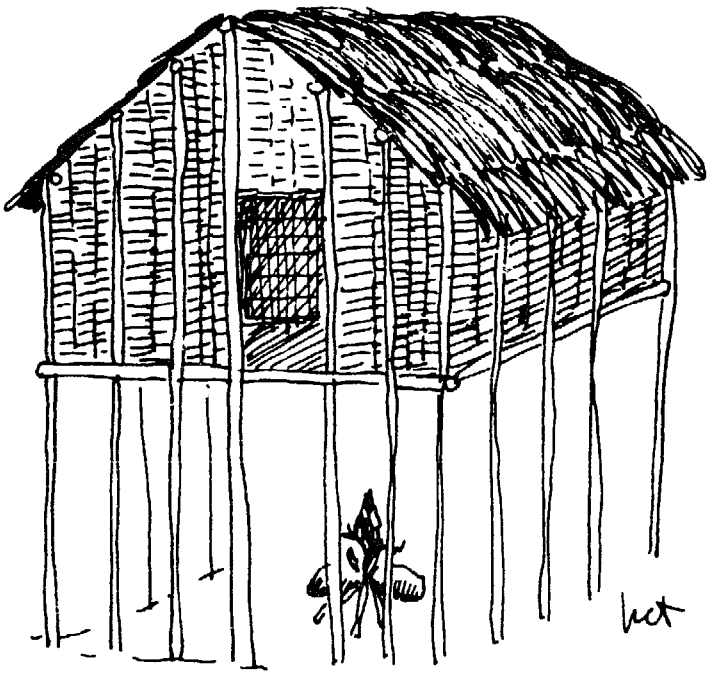


Figure 5: The *Dungu*

Within the framework of supporting stilts a cooking fire is generally found. This fire either supplements the inside cooking fire or completely replaces it during some seasons of the year. Sometimes the open area under the *dungu* is made into a more or less elaborate kitchen in its own right by placing hessian,

matting, or some other wind-breaking material in between the stilts and shifting much of the kitchen apparatus (kinu, pots, gourds, etc.) into this outdoor kitchen space (see Figure 5). Nevertheless our opinion is that the drying efficiency of the fire under the *dungu* is probably lower than in the *dari* because of crosswinds and the less continuous use of the *dungu* fire as opposed to the fire under the *dari*.

Access to the *dungu* is generally through a small door (½ metre square) in one end. A ladder can be put in place for easier access than to the *dari* making crops stored in the *dungu* somewhat easier to inspect. In addition, the *dungu* is generally cleaned thoroughly before putting in fresh grains. The old thatch is removed and the grain (usually sorghum) is added before the roof is replaced with new thatch. Removing the old thatch eliminates the remaining rat population from the previous season; it also allows for the sorghum to be properly stacked inside the *dungu* a procedure which the villagers claim, reduces the insect penetration.

In principle, the *dungu* is more easily protected against rats than the *dari* since the former is not part of the house. In practice, the great number of stilts and posts, some supporting the platform, some independently rising to support the *dungu's* roof, make the placement of rat-guards (rodent baffles) expensive and difficult. The normal placement of the *dungu* close to the house or under overhanging trees provides easy access for rats.

The *dungu* was used for storing both maize and sorghum. If maize is stored, it must also have its husk, because of the contact with smoke from the fire below. Unhusked maize in a *dungu* has therefore the same problems regarding insect infestation as in a *dari*. Likewise the same caution and limitation of the use of insecticidal dust in the *dungu* applies as in the *dari* as long as cooking takes place underneath the *dungu* as well.

Although it was widely agreed in discussions that the *dungu* was a valuable storage structure with many advantages over the *dari*, there were Actually very few in use in the village. (See Appendix 4.4.1. for some of the reasons given for this fact.)

A somewhat different version of the *dungu* called the *upango* also existed. It too is a separate storehouse used primarily for sorghum. The *upango* differs from the *dungu* in that it is not constructed on stilts but rather as a short platform only some 30 cm. above the ground. The sides of sorghum heads are stacked on the platform which prevents direct contact between the grain and

moist soil underneath. Still evaporation from the soil does take place and there is no protection against rats.

6.6.3. The Chanja

The *chanja* is a sun-drying platform or crib, depending on the height of containing sides. Several variations on this functional design existed in the village, some being constructed during the project in response to innovations by the Chairman of the Storage Committee. A much greater diversity in design of *chanjas* as opposed to *dari* or *dungu* reflected the fact that the *chanja* was a more or less experimental idea with no traditional counterpart in the village. The villagers stated explicitly that there was no tradition of sun-drying ("hatuna desturi kuanika") although small quantities (up to 50 kg.) of shelled maize or grain sorghum are dried on woven mats (*mikeka* or *jamvi*) prior to pounding.

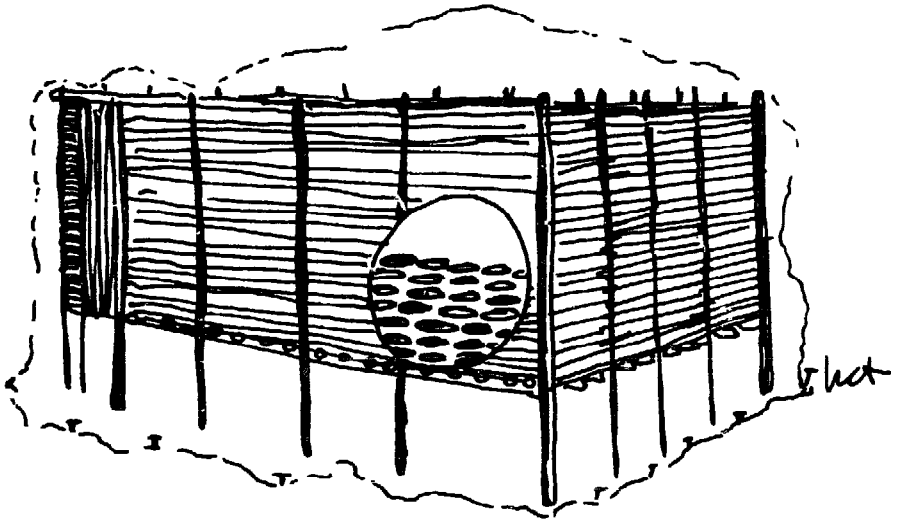


Figure 6: The *Chanja*

The most rudimentary *chanjas* were simply low (½ metre) flat platforms made by placing thick beams across heavy logs or other supports and then crossing the beams with thin poles which held a mass of husked maize for drying in the sun (see Fig. 6).

The Chairman of the Storage Committee constructed a *chanja* about 0.5 metre above the ground on a base of forked posts (see Figure 7). He included needlessly high containing sides (1.5 metres) made of heavy poles. The containing sides were completely enclosed in chicken wire against monkey attack. He had several sheets of roofing iron (c.i.s.) ready to place across the top of the crib in case of heavy rain.

The Education Co-ordinator built a *chanja* about 2 metres off the ground with very shallow containing sides (about 30 cm.)

made of strips of bamboo. He was attempting to learn from the Chairman's mistake of building his *chanja* so near the ground and in concentrating such a high and thick cross-section of maize which was not adequately dried by sun and wind even in two months (see Appendix 6 for more detail on our discussions of and visits to these *chanjas*).

The Divisional Bwana Shamba had a structure in his courtyard which seemed to be a combination of *dungu* and *chanja*. A platform was raised to about 1.75 metres on a series of posts. Maize was piled on this platform and the whole thing was completely covered by a steeply sloping grass roof which was open only on the two ends. We were told that the two open ends had been oriented East-West in order to catch the maximum sunlight, but the size of the open ends, length of axis of the structure, and the size of the roof made it seem questionable whether sunlight had much of an effect. Ventilation was better since the cross-section of maize was not excessively large.

In some respects this structure resembled the modified Nigerian crib (see Section 7) discussed by the Committee and discussion groups except that it was not rat-proofed and had a larger roof. Ventilation in this structure was its major strength. Exclusion of sunlight was its major weakness. All of the *chanjas* were relatively open and easily accessible; the maize in the *chanja* is always husked making inspection for insect infestation much easier than in any of the other structures.

6.6.4. The Gunia

One storage vessel which was largely overlooked in the village discussion groups was the *gunia* (gunny sack made of sisal, jute, or kenaf). This was probably a result of the team's interest in the use of traditional structures and the fact that the *gunia* was nearly always used in conjunction with other storage structures. In fact, a further investigation of storage systems in the village showed that the *gunia* was the second most important facility used next to the *dari*.

When the *gunia* was mentioned in the discussion groups, it was generally criticized for its vulnerability to rat attack and insect infestation. Once rats come into reach of a *gunia* it is no problem at all to chew through the fibres of the sack—much easier, in fact, than with other reed, bark or plastered structures such as the *lindo* and the *kihenge* (see below). Unprotected from insect infestation, the *gunia* provides an ideal environment for the multiplication of insect pests.

The advantage of the *gunia* is its relative ease of handling. It is the most important form (larger than the *debe*) through which village produce is marketed. The price of a *gunia* (3/= to 5/= depending on the quality and age) was considered to be within the range of most peasants. Its availability was a more serious constraint.

6.6.5. The Kihenge

Many sorts of *vihenge* were used in the village. These all have in common that they are roughly cylindrical and made of woven plaits of elephant grass (*magugu*), reeds (*matete*), or sorghum stalks (*mabua*). The smallest ones seen had a capacity of about 100 kg. of paddy, shelled maize or threshed sorghum. The largest one held over a half a ton of paddy. Some of the *vihenge* made with reeds or stalks were also mudded to give reinforcement against rats. If not mudded on the inside, the *vihenge* were sometimes lined with straw, or, in one case with hessian. Some villagers said that such linings are removed and placed in the sun in between crops.

KIHENGE

Figure 7: The *Kihenge*

One variation on th basic cylindrical design was in fact conical, the small end of the *kihenge* ending in a mouth which could be covered and sealed. This variety was make of thick plaits of grass and was plastered on the outside with mud.

Most *vihenge* looked quite durable and were said to be used from one season to the next. They were most often found in the sleeping roon of the house, and always inside, although in other parts of Tanzania they are also found outside under small shelters. Some of the *vihenge* rest directly on the mud floor, perhaps on a layer of rice chaff, others are placed on wooden or stalk platforms (c. 30 cm. above the ground).

There were only a few villagers who knew how to manufacture good *vihenge* and they were sold at a price which not all villagers could afford.

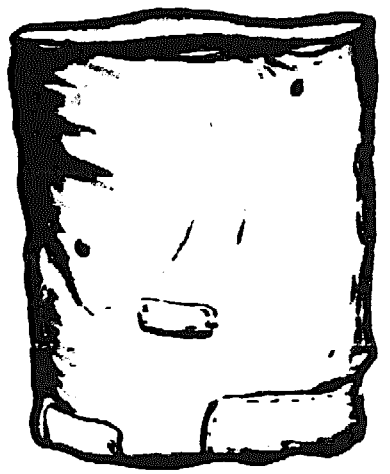
6.6.6. The Lindo

Sewn bark cylinders with lids (*malindo*) having a capacity of about 100 kg. of grain were seen in use. These traditional Kutu containers were used to store shelled maize as well as paddy. They were said to be fairly effective at preventing rats from getting at the food but offered no protection against insects. The skills required to make *malindo* were said to be even less common than for *vihenge* and not many new ones were being manufactured nor were they used very extensively.

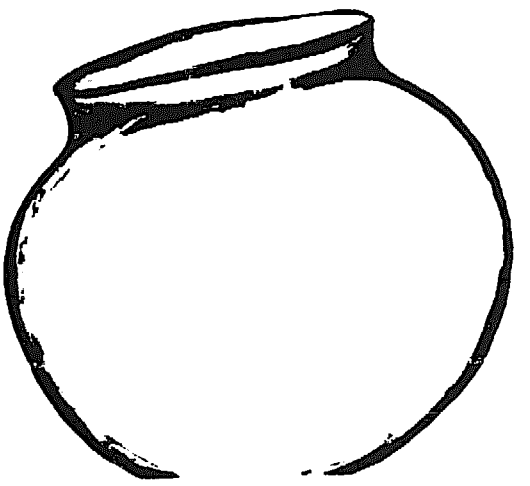
6.6.7. The Chungu

Earthern pots (*vyungu*) with a capacity up to 100 kg. of grain were said to be the first line of defence against rats, at least for the protection of sorghum seed, in one part of the village. They are also used for storing small amounts of paddy. *Vyungu* are not made locally in the village, but rather by skilled craftsmen in the Uluguru mountains.

LINDO



CHUNGU



SECTION 7.

MODIFICATIONS

The process of designing modified storage systems *with* instead of *for* villagers was complex and contained several surprises. First of all it was necessary to convince the villagers that the outside team *did not have a preconceived idea* which it had "up its sleeve" all the time just waiting for the little drama of village democracy to play itself out. Even some of the team's closest collaborators on the Storage Committee found this difficult to believe. It was only after having carried a certain line of design (the Nigerian crib) forward in discussions for several weeks only to drop it when the villagers brought up serious criticisms, that the team's credibility was finally established. It was then clear that the team did not have a vested interest in any particular design.

Secondly, the design process was an exercise in trying to see *new conbinations of old things*, an exercise in trying to see things afresh, more objectively. For example, the *kihenge* had only ever been used for storing paddy by most people. Could it not also be used for shelled maize or sorghum? Some people had only ever used a *dari* and were suspicious of the motives of those who asked them to consider the benefits of using a *dungu*. But what is a *dungu*, after all, but a *dari* moved outside? The *dari* dried quite efficiently, but was impossible to protect from rats. The *dungu* was protectable, but did not dry so well. Was it not possible to dry one's maize in the *dari* for a month and then husk the maize and transfer it to a rat-proofed *dungu*, sprinkling on malathion dust as one stacks the maize cobs in the *dungu*? Such discussions focussed less on engineering changes and more on modifications of behaviour and re-combinations of elements of existing storage systems.

The villagers already had 'parts' of solutions to their storage problem. It was the aim of this project to reinforce these existing solutions so that they would be more effective, not to replace them with new solutions. As it was pointed out in the last section, different storage systems were found in the village which served the differing needs of three socio-economic groups. Discussions were based on the existing systems, no matter how unsuitable or inappropriate they were thought to be. The discussions brought forth three separate streams of modifications reflecting the conditions of the three groups in the village.

7.1. Dungu + Chanja = Nigerian Crib

The Village Storage Committee was convinced from early in the discussions that all modifications must begin by moving storage outside the house. It was agreed that storage in the house at present makes rodent control virtually impossible. A review of world-wide and African attempts at low-cost improvement in storage confirms this view (Hall, 1970; Mosha, 1975; Ampratwum & Bockhop, 1975; GTZ, 1975). Therefore much of our energy was focussed on finding an appropriate outside structure and accompanying storage system.

As noted earlier, a number of rich peasants had been forced by circumstances of large harvests of grain with high moisture content to experiment with open sun-drying cribs (*chanja*). Other rich and middle peasants used the *dungu*. The Storage Committee was critical of both the existing *chanja* and *dungu* but recognized some advantages as well as limitations in each of these lines.

Hence from two sides the thinking of the Committee began to converge on some rat-proofed outside structure which could be used for drying as well as long-term storage. The thinking of the Committee developed in the course of the dialogue with the villagers in discussion group meetings as well as with the team privately. In discussion groups the line of development was seldom direct: *dari* was compared with *chanja*, *dari* was compared with *dungu*, *dungu* and *chanja* were compared.

There seemed to be a prima facie case for a sun-drying crib: (1) large institutions such as a large-scale farm, a prison, an army camp in the same general environmental situation were presently using sun-drying cribs; (2) rainfall records and the team's measurements of daily fluctuations in relative humidity (see Appendix 8) suggested that, at least at this time of the year (indeed the major maize and sorghum harvest season), relative humidity was low enough during much of the day and rain days were few enough to allow for adequate sun-drying. Still there were *some* rain days which could erase the drying effect of many sunny days if the crib were not covered and protected against the rain. Nor could an uncovered crib be used for more permanent storage. Neither the large institutions not even the rich peasants of Bwakira Chini intended that their cribs be used for storage. The cribs were intended for drying only; from there the maize would be shelled and put into jute bags (*gunia*) for storage.

The Committee however, was interested in a dual-purpose structure (drying plus storage), so it had to be covered. At this

stage in the dialogue, the team began to introduce design features of such sun-drying and storage cribs as those developed for Swaziland (T.S.P.C., 1975) and Nigeria (Adesuyi, 1975). The artist from the Institute of Adult Education did a large drawing of the "Nigerian crib" as the Committee came to call this line of improvement for short (see Figure 8). The team stressed that this structure was much like a *dungu*, but more open, like a *chanja*. The following structural features were emphasized:

1. Adequate clearance above the ground (1.5m.) in order to avoid rising damp, to encourage ventilation, and to give enough height to allow for rat protection;
2. Narrow width (not more than 1 m.) and open walls to ensure the passage of air through the crib;
3. Metal rat guards placed at least 1 m. high on each supporting post.

The Committee protested that in trying to reduce the number of supporting posts to a minimum there were now too few. The artist was sent back to produce a modification. Also the Committee thought the use of chicken wire for the open sides was too expensive. "Why not use narrow poles (*fito*)" they asked. The artist incorporated this change as well into a second sketch (see Figure 9).

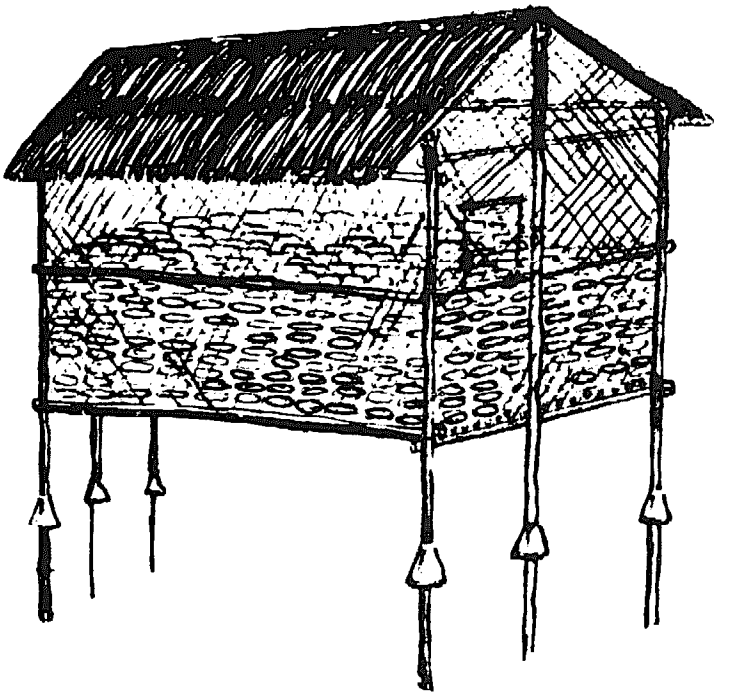


Figure 8: The Nigerian Crib — First Sketch

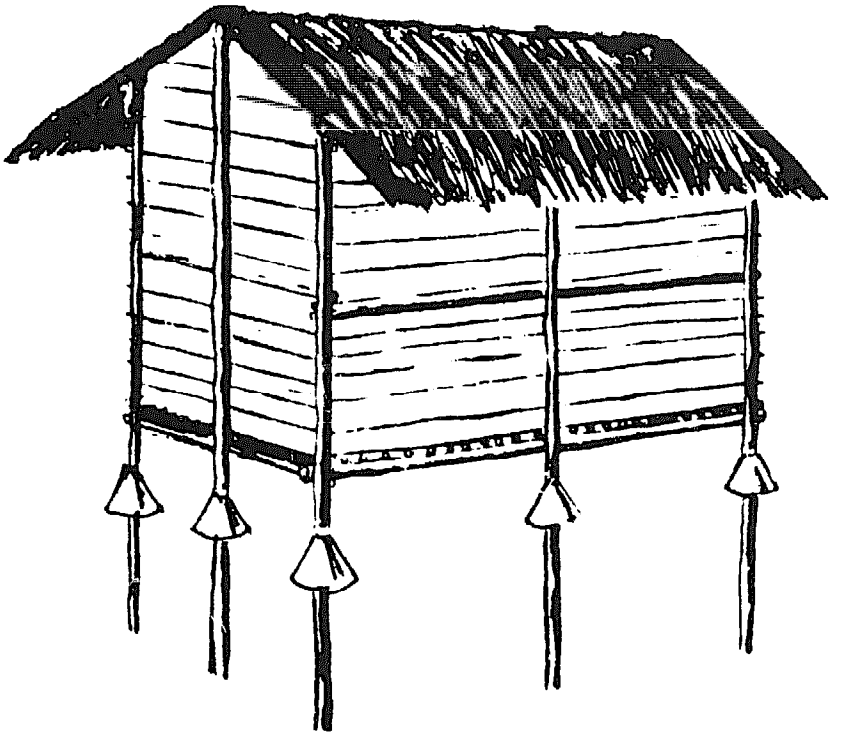


Figure 9: The Nigerian Crib — Revised Sketch

The Committee seemed content, but in several discussion meetings with villagers, strong criticism was made of the crib on grounds that for the poorer families the December planting of maize is important and, as noted in an earlier section, this maize is harvested during the rainiest month of all! Would the small roof shown on the drawing give enough protection? If a larger roof were used, would the sunshine and ventilation be sufficient? What about the strong winds from the foothills of the Uluguru mountains which come down the river and streambeds and blow rain horizontally into such a structure?

Over the course of several weeks a number of suggestions were made concerning these objections. A removeable roof was mooted, to be put on during rain and taken off in sunny weather. This requires expensive roofing material like c.i.s. (corrugated iron sheets) or palm shingles (*makuti*). Such a portable roof of grass would be very heavy and unwieldy. Could a tarpaulin be placed over the whole crib? But tarpaulins are very expensive (1,300/= for a 2 ton structure)! Could empty plastic fertilizer sacks be fixed to the open sides of the crib like curtains, to be rolled down in stormy weather with horizontal squalling wind and rain?

Suitable solutions for the problems and objections raised about the "Nigerian crib" could only be found by the richer peasants, none of whom, at any rate, harvested maize in April. For them, this modification remained the most attractive alternative for combining drying and storage. But for the mass of villagers who lack the means to respond flexibly to the problems brought about by a radically different design, the "Nigerian crib" was dropped as a possible modification. Instead a more familiar structure was advanced as the basis for improved storage among middle and poor peasants.

7.2. The Improved Dungu

One line of development, present from early in discussions and intensified after serious questions were raised concerning the suitability of a sun-drying crib, was improvement of the traditional *dungu*. The first major improvement was to reduce the number of supporting posts or stilts in order to allow the *dungu* to be rat-proofed. A traditional design with a capacity of from one to two tons might have as many as twenty posts in contact with the ground. The Committee proposed to reduce these to eight. Rat-guards were to be placed on each post at a height of about 1 metre.

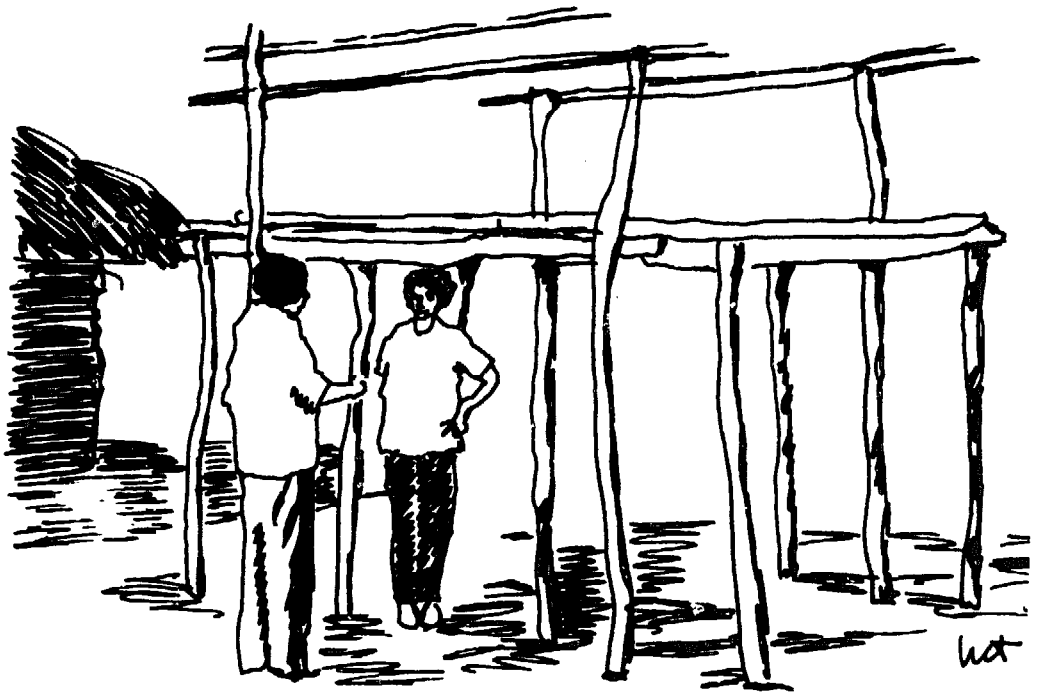


Figure 10: Traditional *Dungu* Construction showing separate supporting posts for platform and roof.

In order to reduce the number of supporting posts, the superstructure of the traditional *dungu* had to be re-designed. Previously the posts supporting the roof rose directly from the ground independently from the other posts supporting the platform (see Figure 10). Structural modifications were made so that some of the roof posts would rise from the main lateral beams to each side of the *dungu* platform. A further implication of reducing the number of supporting posts was that each one had to be strong; and another theme to emerge was that of "permanence". If improved structures were to be built, then they would have to last. Not only was the strength of various locally available hardwood trees discussed and compared by villagers and the Committee, but also their resistance to insect attack especially by wood borers and termites. Some of the hardwoods discussed were: Mwanga (Pernicopsis angolensis), Mpingo (Dalbergia melanoxylon), Mkambara, Muhamvi, Mkundekunde, Mvuli or Mhamvulu, Mperemba, Mcharaka and Msalambega. There was a growing concensus that the best tree for supporting posts was Mwanga and that Mpingo and Mkambara were best suited for the platform beams.

Villagers had tried rat guards previously between 1959 and 1961 when a campaign against rats had been attempted. At that time they had wrapped flattened sheet metal or used tins around posts in order to make them too slippery for the rats to climb. The discussion groups brought out a number or reasons why this former campaign was unsuccessful: (a) people did not understand the necessity for placing the rat guards on all the *dungu* posts; (b) the metal strips were too narrow so the rats simply jumped over them; (c) some rat guards were placed too near to the ground; (d) the rat guards were placed at different heights on proximate posts allowing the rats to jump from post to post; (e) the metal strips quickly rusted and pitted allowing the rats to get footholds in the rotting metal; and (f) the storage structures themselves were built under trees or near to the house providing the rats with places from which they could jump onto the roof of the store. Taking the above factors into consideration a new conical rat guard which physically blocked the rat's upward progress was proposed. In addition, long discussions were held and recommendations finally agreed upon concerning the placement of rat guards on the supporting posts of the *dungu* and the proper positioning of the *dungu* itself. In order to secure the rat guards tightly to the post, they were nailed starting at the back (opposite the seam) and then nailed around while pulling the metal tight to the post. The last nail is placed at the seam itself.

Experimentation was carried out in order to find a low cost method of making conical rat guards. Galvanized flat metal sheets (26 gauge) were brought to the village but the cost of producing one rat guard from this material was between 3/= and 4/= (depending on the size).* It was found, however, that two smaller though less durable rat guards could be made out of one used paraffin tin (*debe*). (See Figure 11.) The cost of a used *debe* in the village was between 2/= and 4/=, depending on its condition,** so one of these rat guards could be made for 1/= to 2/=.

The expenses required for improving a *dungu* were thus applicable over a fairly wide range of the middle and poor peasants in the village who had harvested one ton or more of maize or sorghum. The costs of the improvements depended in large part on how large a *dungu* the individual peasant needed to build which in turn depended on the amount of crops harvested. The poorer peasant with a smaller harvest would build a smaller *dungu* with fewer supporting posts and thus need fewer rat guards. In addition, the labour-time needed to cut the supporting posts would also be less.

The behavioural modifications implied in the use of the improved *dungu* are perhaps greater than the structural modifications. It was discussed, for example, that maize could still be dried in the *dungu* or even in the *dari* with a fire underneath. The maize would then be removed, husked and replaced in the rat-proofed *dungu* with the addition of malathion (1%) dust sprinkled over every second layer of stacked maize cobs. In the case of sorghum, malathion dust could merely be sprinkled around the edges after drying by fire under the improved *dungu* since insect infestation is claimed to be very slow in penetrating to the centre of the sorghum stack. Alternatively, if the sorghum was able to be dried in the fields (as was the case this year),*** malathion dust could be added when the sorghum heads were stacked in the *dungu*. In either case, the fire beneath the *dungu* would no longer be used after the insecticide was added.

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* The size needed depended on the girth of the pole to which the rat guard was to be fitted.

** Even *debes* no longer suitable for carrying water could be used.

***During this year's sorghum harvest, some villagers mentioned that wild animal and bird damage to standing crops had definately been reduced this year. They attributed this reduction

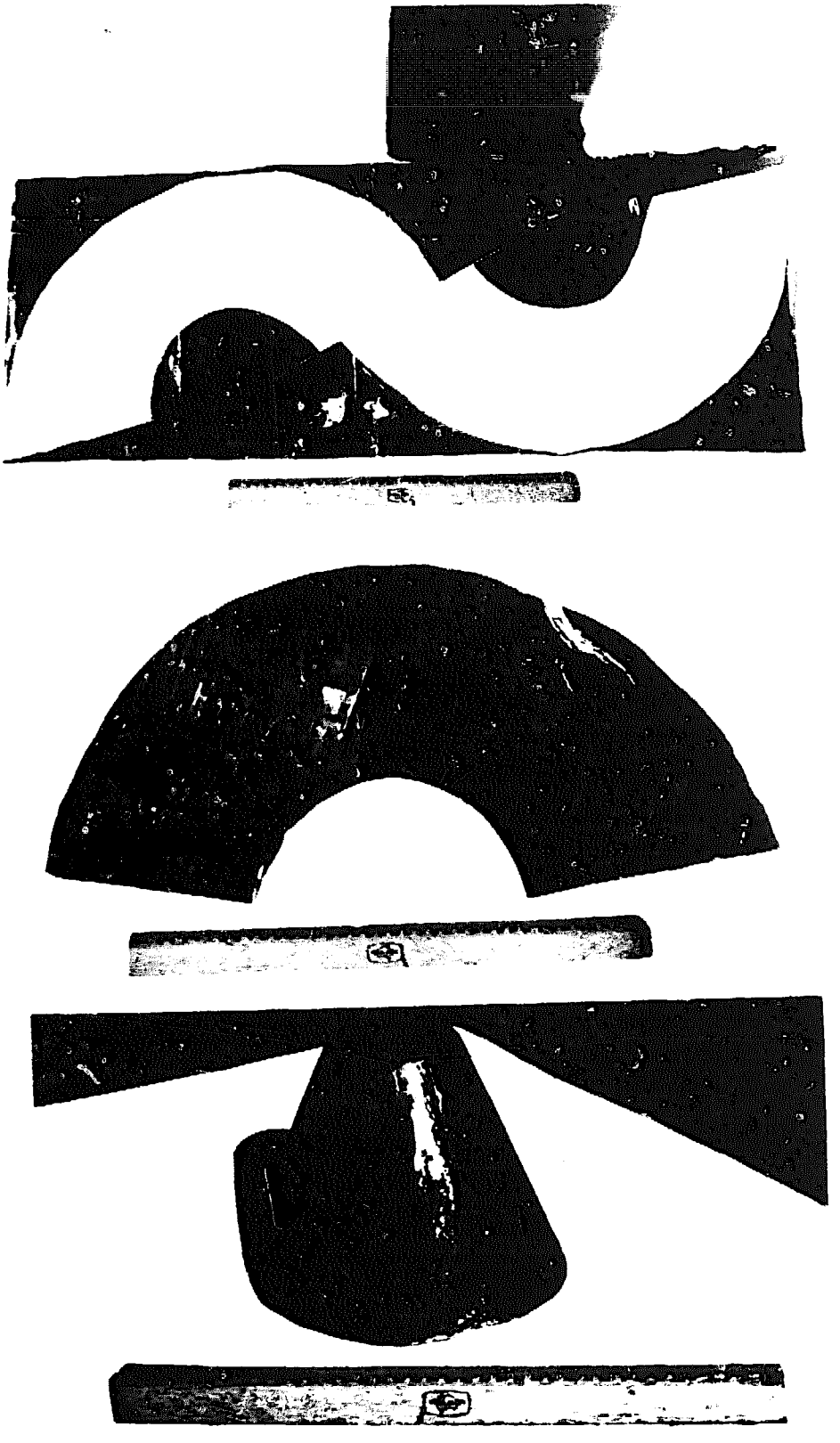

Figure 11: Rat-Guard cut from used *debe*.

7.3. Insecticide

The vast majority of peasants at Bwakira Chini believed in the efficacy of chemical additives for reducing or eliminating insect infestation in their stored crops although only a few had any prior experience in their use. They did not have any idea which insecticides to use, where they could be obtained or at what price they were sold. The information collected by the team generally supports the findings of Mushi et.al. (1969) that peasants in Tanzania, are willing to add insecticide to their stored produce and that some farmers even used DDT and other unsuitable insecticides on their stored produce in the hope of protecting them from insect attack.

The team's findings in Bwakira Chini go even further in stating that all *levels* of peasants in the village (rich, middle and poor) were both willing and able to purchase malathion (1%) dust* at the current retail prices.** Not only was the price (-/75 per 100 g.— enough for 1 bag of shelled maize) considered to be easily within the financial limitations of all villagers but again the outlay for insecticide also depended on the amount of crops one had (much for the rich peasant, little for the poor peasant).

The question of how long the farmer had to wait before using the insecticide-treated grain was raised numerous times. The villagers were told that the treated grain could be used two weeks after applying malathion without making any special preparations other than washing the grain which is normally done anyway. Therefore, two weeks' food supply had to be put aside before the crops were dusted with insecticide.

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to increased cultivation (the result of concentrated settlement) which reduced the area of bush adjacent to the fields. The result was that, given the level of diligent day and night guarding already practiced, much of this year's sorghum crop was able to dry in the fields.

*At the time of the project malathion (1%) dust was the only commercially available "safe" insecticide for use on stored food crops. Fenitrothion (0.5%) was considered but it was only available in special orders of one-half ton or more. The team felt that it was only justifiable to discuss with the villagers those products which they could obtain for themselves.

**There was one group of villagers who were not inclined to use insecticide because they said that it could be intentionally misused in order to poison one's neighbours. These same villagers were also reluctant to add an unknown substance to their food.

It was made quite clear to the villagers whenever the subject of insecticides was brought up that it was uncertain how long the effectiveness of malathion dust would last or even whether it would have any effect at all on insect infestation. It was explained that this insecticide breaks down very rapidly when exposed to air and moisture and that there is no quality control testing carried out by the manufacturers. Therefore, the Village Storage Committee took upon itself the task of researching the effectiveness of malathion under the actual condidions present in Bwakira Chini and making recommendations to the villagers based upon the results of these tests. They are doing this by following-up the experience of each villager who used insecticide this season (see next section for further details on follow-up). The biological cycle of the major insect pest Sistophilus) was also explained to the villagers so that they could relate the effectiveness of the insecticide to the life cycle of the insect which it is supposed to control * (see also Appendix 7 on the School Experiment).

7.4. Air-Tight Storage—Rejected

In one discussion group interest was expressed in some sort of concrete or burnt brick silo. In response, the team's artist produced sketches of amall air-tight brick constructions based on those presently under study in Tanzania (by TIRDEP at Tanga, Peterson at Uyole - Mbeya, and T.F.N.C.) and those tested in Africa (Ghanian-German Agricultural Development Project, n.d.) and Asia (Pradhan and Mookherjee; Watt, 1976). These sketches were presented to subsequent discussion group meetings (see Figure 12).

The discussion groups raised numerous objections to this design. First, it was too expensive and time-consuming to build and only a few villagers possessed the masonry skills required for its construction. Second, it was recognized by the villagers that only thoroughly dry grain could be placed inside such a structure or else the grain would "sweat" (*toa jasho*) and rot. Since drying of grain was their biggest problem, this design could only be used in conjunction with a separate drying structure. In addition,

* The biological cycle of the Sistophilus from egg to adult is around 28 days and the breakdown time of malathion might be as short as three weeks. If the lasting effectiveness of malathion were this short then Sistiphilus eggs in the grain at the time of the first application would emerge into adult life unharmed approximately one month after the first application.

daily temperature fluctuations are quite high (as much as 20 C) causing the moisture content of the produce to increase at the cooler parts of the silo and resulting in mouldy produce. Third, the possibility of obtaining true air-tight conditions was also questioned. Other mud brick constructions in the village had a tendency to crack. In addition, nearly continuous access to food supplies was needed which meant that the outlet chute would have to be opened at least after every few days allowing air to enter.

The discussion groups finally rejected the air-tight silo; they felt that it could not help them to solve their immediate storage problems.

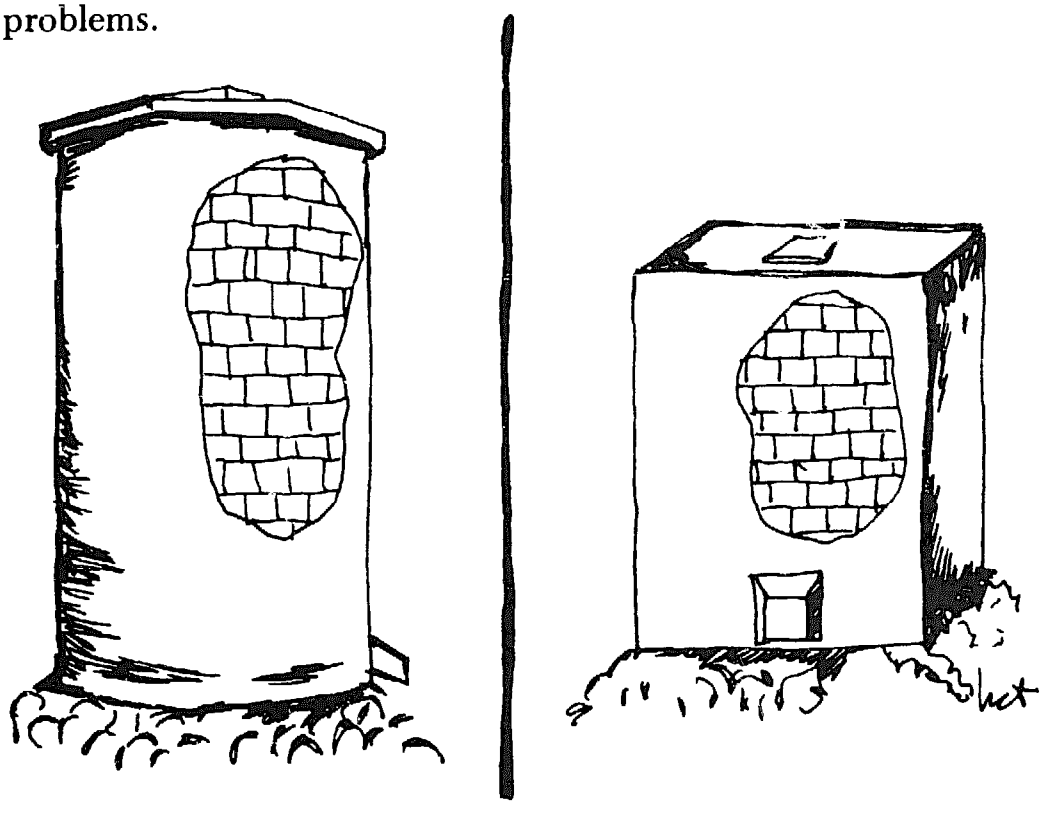


Figure 12: Air-Tight Brick Silo

7.5. Possibilities not discussed with village groups

Certain other small scale storage possibilities were not presented to the village discussion groups by the team. These include those structures whose cost was too high, whose necessary materials are difficult to obtain locally or at all in Tanzania, and those the team felt were not sufficiently well tested in village conditions to recommend for widespread use. Although the brick silo would have been included in this last category, it was in fact discussed because of a demand that originated within a discussion group.

Falling into this group of possible designs are the full range of air-tight containers (Hyde et. al, 1973), underground storage (Boxall; also some work in Tanzania at KATRIN), and ferro-cement structures (Instar, n.d.).

7.6. Communal Storage

Every effort was made by the team and the Storage Committee to encourage collective work in the discussion of improved storage structures and in the actual mechanics of making the improvements. Work brigades for felling trees to make *dungu* posts were suggested. At no time, however, did the team try to "force" the idea of communal storage into the dialogue. Nor did the villagers themselves at any time bring up communal storage as a topic for the discussion group meetings.

The project was committed to a dialogue on storage beginning with the existing conditions and building upon those *together* with the villagers. The dialogue process never reached the stage of communal storage. It would have been an imposition on the dialogue (as opposed to a contribution) to introduce communal storage since it could not be assimilated into the dialogue. Communal storage was too far removed from the perceived problems to be a solution to those problems.

SECTION 8.

IMPLEMENTATION

Within a period of less than eight weeks after the arrival of the team at Bwakira Chini, implementation of storage improvements was already in full swing. Implementation followed as a direct response to the dialogue methodology employed during the project. Those villagers who had participated in *reflecting* upon their storage problems during the discussion meetings were stimulated to take *action* on them.

Implementation followed the three lines of modifications outlined in the previous section:

(a) A few individuals continued to experiment with rat-proofed sun-drying structures incorporating the ideas and criticisms voiced during the discussion group meetings (see Figure 13);
(b) Fifteen new, improved *dungus* were completed and put into use (see Figure 14);
(c) Malathion dust was being used extensively in the village for the first time even by the poorest peasants who had no more than two to three bags of shelled maize.

8.1. Inputs

The two major inputs required in order to implement the modifications suggested were used paraffin tins (*debes*) and malathion dust. Used *debes* were not easily available locally in the large quantities which were required within the short period of time which had been set for the commencement of implementation.* Galvanized metal sheeting (6 ft. x 3 ft.—26 gauge) was supplied to the village as an alternative to *debes* and C.D.T.F. agreed to subsidize the difference in cost between the two materials.

Malathion dust was obtained from the manufacturers in Morogoro Town. Members of the Storage Committee accompanied the team to the factory in order to become acquainted with the procedure for purchasing this input.

Both of these inputs were being sold to the villagers through the village co-operative shop. When the original stock was de-

* In fact, not as many rat-guards were made as had been anticipated and the required *debes* could have been obtained locally. Ultimately, it was the time constraint and the desire to show implementation which forced the team to go outside the village for materials.

pleted, the shop would renew. The village expected to do a good business in selling insecticide since their shop was the only one in the Division which stocked this input.

The shop was selling malathion at 1/50 per packet of 200 g., -/30 above the wholesale price. The metal sheets were sold at 6/= per piece (making 3 large rat-guards). The unsubsidized price for such a piece would be 12/15. Nails were also sold through the village shop: five nails for -/10. Nails had to be purchased by the team in Dar es Salaam and brought to the village since they were unavailable in Morogoro.

8.2. Credit

Some of the poor peasants who were constructing *dungus* for the first time claimed that they would not have enough cash to purchase *debes* or sheet metal for rat-guards until they sold some of their produce. It was necessary, however, that the rat-guards be placed on the improved *dungu* before any crops were put inside, otherwise some rats might have already entered. The Storage Committee decided to take this up as a special problem and requested the Village Council to extend credit to these poorer farmers at the village shop for the purchase of sheet metal. The Village Council agreed to review individual requests on the recommendation of the Storage Committee but also submitted its own proposal: these poorer farmers could receive sheet metal in exchange for sorghum which would be used to brew beer at the village *pombe* shop. The *pombe* shop would, in turn, re-imburse the village shop for the cost of the metal.

Credit for the purchase of malathion dust was not considered because the need was not so pressing and the cost was very low.

8.3. Practical Problems

No-one in the village had any practical experience in mixing malathion with crops (including the Divisional Bwana Shamba). Nor did the instructions printed on the packet help much since they advised mixing with a spade on a cement floor! The villagers decided to mix the insecticide with their hands on a woven mat (*mkeka*). No precautions were taken though the villagers were later advised to cover their mouths and noses with cloth when mixing the insecticide and to wash thoroughly after finishing.

Another problem was the re-application of malathion if insect infestation was found one to two months after the original application. It was stressed that this was a distinct possibility since some tests at Morogoro had shown that malathion was only effective for six weeks (Gerard, personal communication). If this were

Figure 13: Raised Storage Crib for Sorghum

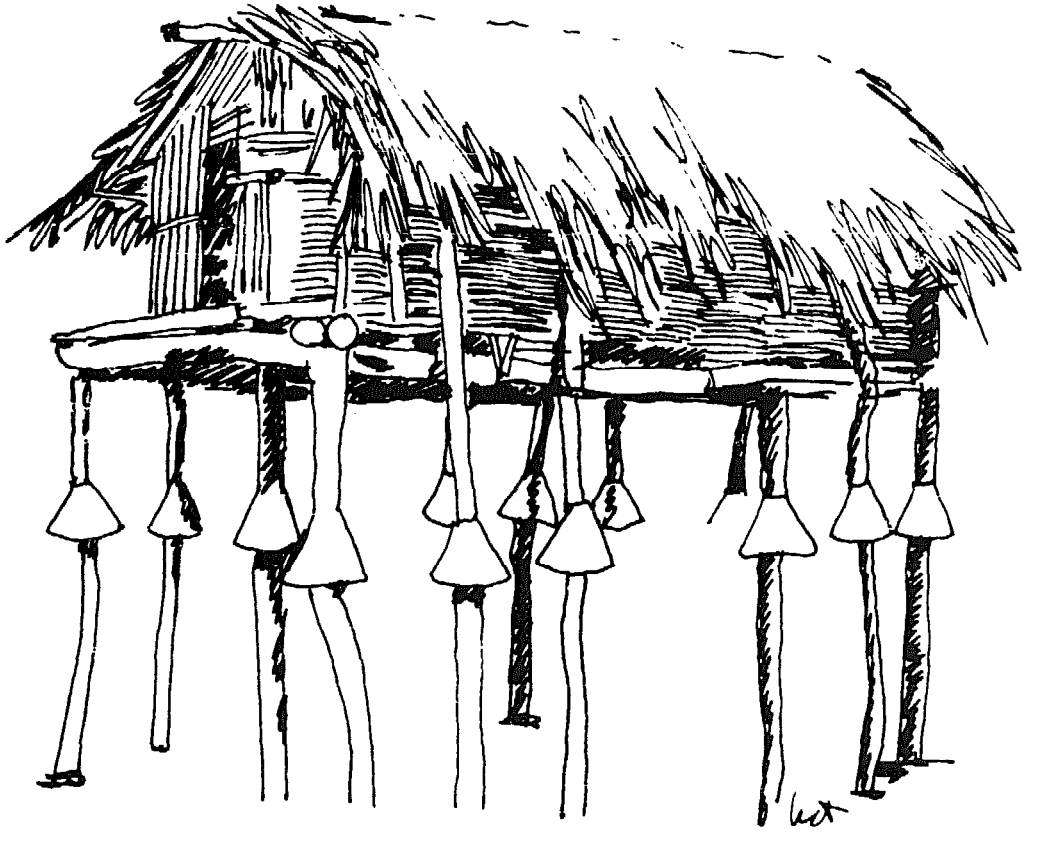


Figure 14: An Improved 2-Ton *Dungu* with Rat-Guards

the case, there were three alternatives open to the peasant who had stored maize in an improved *dungu*. First, he could go through the long, time-consuming process of unloading the maize from the *dungu* and then re-stacking it with the addition of malathion. Second, he could sprinkle malathion around the sides and on the top of the stacked maize hoping that this would have some effect on the infestation in the middle. Third, he could shell the maize, mix it with malathion and then put it in a *kihenge* which had been mud plastered to prevent rats from entering.

Finally, there was the problem of the placement of improved *dungus*. Most villagers who were building these wanted to place them inside their courtyards as close to their houses as possible. They feared theft of their crops from the store. Inside the family compound, however, one often found fruit trees and other structures which rats could use for access to the store. Thus much care and planning had to be exercised in choosing a site for the outside storage structure.

8.4. The Role of the Committee

The Storage Committee defined their role in the implementation phase to include visits to anyone engaged in the construction of an improved *dungu* or sun-drying crib or anyone who intended to apply malathion dust to his crops. The Committee members spent long periods of time discussing construction techniques, the application of insecticide and the fixing of rat-guards with individuals and groups of villagers. They also participated in all these activities.

The Storage Committee had already decided that they should continue to operate as a group. They felt that in the short period of the project only the surface of the village's food and storage problems had been scratched and that the discussions had stimulated new challenging questions. Some of the questions which the Committee wished to pursue were the effectiveness of the insecticide and the rat-guards. The village shopkeeper was instructed to keep a list of all villagers who purchased malathion or sheet metal at the shop in order that the Committee could follow-up the use and experience of the villagers with these inputs. The Committee was provided with follow-up data sheets to record the experience of anyone who undertakes rat-proofing or dusting with malathion. On the basis of the data collected, the Committee hoped to be able to say next year, for example, that in 1976-77 X number of villagers in Bwakira Chini used malathion dust in the recommended application and the average length of time of effectiveness was X weeks. In short, the Committee

intended to compile basic research data which would be useful to the peasants of Bwakira Chini.

The Storage Committee was not content to confine its activities to only Bwakira Chini. Already, they had responded to enquiries from the two other villages in the Ward by talking to these other villagers about their experience. The team encouraged this trend and took this process one step further by arranging for the Committee to share its experiences with still other villages in the Division. The idea was not that the Committee members should become grain storage instructors for the Division but rather that they should relate to other villages what had happened at Bwakira Chini and the role which they had played in order that these other villages could set up their own storage committees.

Having mobilized the villagers to deal with the storage problems which they identified, the villagers were also in a good position to evaluate the effects of the project as a whole. The evaluation will be largely qualitative placing high value on the observations and opinions of the villagers themselves.

8.5. The Seminar at the University

The final event of the eight-week project was a seminar on village crop storage given by members of the Storage Committee to some fifty third-year crop husbandry and rural economy students at the University of Dar es Salaam, Faculty of Agriculture. The Committee members first made a brief presentation about: (a) the location, physical environment, and political history of the village; (b) the major crop pests both in the field and in storage; (c) the method of group discussion used in the project to identify problems and solutions; and (d) the various lines of storage modifications discussed and implemented. This presentation was followed by a long and lively discussion period during which the students raised numerous technical and social questions about the structural modifications proposed. The Committee members had ready answers to the students' questions because all of the points raised at the siminar had been previously discussed at length in the discussion group meetings in the village. It was at this point that the Committee members really began to see themselves as storage experts and came to realise how thorough and effective the methodology had been in clarifying the storage issue. After the siminar one student asked the Committee members how much special preparation they had made for the seminar. They could only laugh in reply because no special preparation had been made. They knew that there were plenty of other villagers who could have participated equally well

in this seminar. The increased self-confidence of the villagers that they could master their environment and exercise more control over their own lives was one important result of the experience at Bwakira Chini.

8.6. The Seminar at the Village

Nearly three months after the end of the initial project period, an attempt was made to expand the project to other villages in the surrounding area. Representatives from 15 villages in the Division attended a week-long seminar held at Bwakira Chini. Each village sent either two or three members. In all some fifty people attended the seminar including two members of the project team.

The Village Storage Committee members again led the proceedings: they explained the history of the project and how they went about setting up discussion groups in the village. Small groups were formed by the participants so that they could practice the elicitation of problems through the method of dialogue. Later, the principles of storage were discussed as they had been during the project itself. Finally, the participants discussed how they would go about analysing the specific storage problems of their own villages.

It is hoped that some follow-up of the seminar participants can be made. The participants themselves encouraged this idea.

8.7. Some Preliminary Results: Malathion Dust

Three months after the initial application of malathion dust to their stored crops, the villagers of Bwakira Chini made their first qualitative evaluation of the effectiveness of the insecticide. They were very pleased with the results. Over half of the approximately twelve tons of crops which had been treated with insecticide were surveyed. Not a single living *Sitophilus* was found in these crops during the survey although large numbers of dead ones were found.

The villagers proudly needled the team members who had cautioned them that the effectiveness of the insecticide was possibly only two months from the time of application and might not be effective in produce which was already heavily infested. The villagers felt that they had done better than the "experts" expected.

One explanation for the success of the malathion is the impossibility of re-infestation from standing crops in the field. Three months after the end of the harvest season the fields surrounding the homesteads are clear and bare with hardly any grass and little crop residues. Cross-infestation can only originate from infested stored crops. Thus the possibility exists for considerably reducing the population of stored crop pests.

APPENDIX 1.

PHYSICAL ENVIRONMENT AND FUTURE STORAGE PROJECTS

The applicability of the design results of this project is in part dependent on an understanding of how the lower Mgeta area fits into the climatic and agro-economic patterns of Tanzania. The team would, however, recommend that none of the design results of this project are immediately applicable anywhere in Tanzania — even the next village — unless such design results are put to the local inhabitants as possibilities in the course of a mobilization programme somewhat on the lines of the one undertaken in this project. The design results of this project represent the collective self-expression of villagers who have to some degree become self-conscious of their local conditions and of local resources for solving their perceived storage needs. These perceptions and auto-design expressions have been made by villagers at a certain level of economic development under particular social and economic relationships, and at a certain level of co-operation. Hence even generally valid zonal recommendations for storage (e.g. crib for sunnier, drier areas; covered, fire-dried storage for wetter areas) are meaningless until they are given a particular content by the villagers who must reach a decision to build such and such a particular structure and change their behaviour in such and such ways.

Therefore, the project's design results are not recommended mechanically for all similar areas in the country from the point of view of climate, cropping pattern and agricultural calendar. However, to the extent that some individuals or institutions might be interested in the possibility of *campaigns* on storage which might in part draw on the experience of this project (and the far greater experience of such prior campaigns as *Mtu ni Afya*, (the team should offer the following observations:

1. It was found that motivation for implementation was very narrowly focussed around the actual harvest date of particular crops. Given such highly focussed patterns of motivation, national campaigns on storage would be impossible. At best zonal campaigns would be possible in areas with similar harvest seasons for similar crops.
2. In this respect similar areas to the project study village would include other low-lying parts of Morogoro Region, much of the Rufiji basin and some of Handeni and Bagamoyo Districts (but excluding the coastal strip); and

much of the south-east below about 200m. altitude, but again, excluding the coastal strip.

3. Background environmental data were drawn from the East African Meterological Department and from BRALUP's series of research papers on the agro-climatic zones of Tanzania (Conyers, 1973). Interested planners are referred to these sources in the course of determining feasibly sized and shaped areas for possible storage campaigns.

APPENDIX 2.

THE GRAIN STORAGE PROJECT TEAM MEMBERS

Community Development Trust Fund

As Planning Officer for the Community Development Trust Fund, **David Neigus** was involved in the project from the initial discussion stage up to the completion of the report and the project follow-up. He was in charge of the project proparations, participated in the village dialogue, contributed to the writing of the draft report and did the editing of the final report.

Institute of Adult Education

The Resident Tutor of the Morogoro Branch of the Institute of Adult Education, **Ezra Mduma**, led the mobilization phase of the project in the village through the dialogue method. As the only team member permanently based in Morogoro he played an important liaison role with the District Authorities and is in charge of the project follow-up.

An artist from the Institute of Adult Education headquarters, **Tom Kaisi**, joined the team in the village for a period of three weeks during which he made poster drawings of existing storage structures in the village, proposed modifications and sketches depicting themes in the socio-economic reality of the village. He was also an active participant in the discussion groups during his stay in the village.

Economic Development Bureau

The team leader of the Economic Development Bureau consultants, **Ben Wisner** of the Department of Geography, University of Sheffield, England, provided overall guidance to the team in all phases of the project from mobilization to report writing. He played the leading role in analysing and interpreting the material and information generated by the village dialogue and feeding this back into the team and village discussions.

Luciano Chavez Franco of the National Agricultural University, Chapingo, Mexico, collected technical data in the village recording temperature, relative humidity and identification of insect pests and moulds. His technical explanations af various storage phenomena were compared with the villagers explanations of their existing storage practices.

APPENDIX 3.

PROFILES OF STORAGE COMMITTEE MEMBERS

Committee Chairman

The Chairman was a rich peasant with a large surplus production of grain who had moved to the village in the early 1960's from the Uluguru mountains. He set himself up originally in this area as a shopkeeper and trader. Through his accumulation in business he moved into agriculture as well. He re-opened a very fertile area of rice-growing land which had been overrun by nut grass weeds (*ndago*). He was able to hire a tractor to plough this land over a period of three years, eventually making it not only cultivable but highly productive as well. His major cash crop, however, is sorghum which he stores for six months and then sells at a high price in the Uluguru mountains for beer-brewing. Formal education—standard IV.

Committee Member 2

This young peasant was very active in village affairs despite having lived in the village for just over one year. Besides participating actively in the Storage Committee, he was also a member of the Village Council and a member of the Village Health Committee which looks after environmental sanitation. Much of his time was spent on bicycle repair work on which he relied as an addition to his farming income. He and his family had moved to the village from an area some five miles away where they had been settled prior to villagization. Much of his bicycle repair business was carried out in this area. Formal education—none.

Committee Member 3

This peasant held important political leadership positions in the village which prevented him from regularly attending the Storage Committee meetings and discussions. Much of his time was taken up with travel outside of the village. He was a member of the original settlement scheme and of the subsequent Ujamaa group. Formal education—standard VI.

Committee Membrer 4

A village elder who was invited to join the committee to represent his age group and also on account of his thoughtful comments in the first few meetings. It was he who first suggested that the whole food production system be discussed and that storage problems be investigated as a part of that system. His history in the village dates back to the colonial days when he was

employed as an overseer and clerk on the European-owned estate.

Committee Member 5

This peasant came to the village from a nearby village during the settlement scheme period and stayed on (unlike more than half of the "settlers" who left after the dissolution of the scheme). He was a quiet, thoughtful and dedicated member of the Committee, hardly missing a single meeting but never talking very much (only at times when he felt he had something very substantial to contribute). He was a driving force, however, in seeking local solutions to storage problems and promoting the "people's science". Despite vocal opposition from other village members, he insisted that the village should experiment with various types and quantities of ashes used in the village in order to assess their effect in reducing insect damage to stored grain.

Committee Members 6, 7 and 8

Three other Committee members who were chosen by the Village Council played very minor roles in the discussion groups and in the dialogue. One of them was obviously too busy with his time-consuming position in the village political leadership and his other business activities. Another was merely not interested though it was widely reported that he was having difficulties storing a substantial maize and sorghum harvest. The last member of this trio seemed to take the entire affair very lightly but eventually built an improved ***dungu*** when rat damage to stored maize in his ***dari*** became unbearable.

Ward Education Co-ordinator

Although not a native of the region, this man had spent all of the more than twenty years of his working life in Morogoro. He had been resident in the village for five years, first as the head teacher in the primary school and later in his present job. He was extremely well integrated into the village, mixing with all groups in all social situations. He had also farmed and so could talk about storage problems with as much authority as other peasants. His keen understanding of both the project's aims and methods was invaluable since he was able to relate this to other people.

Division Bwana Shamba

This man, the chief agriculture extension worker in the Division, was added to the Committee after the Ward Bwana Shamba who had been chosen originally showed a complete lack of interest. A native of the region whose home was not far from

Bwakira Chini and who had held his present position for five years, he was knowledeable about the agricultural problems of the area. He himself had experimented with a new type of storage structure for his maize crop. When the Committee went to visit this structure, they found that the maize was heavily infested with *Sitophilus*. Thus the Division Bwana Shamba became the first Bwakira Chini resident to experiment with malathion dust as a result of this project. He had previously attended a seminar concerning the use of this insecticide but had never tried it himself.

APPENDIX 4.

SEQUENCE OF EVENTS

The project's work programme is shown in Figure 16. During the first three weeks in the village the team was to undertake through dialogue with discussion groups and through physical measurements an assessment of the dimensions of the storage problem, its causes, and the extent of village resources for solving it. Beginning in week three a second round of discussion meetings was to look critically at the full range of technical possibilities open to the villagers and to make explicit the likely implications of each design or modification proposed. Implementation was to begin near the end of the fifth week, and the system for evaluating the success of the new constructions was to be activated in the seventh and eighth weeks.

Here below follows an account of the real-time sequence of events in the village. Discussion groups did not necessarily limit their considerations to neatly defined topics such as 'causal analylsis' or 'design range'. Discussions ranged more freely, and it was the task of the team, including the Storage Committee, to systematize the results of these discussions for re-introduction into future discussion meetings. Implementation began in the sixth week and continues.

Village Council and Storage Committee

During the first week in the village the team met with the Village Council to explain its intentions, to discuss the problem of storage generally, and to ask them to nominate a Storage Committee. The original idea of the Storage Committee had been that it would be constituted by two members from each of the five existing committees of the Village Council. However, the team also noted that it would be best if the individuals also had keen personal interest in the problem of storage. In fact the Ward Party Secretary (Katibu Kata) and several village councillors immediately thought of individuals who were not only interested in storage but who had undertaken storage improvements themselves. First among these was a former vice-chairman of the village who was to become the Chairman of our Storage Committee. Village councillors nominated others, not necessarily following the quotas suggested for representatives from the several committees. Subsequently other persons with an interest asked to become members and still others were invited to fill gaps in the committee such as the lack of elders (*wazee*). Two govern-

ment servants were also included, the Ward Education Co-ordinator, and the Ward Agricultural Extension Officer (Bwana Shamba)—later replaced by the Divisional Bwana Shamba when the former found it difficult to attend meetings. In all the Storage Committee numbered ten.

After the Village Council meeting the team met briefly with the newly constituted Storage Committee to organize a joint programme. The next meeting with the Storage Committee began by listening to some of the tape recording of the Village Council meeting and then developed into a wide-ranging discussion of the storage problem. A summary of this meeting is presented below because it demonstrates very well the level of consciousness of the committee and shows also that many of the themes which emerged in later discussions were present from the start if only in the minds of a few villagers. These themes became the basis for a catalogue of storage knowledge existing in the village which became elaborated through the dialogue and continues to develop with local research being conducted by the Storage Committee.

C.D.T.F. VILLAGE GRAIN STORAGE PROJECT

WORK PROGRAMME

DESCRIPTION OF WORK	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
DIMENSIONING THE PROBLEM	xxxxxxxxxxxxx							
RESOURCE SURVEY	xxxxxxxxxxxxxxxxxx							
CAUSAL ANALYSIS	xxxxxxxxxxxxxxx							
VISUAL INPUTS	xxxxxxxxxxxxxxxxxx							
DESIGN RANGE	xxxxxxxxxxxxxx							
TRANSCRIBING TAPES	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx							
DESIGN IMPLICATIONS	xxxxxxxxxxxxxx							
CONSTRUCTION	xxxxxxxxxxxxxxxxxx							
REPORT WRITING & REPRODUCTION	xxxxxxxxxxxxxx							
INSTRUMENT MONITORING	xxxxxxxxxx							

Second Storage Committee Meeting

(Tape 2, Side A—see Appendix 5 for full tape listing)

Tape Counter	Subject and Speaker
105	One committee member recalls having seen a storage structure raised on only six supporting posts (this is significant because the traditional designs use as many as two dozen posts, making it virtually impossible to protect from rat invasion).
114	Another committee member recalls seeing people dig trenches around their free-standing storage structures across which rats could not leap (the team later learned that this innovation originates from a 1959-61 campaign in the area, especially around Kisaki).
118	Ward Education Co-ordinator expresses doubts as to whether a small committee on storage can really succeed in mobilizing the people to improve storage.
130	Reassurance by the Adult Education Institute team member. He reiterates the Storage Committee's responsibility to engage the villagers in dialogue. Can they do this?
138	Chairman of the Storage Committee worries that the Committee does not have the necessary technical knowledge.
140	A committee member—who is also a Muslim religious teacher and Village Secretary—reminds the committee that, in his opinion, the villagers themselves have a great deal of knowledge of storage in their heads although they do not practice it.
155	Ward Education Co-ordinator summarizes storage ideas which have already been mentioned in this meeting: digging trenches, smearing used tractor oil on posts used in construction, use of bamboo for construction. He warns against the use of bamboo which is attacked by insects in this area.
158	A committee member—who was to become one of a core of four members who attended nearly every village meeting—interjects that although many people in this village know about the possibility of outside, free-standing storage, they are afraid to use it because of the presence in the village of thieves, especially young men who do not farm, but just lie around and wait for a chance to steal.
168	Committee member: "People shouldn't frighten one another away from development!"

176 Ward Education Coordinator notes that the problem of theft has been raised as an example of where a total analysis of the storage problem takes one. It will not necessarily be discussed with villagers in the groups (in point of fact this problem *did* emerge from the subsequent discussion groups). He notes that even if one builds an outside structure it will still be within the home compound (*uani*), and therefore relatively secure.

178 Committee member asks the outside team about its technical contribution.

193 Adult Education Institute team member re-emphasizes the point that we are not bringing a previously worked-out design or solution, but want to work with the Storage Committee in taking the existing storage technology and improving it with small modifications.

213 Committee member—who is also the Ward representative to the Divisional Development Committee—emphasizes that we must end up by building something. Words are not enough. Action is required.

221 Chairman of the Storage Committe returns to the problem of rats and the indefensibility of the storage system *inside* a house. People must move their storage *outside* the house. Other committee members agree.

223 Committee member notes that large storage containers (*lindo*) are made by sewing the bark of certain trees into cylinders. This is adequate for rice which doesn't suffer much from insects. For other grains there is also an insect problem, not just a rat problem.

227 Ward Education Co-ordinator proposes that our goal should be more permanent storage structures than used at present. He lists four hardwood trees he says are very permanent.

233 Team member asks why the people don't already use such trees in constructing their storage.

235 Committee member answers that the villagers do not harvest enough to trouble themselves about storage.

237 Another committe member says that people do use these hardwood trees for their houses.

These excerpts are significant for the light they shed on the Storage Committee. In this meeting on 10th July, 1976, one hears many anxieties expressed: the people will not build outside their homes because they fear thieves; the people do not harvest

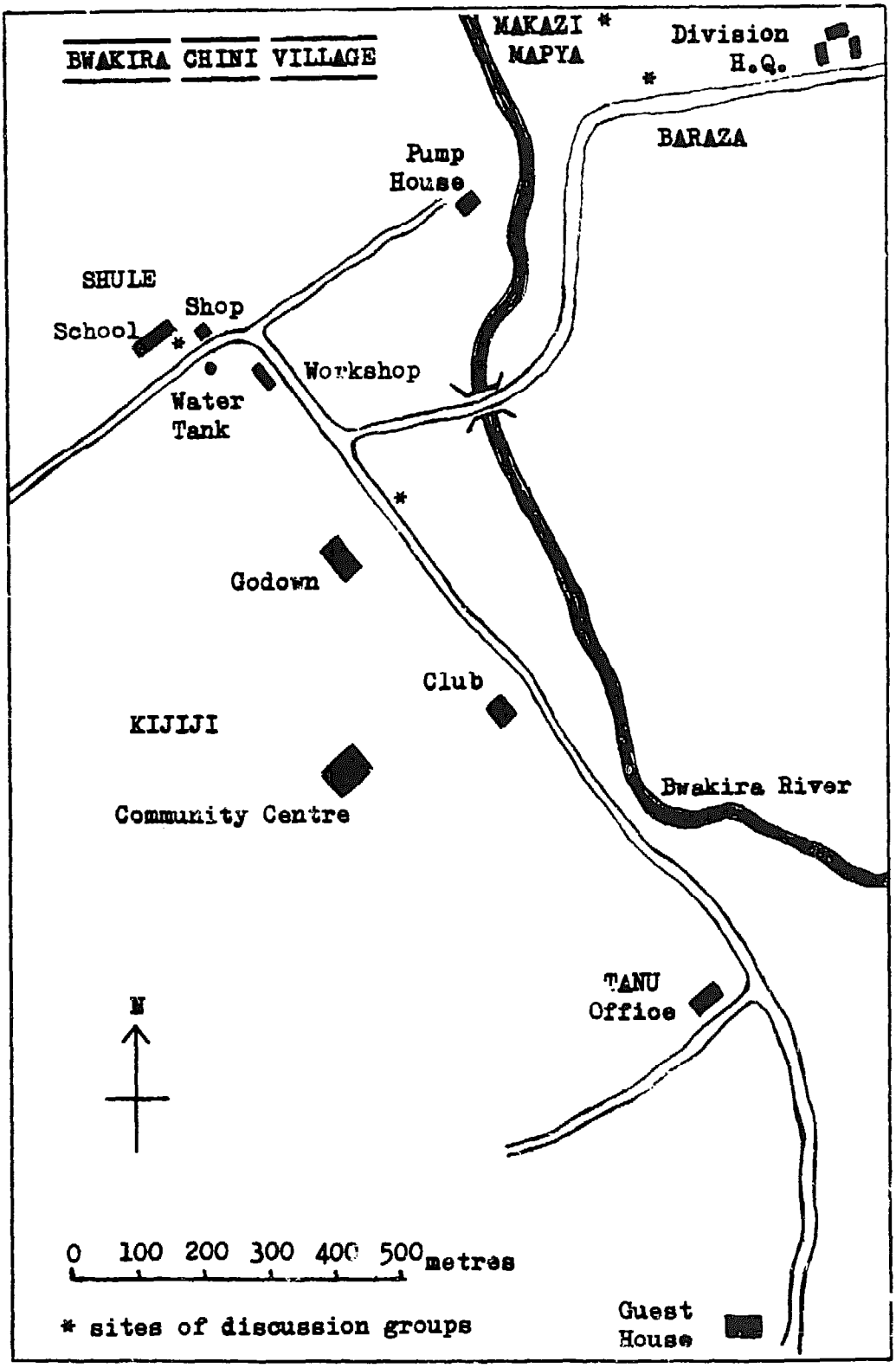
enough to worry about improved storage; rats cannot be controlled inside houses; the Committee does not have adequate technical understanding of the problem. Against these anxieties there is also expressed a wealth of experience with storage improvements and an underlying confidence in the people's good sense. The Committee is obviously a group of considerable experience. They are not, on the other hand, a group of people with very much formal education. They are mostly farmers, and such people are to be found in all Tanzanian villages.

Five weeks later, members of this Committee were busy cutting out rat-guards from old paraffin tins (*madebe*) together with farmers from a section of the village where greatest initial resistance to the idea of outside storage had been encountered. Half a dozen new outside structures had been started by these farmers. Committee members visited these and discussed with farmers structural modifications that would minimize the number of supporting posts, hence the number of rat-guards required. The Committee had become very self-confident. It had become a smoothly functioning team of villagers that took existing knowledge from fellow villagers, systematized that knowledge and put it together with knowledge from outside the village. The Committee had developed a continuing relationship with such outside resources as the University Agricultural Faculty in Morogoro and knew how *to demand* knowledge and support for future storage improvements when required. *One of the major results of this project is the creation of the storage committee as a continuing human resource.* It is therefore important to try to understand as clearly as possible what series of experiences and what conditions favoured their emergence.

Discussion Groups

The Committee and the team agreed early on that it would be difficult to have a full series of meetings with every one of the village's 27 ten-cell groups individually. The original desire had been to meet with existing adult education groups, but these had been temporarily disbanded following the National Adult Education examinations. The compromise solution offered by the Committee was that they divide the village into four major settlement zones and create storage discussion groups in each by combining three or four ten-cells in each area. Map 2 shows the four zones into which the village was divided: (1) Kijiji, (2) Shule, (3) Makazi Mapya, (4) Baraza.

The programme was arranged in order to meet twice with each


BWAKIRA CHINI VILLAGE
MAKAZI MAPYA
Division H.Q.
BARAZA
Pump House
SHULE
School
Shop
Workshop
Water Tank
Godown
Club
KIJIJI
Community Centre
Bwakira River
TANU Office
N
0 100 200 300 400 500 metres
* sites of discussion groups
Guest House

of the four storage discussion groups in an initial round of dialogue. This was done. By the end of this first round village interest was high enough so that a number of ten-cell leaders who had not been included in the initial round requested a meeting. This became in fact a fifth discussion/action group which overlapped somewhat with the Kijiji zone. This new group took in much of the old core of the previous settlement scheme members.

Round One: Kijiji and Shule Zones

The first meetings in all four zones were very similar. Villagers found it hard to understand that the team had not brought a solution to the storage problem, that it did not want simply to convince or force them to do something, and it did not have some gift for them. The Committee and the team tried hard to elicit the villagers' perception of their storage problems and the range of techniques already used to solve them.

In between first and second meetings, the team visited homes, saw, and subsequently drew large poster pictures of existing structures. These pictures were introduced into the second meetings, and various comparisons of strengths and weaknesses of different storage systems were discussed.

In the Kijiji zone the first meeting was very slow. The Committee dominated in its attempts to introduce the subject of storage and to convince people that their participation was genuinely desired in understanding the problem and in designing solutions. The problem of early harvest, moist grain, and the use of the *dari* for drying came out of this discussion meeting very well.

The second meeting in this zone explicitly compared the strengths and weaknesses of a sun-drying system such as that the Committee Chairman had already built for himself and the heat-dried system used by the majority of peasants, relying on fire under a ceiling or roof storage platform (*dari*). Discussion was focussed but dominated too much by the team. The Committee and team still felt that this group had not not yet internalized the search for real alternatives as its own, but still waited for some answer to be given from the outside.

The third meeting of the Kijiji zone centred on the problem of rats and the use of roof-storage. Villagers said they also used cylinders of woven reeds, sometimes plastered with mud—*kihenge*— for storing rice. They noted that rats found it more difficult to attack rice stored in this manner. They recognized the *possibility* of storing other grains in the *kihenge*, but did not so this. The major reason seemed to be that grains other than rice which

has a protective hull, are more intensely attacked by insects when stored in the *kihenge*. This led to a discussion of the use of ashes of certain trees in preserving seed. Could not these same ashes be used to preserve food from insect attack? Would the necessary quantities of ashes be available and at what cost? Commercially produced produced insecticide was compared to ashes in terms of cost and effectiveness. Both the financial and the labour costs were considered. The meeting debated a number of possibilities for improving storage but the discussion was relatively abstract and the Committee did not feel that this group was prepared to implement on the basis of these discussions.

At the Shule zone the first meeting was similar. It was slow to develop, but then focussed on the complex of problems leading to early harvest (pigs, monkeys, etc.), the necessity to dry after harvest, and the subsequent insect attack of the grain was not properly dried. It turned out that several members of this discussion group used or intended to use a free-standing, fire-drying structure called a *dungu*.

The second meeting at the Shule zone explicitly compared *dari* and *dungu* (just as the second meeting at the Kijiji zone had compared sun-drying crib (*chanja*) and *dari*). A vote was taken to see who favoured the *dungu* over the *dari*. Everyone said they favoured the *dungu* because it could be protected from rats and there was less danger if it caught fire. Another vote was taken to see who actually had a *dungu*. Only a very small number actually had them. Most used the *dari* system. This contradiction between theory and practice was discussed and two lines emerged: First, the problem of theft and the more general problem that one was not happy storing in a way that let neighbours see how much food one had. Second, it became clear that it requires extra work to build a *dungu*. When one builds a house one automatically builds a *dari*. A *dungu* is really another small separate house. many farmers did not harvest enough maize to make the extra effort seem worthwhile. In addition, dialogue revealed that many farmers had exhausted their food supply between June and December and then used much of their labour time working for their wealthier neighbours cultivating their fields for payment in kind or cash. This system (called *mraba*) seemed to lock the poorer farmers into a vicious circle. Each year they cultivated only a small individual plot of food crops because much of their labour went into cultivating for their wealthier neighbours. Each year their harvest was small, which meant they finished their food quickly and were forced to seek *mraba* work in order to eat.

Each year their labour time was also insufficient to cut trees and collect other materials to build a *dungu*. Each year they harvested so little that it appeared unnecessary to shift from the *dari* to the *dungu* system.

In separate evaluation meetings with the Storage Committee on 27/7/76 and 28/7/76 (Tapes 5A and 5B), it was thought that more progress had been made in the two meetings at the Shule zone than in the meetings at the Kijiji zone. There seemed to be an emerging consensus on technical recommendations that would be based on some improvements of the *dungu* rather than the *dari*, although the social and economic problems implicit in the *dungu* construction still remained. Improvements of the Chairman's sun-drying crib (*chanja*) were discussed with the Committee as well as a Nigerian design for a sun-drying/storage crib. The relations among, as well as problems of, *dari*, *dungu*, *chanja*, and the Nigerian crib were debated. The team's consistent line was that no single design was *all bad* or *all good*; rather it was necessary to discuss all strengths and weaknesses with the discussion groups and to try to maximize strengths and minimize weaknesses. The Committee internalized this approach very well and communicated it to the discussion groups often.

Round One: Makazi Mapya and Baraza Zones

First meetings in Makazi Mapya and Baraza zones contrasted vividly. Makazi Mapya was a section of the village somewhat removed from the others. There Waluguru people from the foothills had settled together during the previous fifteen months as part of the villagization programme in the District. Their homes were temporary, not yet mudded. They had cultivated only a few acres of sorghum for each family. They were generally not yet well integrated into the life of the village, and viewed their new neighbours with suspicion. The first meeting here was burdened by a rumour that the team had come to force them to store collectively together with the other people in the village.

Discussion dragged slowly at this first meeting. The participants volunteered only the information that they used *dari*, bark cylinders (*lindo*) and big earthern pots (*vyungu*). They claimed to have little problem with insect infestation and when the rats became too destructive, they removed some seed for the next season's planting from the *dari* and stored it in a pot (*chungu*). They totally rejected the idea of storing outside their houses.

The Baraza zone consisted of long-term residents of the village who had always been outside the settlement scheme and subsequent ujamaa group. The first discussion meeting at this zone

began with affirmations that rats could not be controlled. The rats in this area were super-rats—they even ate through earthern pots. The discussion, however, progressed to the point where it was admitted that human beings *could* be more clever than rats. The example was given of the hanging pot used for left-over food (*susu*). The idea of rat-guards for free-standing structures (e.g. *dungu*) was suggested. Discussants said that had been tried before in the early 1960's and had failed. Detailed discussion revealed that it had failed because (a) rat-guards had been placed too low on the posts, so rats could jump over them, (b) rat-guards had been the wrong shape and size, (c) rat-guards had been put at different heights on different posts, giving the rat a chance to use alternate posts for access, and (d) rats may have been hidden in the bundles of grass used for thatching! This first meeting also raised the possibility of building burnt-brick storage silos. The first meeting of this group, therefore, ended with a general impression that lines of advance had been identified which would be pursued in the second meeting.

A Committee meeting (no. 7, 30th July, 1976—tape 11A) compared the progress of the first meetings at Baraza and Makazi Mapya zones. It was decided that the return visit to Makazi Mapya should insist that no line of action was being forced on the villagers and should stress the relationship between the storage discussion meetings and the villagers' normal adult literacy meetings which had by then reconvened. The Committee said that it had been a mistake to approach Makazi Mapya with such enthusiasm for the *dungu*, since it was alien to the villagers in Makazi Mapya. The Chairman, who is Mluguru himself, the tribe of the Makazi Mapya villagers, suggested that the Committee could approach the problem more subtly. The Waluguru call their *dari* by the name *kano*. The Committee should simply suggest there could be some advantages in shifting the *kano* outside. The outside structure would still be a *kano*, not a *dungu*, albeit an outside *kano*.

As a result of these preparations, the second meeting in Makazi Mapya was more successful. There was detailed discussion and criticism of outside structures. The Nigerian Crib was also discussed, and was criticized especially because of its apparent lack of protection from rain blown horizontally by the wind. No commitment to implement anything emerged, but the meeting was more open and discussion freer.

The second meeting at Baraza was surprisingly slow by comparison with the first. The many women who had attended the first meeting and given many opinions were silent. A design for a

burnt-brick silo—requested by the previous meeting— was presented but rejected by the meeting on several grounds (see Section 7 of this report). There was further discussion of the *dungu* and Nigerian crib, and an implementation meeting was scheduled. The Committee tried to make the point that *no* design, not even the Nigerian crib was complete, and that it was the task of the implementation meetings to refine these designs, discuss available building materials, division of labour, etc.

Round Two

In retrospect the positions of Makazi mapya and Baraza zones were surprisingly reversed in the second round. This round—implementation meetings—began with Baraza zone. But nothing happened! All their interest turned out to have been verbal alone as the Ward Education Co-ordinator had predicted. In fact, this section of the village was an old section whose rice fields pre-date the villagization. They had mostly rice, only a little sorghum, and their maize was nearly all eaten. They had no need for improved storage at their present level of production, hence their participation in the meetings had been only verbal. The poorer members of this section who didn't even have much rice, would soon be working *mraba* for food and doing other sorts of casual wage labour—work on the roads, construction for other villagers, cotton picking. They were uninterested in actually constructing the rat-proofed structures their discussion meeting had partially designed!

On the other hand, the second round in Makazi Mapya was also a surprise. Several villagers there announced at the beginning of the meeting that they had already cut posts and beams for their *dungus* (which they were building for the first time) and requested the Committee to come and see them. The rest of the meeting was spent showing how the rat-guards could be cut out of old paraffin tins and discussing the use of malathion dust. Makazi Mapya, unlike other sections in the village, seemed to reject the use of a potent unknown chemical on their food. This was discussed at some length, but following our established method, no pressure was applied. Their objections were noted, clarified, and will become subject of future meetings with the Committee.

The villagers in Makazi Mapya, unlike those at Baraza, had sorghum that they were harvesting just at the time of the discussion meetings. The modified, rat-proofed *dungu* seemed to them a real possibility for preserving a greater amount of their sorghum. Therefore, they were interested and began implementation despite their earlier suspicion.

This pattern of implementation was repeated in all other areas of the village where people had sorghum or maize to store. Villagers in the Kijiji and Shule zones as well as the ad hoc fifth discussion group agreed to build *dungu*, some making appointments with the Committee for on-the-spot advice, others making arrangements among themselves for mutual aid in going to the forest to cut timbers. It was at these implementation meetings that the most interesting discussions emerged about types of trees for construction and structural properties of various *dungu* designs.

APPENDIX 5.

LIST OF TAPE RECORDINGS

Tape/Side		Subject
1	A	**Village Council Meeting** The team is officially introduced to the Village Council. The purpose of the project is explained. Storage Committee is chosen.
1	B	**Storage Committee Meeting—1** The work and methods of the Committee are discussed.
2	A	**Storage Committee Meeting—2** A strategy for organising the discussion groups is planned.
2	B	**Storage Committee Meeting—3** Visit to the *chanja* of the Storage Committee Chairman.
3	A	**Storage Committee Meeting—4** Visits to *chanjas* of two other villagers. **Kijiji Group Meeting—2*** The advantages and disadvantages of *dari* and *chanja* structures are discussed.
3	B	**Shule Group Meeting—1** The range of food production and storage problems discussed.
4	A	**Kijiji Group meeting—3** Discussion on protection against rats and insect attack. Insecticide introduced and compared with ashes.
4	B	**Shule Group Meeting—2** *Dari* and *dungu* structures are compared and contrasted.
5	A	**Storage Committee Meeting—5** Progress of the dialogue is reviewed and discussed. "Nigerian Crib" is introduced as the outside team's contribution to the dialogue.
5	B	**Storage Committee Meeting—6** Preparation for the next round of discussion group meetings beginning at Makazi Mapya.

6	A	**Makazi Mapya Group Meeting—1** Introduction to the subject of storage under difficult circumstances.
7	A	**Baraza Group Meeting—1** Open discussion on the full range of storage possibilities. Air-tight storage brought up.
11	A	**Storage Committee Meeting—7** Difference in group response in the previous two discussion groups compared.
8	A	**Makazi Mapya Group Meeting—2** Outside storage is discussed though group members insist that they will only store their crops inside in the *dari*
9	A	**Baraza Group Meeting—2** Advantages and disadvantages of various outside storage systems are discussed in relation to the known pests. Air-tight storage is rejected.
12	A	Preparation for the implementation meetings. Construction of a "model" storage structure is rejected. Decision to make one additional introductory meeting at Kilabuni.
10	A	**Kilabuni Group Meeting—1** Discussion on construction methods and materials. Modifications of traditional *dungu* discussed.
10	B	**Baraza Group Implementation Meeting** Members decide that they do not have enough crops to construct improved storage.
6	B	**Kijiji Group Implementation Meeting** Discussion of how to construct an improved *dungu*.
8	B	**Makazi Mapya Group Implementation Meeting** Announcement that group members have already cut posts for constructing improved *dungus*. Discussion on making rat-guards and use of insecticide.
13	A	**Storage Committee Meeting—9** Preparation for report to Village Council. Preparation for seminar at Agricultural Faculty, Morogoro. Review of the progress of implementation.

APPENDIX 6 .

INDIGENOUS VILLAGE STORAGE INNOVATIONS

The Chairman's Chanja

The Chairman of the Storage Committee had built prior to the project a sun-drying crib used for drying approximately one ton of husked maize, harvested in a wet condition (see Figure 7). He had seen such structures while working as foreman on a large-scale Asian farm in another part of Morogoro District (Wami) in the late 1950's. The Committee was concerned to monitor the condition of the maize in his crib intermittently, and held one formal meeting on site. At that time the Committee members and neighbours made several criticisms of the crib, including the following:

(1) It was too low, less than ½ metre above the ground. The ground underneath the store was moist, and there was sprouting maize underneath, presumably having fallen through from inside.
(2) It should have been built on a small hill, artificially raised in order to allow rain water to drain away from underneath the crib.
(3) The crib was open to the rain.
(4) The wire he used to protect the crib from monkeys was too expensive for the average villager.

The team had previously mentioned these first two points to the Chairman privately. In addition the team had noted the following:

(1) The depth and width of the mass of maize to be dried was too great to allow fast drying and adequate ventilation.
(2) Palms in the courtyard produced too much shade and should be pruned.

At the time of the first inspection (July), the maize had been drying for a month (harvested in June). It was still quite moist, but not physically deteriorated and not yet infested by insects. By early August when Committee members again inspected it, and samples were taken from the centre of the structure, serious mould and fungus was apparent, as well as moderate insect infestation (Sistophilus).

The Chairman was convinced that earlier criticism of the *chanja* had been correct, and had now constructed another one much higher off the ground for his sorghum harvest. This new

structure is covered by a corrugated iron roof and the sides are protected against the driving rain.

Other Sun-Drying Cribs

During this recent maize harvest season the Chairman of the Storage Committee had shown two other individuals how to construct sun-drying cribs. One of these was a Storage Committee member. The Committee visited his *chanja* on 11th July, 1976 (Tape 3A). Apparently the committee member had been unable to husk and store his newly harvested maize due to pressure of other work. It had sat heaped on the ground at his home for a week until the Chairman had suggested that this Committee member construct a *chanja*. This maize showed signs of fungus and mould damage and had a light Sitophilus infestation just one month after harvest. The Committee's criticisms of this *chanja* were much the same as those of the Chairman's.

The Chairman also instructed a second man in the construction of a *chanja*, which the team subsequently assisted in building. He is a government driver who had also farmed, but who had been unable to store his harvest due to time pressures. It had lain unhusked for three to four weeks and was in terrible condition with much mould attack, including some penicillium varieties dangerous to humans and small farmyard animals.

APPENDIX 7.

STORAGE EXPERIMENTS AT THE VILLAGE PRIMARY SCHOOL

"The School is the Village"

It was the intention of the team to include as wide a range of people as possible in the discussion of storage problems in the village. Since the project was being carried out through adult education methodology it was felt that the other village educational institution, the primary school, should be included as well. In addition, the Head Teacher of the primary school is the village adult education co-ordinator.

The interest of the school children had already been aroused by the presence of "outsiders" in the village and by the discussion groups in which their parents were already participating. It was felt that this interest and curiosity could be enhanced by designing a specific programme in which the students could participate themselves. The school teachers accepted this idea enthusiastically in the spirit of the doctrine that "the school is the village and the village is the school".

Setting up the Experiments

Various simple experiments for testing variables which affect the storage of grains were set up with the help of Prof. Brian Gerard of the University Agriculture Faculty. The expressed purposes of the experiments were:

(1) To show how certain topics in the school curriculum can be relevant to development projects in the village;
(2) To develop the interest and skills of the pupils in the scientific analysis of a common problem;
(3) To test the effectiveness and persistence of various commercial insecticides and local additives such as ashes on insect infestation.

The equipment needed for the experiments was containers with lids (either plastic pots or glass jars), maize/sorghum grains, weevils (Sitophilus), insecticide and local additives. All of the necessary equipment could be obtained at the village except the insecticide which was not available at the village shop at the time the experiments were initiated. Small (200 c.c.) plastic pots were brought in by the team so that the students could watch the experiments in progress though local substitutes could have been found. The materials were handed over to the school teachers

and a verbal explanation was given of the variables which could be tested and the types of experiments which might be carried out. It was left up to the teachers and the students to devise the specific experiments themselves.

The Results

The experiments were conducted in the science classes of standards V-VII. The classes were divided up into five groups, each of which carried out and recorded its own experiment plus control. The experiments were carried out over the last three weeks of the team's stay in the village and were expected to continue. They were all set during a science period and then opened during the same period a week later. The results were discussed during the class and new experiments were devised to answer questions or queries which had come to light.

The following is an actual experiment carried out by the students:

Pot A - filled with maize only (100 g.)
Pot B - filled with maize (100 g.) and malathion 1% dust (one level teaspoon)
Pot C - filled with maize (100 g.) and 20 weevils
Pot D - filled with maize (100 g.), malathion 1 % dust (one level teaspoon) and 20 weevils
Pot E - filled with maize (100 g.), sesame ashes (three level teaspoons) and 20 weevils.

After filling the pots, they were closed so that the weevils could not escape but not sealed so that air could enter. The pots were opened after one week with the following results:

Pot A - found exactly the same as the previous week
Pot B - 2 weevils were found alive despite the fact that none had been placed in the pot
Pot C - 19 weevils were found alive and 1 weevil was dead
Pot D - 23 weevils were found dead although only 20 had been placed in the pot
Pot E - 9 weevils were found dead and 11 weevils were still alive.

The following discussion emerged from the results of the above experiment:

The fact that two of the pots (B and D) produced more weevils than had been originally placed spurred a lively dissussion in the class. How did the additional weevils get there? They could not have entered so they must have been hatched inside. But how is a weevil hatched? Did the adult weevils mate

in the pot and reproduce? But Pot B did not have any adults. could the eggs already have been laid on the grain? But all the grains were clean when placed in the pot. Perhaps, the weevil lays its eggs inside the grain so they are not easily detected. That's it! The maize which we put in the pots was already infected. (The students search to find the grains from which the weevils have emerged.) Now, how long does it take for an adult weevil to emerge from the grain after the egg has been laid? 28 days! And how does the weevil develop inside the grain? First, it becomes a pupa (*funza*) and then develops into an adult insect and all the time gets its energy by eating the grain. (The students break open the affected grains to inspect the damage.) But why did the insecticide not kill the insects before they emerged from the grains? Because the effectiveness of the insecticide cannot penetrate the protective covering. So it is useless to apply the insecticide to unhusked maize!

Fresh weevils were added to the pots containing both maize and insecticide but the dose of insecticide was not renewed. The students will continue to count the number of dead weevils each week and calculate the percent dead. They will also continue to add fresh weevils each week in order to test the persistence of the insecticide over a long period of time. Other experiments are testing the effectiveness of both insecticide and ashes on wet and dry grain and the extent of weevil damage on wet and dry grain.

The school experiments continued for another month during which the lasting effectiveness of the insecticide was proven. Weevil damage was also shown to be much greater on moist grain than on dried grain. The school teachers were so convinced by the experiments that they also purchased malathion dust for their crops just like the other villagers. Finally, at the end of the school term, the science teacher included three questions about the storage experiments on the final examination. A higher percentage of students answered these questions correctly than any of the other questions on the examination.

APPENDIX 8.

TECHNICAL ASPECTS OF STORAGE AT BWAKIRA CHINI

In this appendix some of the principles of grain storage are explained which can be used to interpret the temperature and relative humidity figures recorded during the team's stay at Bwakira Chini (July-August, 1976). These figures are relevant since they were recorded during the time of year when the majority of food grains are harvested and dried. As we have seen, drying is one of the most important variables in the storage equation in this area.

Natural Drying of Grain

Harvested grain containing a high moisture content is subject to rapid deterioration under the influence of high temperatures. Moist grain undergoes chemical changes and is easily attacked by both insect pests and fungi. Fungi can develop on stored grain if the temperature is above 4.4° C (40° F) and the moisture content of the grain is above 12%. Increases in temperature and moisture content above these minimum levels increase the spread of fungi.

Air contributes to the drying of grain in two ways:

1. By removing the moisture which evaporates from the grain,
2. By supplying the heat necessary for the evaporation of moisture.

Both these functions are important though the second is relatively more so, since it determines the limits to drying. Warm air passing through moist grain collects up the water while evaporation cools the air and the grain. Evaporation cannot take place without a simultaneous reduction in the temperature. Nevertheless, the amount of heat the air can give off is limited by the amount of water the air contains.

There is a limit to the quantity of water which can be contained in a cubic metre of air at any given temperature. When the air absorbs the total quantity of water which it can contain, it is said to be saturated. The quantity of water which the air can absorb increases with the increase in air temperature, as is shown in Table No. 1.

An increase in the air temperature not only gives an increase in the moisture absorbing capacity, but does so in a greater proportion each time the temperature rises. If the air temperature rises by 10° C, let us say from 14° C to 24° C, it can absorb an

additional quantity of 9.7 gms. of water for each cubic metre of air. But if the air temperature rises 10° C, from 25° C to 35° C, it can carry an additional amount of moisture, 16.6 gms. of water for each cubic metre of air.

Table No. 1. Grams of water per cubic metre of air

Temp. ° C	Grams	Temp. ° C	Grams
14	12.1	25	23.0
15	12.8	26	24.4
16	13.2	27	25.8
17	14.5	28	27.2
18	15.4	29	28.7
19	16.3	30	30.4
20	17.3	31	32.0
21	18.3	32	33.8
22	19.4	33	35.7
23	20.6	34	37.6
24	21.8	35	39.6

Relative Humidity

Relative humidity is the term used to define the quantity of water which the air contains. A cubic metre of air at a temperature of 30° C which contains 15.2 gms. of water is at 50% saturation, that is, a relative humidity of 50%. The lower the humidity is relative to a given temperature, the quicker will be the percentage of drying which can take place at that temperature.

At a constant temperature, as the relative humidity increases, the ability of the air to extract water from the grain decreases. Thus at any given temperature there is an equilibrium between the moisture content of the grain and the relative humidity of the mean environment, as the tendency of the grain to retain moisture and the tendency of the air to extract it equalise each other so that the grain neither gives up moisture to the air nor acquires it from it.

Table No. 2.

Equilibrium of the relative humidity and the moisture content of the grain

% moisture in the grain / Temp.	4.4°C (40°F)	15.5°C (60°F)	25°C (77°F)
	Relative Humidities		
17	78%	83%	85%
16	73%	79%	81%
15	68%	74%	77%
14	61%	68%	71%
13	54%	61%	65%
12	47%	53%	58%

The air temperature, however, is more important than the relative humidity in determinimg the time needed and capacity for drying. If we consider, for example, air at 50% relative humidity, we will see in Table No. 1 that at 18° C it will contain about 7.7 grams of water per cubic metre of air. This means that it can absorb another 7.7 gms. of water. At 30° C, a cubic metre of air at 50% relative humidity will contain 15.2 gms. of water and will be able to absorb a further 15.2 gms. of water.

Table No. 2 shows that the equilibrium point at which the air no longer absorbs moisture from grain is at a higher relative humidity as the air temperature increases.

DATA ON TEMPERATURE AND RELATIVE HUMIDITY COLLECTED AT BWAKIRA CHINI

Key for Tables 3, 4, & 5

VS = very sunny
S = sunny
PC = partly cloudy
CR = cloudy with rain
CD = cloudy but dry
DBT = dry bulb temperature
WBT = wet bulb temperature
RH = relative humidity
W = weather

Table 3: Indoor Relative Humidity

Time / Day	06.00				12.00				18.00			
	DBT	WBT	RH	W	DBT	WBT	RH	W	DBT	WBT	RH	W
2.7.76	19	18	89%	VS	28	22	57%	PC	24	20	65%	VS
3.7.76	22	19	68%	VS	25	19	54%	PC	24	19	58%	
4.7.76	20	16	63%	VS	24	19	58%	PC	25	19	54%	PC
10.7.76	24	21	72%	VS	26	22	68%	PC	26	21	61%	
11.7.76	24	21	72%	VS	25	23	82%	CR	21	21	100%	CR
12.7.76	23	20	72%	CR	25	22	81%	CR	24	21	81%	CR
13.7.76	22	19	72%	PC	24	20	65%	PC	24	21	65%	VS
14.7.76	22	20	81%	VS	24	20	65%	PC	25	20	60%	VS
15.7.76	21	18	72%	VS	23	21	72%	VS	24	20	65%	VS
16.7.76	21	18	72%	PC	23	20	72%	PC	23	19	65%	PC
17.7.76	21	16	51%	VS	24	18	47%	VS	23	16	46%	VS
18.7.76	20	16	57%	PC	24	18	52%	VS	23	17	52%	VS
19.7.76	19	15	62%	VS	23	19	72%	VS	23	18	58%	VS
20.7.76	20	17	71%	VS	23	19	65%	PC	23	20	72%	CD
21.7.76	23	20	72%	CD	25	20	60%	CD	23	20	72%	CD
AVERAGE	21		70%		24		65%		23		65%	

Table 4: Outdoor Relative Humidity

Time / Day	06.00				12.00				18.00			
	DBT	WBT	RH	W	DBT	WBT	RH	W	DBT	WBT	RH	W
2.7.76	17	16	88%	VS	28	22	57%	PC	24	20	65%	VS
3.7.76	16	16	100%	VS	27	19	45%	VS	20	17	71%	VS
4.7.76	14	14	100%	VS	25	19	54%	PC	26	20	55%	PC
10.7.76	19	19	100%	VS	30	23	54%	PC	28	21	51%	PC
11.7.76	19	19	100%	CD	26	23	76%	CD	21	21	100%	CD
12.7.76	18	18	100%	CR	21	21	100%	CR	20	20	100%	CR
13.7.76	20	19	89%	PC	26	21	61%	PC	22	20	81%	VS
14.7.76	19	19	100%	VS	26	20	55%	PC	25	20	60%	VS
15.7.76	16	16	100%	VS	24	21	72%	VS	22	20	81%	VS
16.7.76	15	15	100%	PC	27	21	56%	PC	21	18	72%	PC
17.7.76	17	14	70%	VS	30	18	29%	VS	21	14	45%	VS
18.7.76	15	14	88%	PC	30	19	34%	VS	22	16	52%	VS
19.7.76	14	12	78%	VS	30	20	38%	VS	23	17	52%	VS
20.7.76	17	15	79%	VS	30	21	43%	PC	24	19	58%	CD
21.7.76	21	19	80%	CD	27	21	56%	CD	21	19	80%	CD
25.7.76					29	21	47%	PC	23	18	58%	VS
26.7.76	18	16	79%	PC	36	23	33%	PC	24	20	65%	VS
27.7.76	15	14	88%	VS	29	20	42%	PC	27	20	50%	PC
28.7.76	19	17	79%	PC	32	21	36%	PC	23	18	58%	PC
29.7.76	16	15	88%	VS	30	20	38%	PC	23	18	58%	VS
30.7.76	15	14	88%	VS	33	20	29%	VS	21	15	51%	VS
31.7.76	17	14	62%	VS	33	20	29%	VS	25	18	48%	CD
1.8.76	20	18	80%	CD	29	21	47%	PC	25	21	67%	PC
2.8.76	18	16	79%	PC	31	22	45%	PC	25	20	60%	PC
6.8.76	18	16	79%	PC	29	20	42%	PC	26	21	61%	VS
7.8.76	15	14	88%	VS	27	19	45%	VS	24	19	58%	VS
8.8.76	16	15	88%	VS	29	21	47%	PC	24	18	52%	CD
9.8.76	16	15	88%	CD	31	22	45%	PC	25	18	48%	CD
10.8.76	16	15	88%	PC	29	21	47%	CD	25	20	60%	CD
11.8.76	18	17	89%	VS	33	20	29%	VS	28	20	45%	VS
12.8.76	20	19	89%	PC	30	23	54%	PC	27	21	56%	PC
26.8.76	20	19	89%	CD	31	21	39%	VS	26	19	50%	DC
27.8.76	16	15	88%	S	29	20	42%	PC	28	20	45%	S
28.8.76	17	16	88%	S	31	21	39%	VS	30	20	38%	PC
29.8.76	21	18	72%	PC	30	20	38%	S	26	20	55%	S
30.8.76	19	17	79%	S	31	21	39%	VS	28	20	45%	VS
31.8.76	19	18	89%	PC	31	21	39%	S	27	21	56%	PC
1.9.76	18	17	89%	PC	31	21	39%	VS				
AVERAGE	17		87%		29		46%		24		60%	

Table 5: Relative Humidity in an Indoor Grain Store (*Dari*)

Time	06.00				12.00				18.00			
Day	DBT	WBT	RH	W	DBT	WBT	RH	W	DBT	WBT	RH	W
22.7.76	23	21	81%	CD	26	22	68%	CD	25	21	67%	CD
23.7.76	24	21	72%	CD	26	22	68%	CD	26	22	68%	CD
24.7.76	24	21	72%	CD	27	22	63%	PC	26	21	61%	VS
25.7.76	23	20	72%	CD								
28.8.76					30	22	48%	VS	30	23	54%	PC
29.8.76	25	21	66%	PC	29	21	47%	S	26	21	61%	S
30.8.76	23	20	72%	S	29	21	47%	VS	27	22	63%	VS
31.8.76	24	20	65%	PC	30	21	44%	S	29	23	58%	PC
1.9.76	25	20	60%	PC	30	22	48%	VS				
AVERAGE	24		70%		28		54%		27		62%	

Interpretation of the Data

The data collected indicates that both outdoor sun-drying and indoor fire-drying can be effectively carried out. The major constraints on outdoor drying seem to be the ability to protect the grain against rain and to ensure adequate exposure of all the grain to the sun and the air. The major constraint on indoor drying is the small amount of grain which can be dried by this method.

In outdoor storage, the low temperatures and high relative humidities recorded indicate that no drying can occur during the night. In fact, some moisture may even be absorbed by the grain. During the day, however, the high temperatures and low relative humidities contribute to the rapid drying of grain.

The temperatures and relative humidities recorded in roof (*dari*) storage are relatively constant throughout the day and night. These are adequate to dry the grain to 12% moisture content but not below since they approximate the temperatures and relative humidities which are in equilibrium with grain having a moisture content of 12%.

APPENDIX 9.

VILLAGE HISTORY

The area around Bwakira Chini was for many years a foreign owned and operated plantation growing sugar cane and kapok. In 1965 it became the site of one of the Village Settlement Schemes undertaken by the former Ministry of Lands and Settlement. As such it was the recipient of massive inputs of credit and equipment which had an overall negative effect in motivating the settlers. The Settlement Scheme was disbanded in 1969. From 1970 to 1974 there was an unofficial "ujamaa" village at Bwakira Chini composed largely of the remaining settlers. Over half of the eighty original settlers left the area after the scheme was disbanded. In 1975, there was a heavy influx of new settlers during the Government's villagization programme. This brought the village population to its present total of 1,221 people in 270 families. In 1976 the village elected a Chairman, Secretary and Village Council in accordance with the Villages and Ujamaa Villages Registration Act of 1975.

Although there is no collective cultivation at present, there are a number of village activities controlled under the Village Council. These include:

(a) The purchase and sale of crops produced by the village members;
(b) A workshop comprised of sawyers, carpenters and masons;
(c) A dairy herd of 40 cattle;
(d) A retail co-operative shop.

The Village Council has resolved to re-introduce the system of block farming for the 1977 cultivation season with the following target acreages: cotton (685 acres) and maize (685 acres). Other crops which are to be grown on individual plots include sorghum (342 acres), rice (342 acres) and sesame (171 acres).

Village infrastructure includes a reticulated water system, pump and storage tank, TANU office, primary school (Std I-VII), rest house and community centre. The Divisional headquarters and magistrate's court are temporarily located at Bwakira Chini.

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