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A Post Harvest Handling System for

CASSAVA

(Manihot esculenta, Crantz)

RESEARCH DIVISION
MINISTRY OF FOOD PRODUCTION AND MARINE EXPLOITATION

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
IICA OFFICE IN TRINIDAD & TOBAGO PORT OF SPAIN, TRINIDAD & TOBAGO

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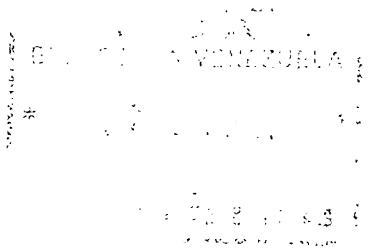

A POST HARVEST HANDLING SYSTEM FOR CASSAVA

Corrections to this Manual

Page 4 - Key Harvest Indicator - yellowing of leaves

FOREWORD

Improvement in food self-sufficiency and food security in Trinidad and Tobago will depend, to some extent, on improvements in the marketing system for food crops. In 1985, the Government of Trinidad and Tobago requested IICA's assistance in the preparation of project proposals for establishment of a marketing system for food crops which would embrace aspects of packaging, handling and postharvest technology.

A mission visited Trinidad and Tobago from August 25th to 31st, 1985 and prepared proposals for the improvement of domestic marketing of fruits and vegetables in Trinidad and Tobago.

On the subject of Research and Training the mission observed that "a national course in postharvest technology and marketing seems necessary."

In pursuing the implementation of the proposed national course in postharvest technology, it became clear that local materials for use in postharvest training were extremely limited. In view of this, IICA sought to assist in the preparation of local training material for use in a national course in postharvest technology and marketing. This publication on the postharvest technology of cassava *(Manihot esculenta)* is the result of joint efforts by IICA and scientists of the Ministry of Food Production and Marine Exploitation to prepare local materials which can be utilized in training programmes designed to improve the marketing systems and reduce postharvest losses in food crops.

This publication is timely and important because, while there is abundant literature on postharvest technology of temperate fruit crops, there is limited information on tropical root crops.

I hope that this continues a series on the postharvest technology of tropical crops which will have application not only in Trinidad and Tobago, but throughout the tropical world. Our Institute is pleased to have collaborated with the Ministry of Food Production and Marine Exploitation in this venture and looks forward to co-operating in future initiatives which will contribute to reducing postharvest losses in tropical crops.

"The responsibility for the opinions expressed in this publication rests solely on the author."

Representative
IICA Office in Trinidad and Tobago

PREFACE

Developing countries often find themselves in the situation where locally grown produce arrives on domestic markets in less than excellent condition and attempts at marketing in the potentially lucrative markets of North America and Europe encounter problems of quality, both from the quarantine viewpoint and overall quality standards.

The goal of achieving a developed marketing system which satisfies both domestic and foreign requirements has remained somewhat elusive for many a tropical developing country.

The reasons for the above condition are varied, amongst them being the lack of a well informed farming community highly sensitive to the need to produce a quality product and willing to engage in the steps necessary to ensure good product life and final consumer acceptance.

It is towards the fulfilment of this condition that this series of manuals directs attention. They attempt to put together the various techniques (generally grouped together as "post harvest technology") that must be applied to a particular commodity not only to ensure quality but minimize total product loss.

The series treats the problems of perishables, more particularly the commodity groupings (1) Fruits, (2) Vegetables, (3) Roots and Tubers, and (4) Ornamentals. The approach consists of an examination of the operations that occur between harvest and market, identification of common problem areas and practical recommendations to the grower/handler.

Although intended for the grower and Extension Officer mainly, it is hoped that it can also be a useful source of information for administrators, entrepreneurs, etc., and even our colleagues in temperate countries with an interest in the post harvest technology of tropical perishables.

This manual is one in the series resulting from the joint efforts of IICA, Trinidad and Tobago Office and the Post Harvest Unit of the Ministry of Agriculture (MOA), Trinidad and Tobago.

It is hoped that the package of technical information provided is supportive not only of the Government of Trinidad and Tobago's efforts in the area of improved marketing but attempts in other developing countries where cassava assumes importance.
It is hoped that critical comments and suggestions especially in the area of new and

improved post harvest techniques for the small to medium sized grower would be part of a constant feedback from users throughout this series.

Correspondence concerning this publication should be addressed either to:

The Research Division
Ministry of Food Production and
Marine Exploitation
Trinidad and Tobago

or

Representative
IICA Office in Trinidad and Tobago

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Crop Research Sub-Division

A POST HARVEST HANDLING SYSTEM FOR CASSAVA *(Manihot esculenta, Crantz)*

Table of Contents

1.0 INTRODUCTION

The cassava root, like the other root and tuber crops, has been traditionally treated as a hardy crop with little attention being paid to proper harvesting and post harvest handling procedures. This approach has accounted for the major losses in the marketing chain often observed in this commodity.

This root is generally more difficult to handle than other tropical roots as it has an intrinsic short shelf-life of two (2) to three (3) days. The flesh deteriorates into the characteristic blue black discolourations and later develops rots and/ or ferments resulting in the final softening of the root. This has restricted its availability, as there was always limited time to market.

Cassava is still one of the more popularly consumed root crops in Trinidad and Tobago and indeed the Caribbean. Presently, there is a drive to increase its production in order to satisfy the local demand for fresh roots and reduce dependency on imports. This anticipated increased volume would require appropriate handling systems to facilitate high quality produce reaching the consumer. It is with this view, that this manual is prepared for existing and potential producers, handlers and extension workers.

2.0 VARIETIES

There are several local varieties of cassava cultivated in Trinidad and Tobago. The more easily recognisable varieties are Maracas Black Stick, Blue Stick, White Stick and Red Stick. These differences are based on such factors as leaf petiole, stem and root colour. However, there is often confusion in nomenclature as different producing areas may claim certain

varieties. For example, Maracas Black Stick can sometimes be called Tobago Black Stick.

In addition, there are museum plots with imported varieties located at the Central Experiment Station, Ministry of Food Production; the Crop Science, Department, University of the West Indies; and the Caribbean Research and Development Institute. These institutions have ongoing programmes of varietal screening and testing for yield performance and cooking quality.

This manual is based on the results of laboratory tests and field observations on the two most popularly cultivated local varieties, Maracas Black Stick and White Stick (Plates 1 and 2).

Plate 1 - *Maracas Black Stick roots and stem with reddish purple leaf petioles*

Plate 2 - *White Stick roots and stem with pale green leaf petioles.*

3.0 HARVEST

The quality of the harvested cassava roots can only be maintained not improved. Therefore, to ensure an initial high quality product, proper harvesting techniques must be employed. This involves harvesting at the correct stage of maturity and minimizing physical damage to the roots during the operation, whether manual or mechanical.

3.1 Maturity

Harvesting at the correct stage of maturity is important as immature roots are more susceptible to physical damage and overmature roots have reduced

cooking quality. Most varieties mature approximately 8-12 months after planting. Harvest indicators are maturity date (which is variety specific) and the yellowing and falling of leaves from the plant (Plate 3).

Plate 3 - *Key harvest indicators - yellowing of leaves*

3.2 Harvesting Methods

Manual harvesting is the traditional method of harvesting cassava in the Caribbean and is still the most common method in Trinidad and Tobago. It is only at Caroni (1975) Limited, the Government's largest estate, that the fully mechanical Richter Harvester is being evaluated.

Plate 4 - *Manual harvesting — using stump for support.*

Plate 5 - *Carefully harvested root with short stub of stem attached.*

Plate 6 - *Imported Variety MCOL 22 (Colombia) cone-shaped compact roots.*

3.2.1 Manual Harvesting

The following four (4) basic steps should be used to minimise physical damage during manual harvesting.

1. Removal of the leafy stem to approximately 30 cm stumps using a sharp tool, e.g. cutlass

2. Carefully loosening the soil around the roots with a fork.

3. Uprooting the roots using the stump for support.

4. Separation of individual roots from the base of the stem leaving a short stub of stem attached.

3.2.2. Mechanical Harvesting

The Richter Harvester has an elaborate system for clearing the above-ground parts, lifting and separating the roots from the soil and loading onto a conveyor system. Such a machine requires a very high capital outlay and is not suited for operation where returns are likely to be relatively low.

Research and development activities at the University of the West Indies and the Agricultural Engineering and Development Division, Ministry of Food Production are being conducted on the efficient use of mechanically aided harvesting systems. The 1-row and 2-row root lifters show potential and evaluation continues under local conditions. In this system, the removal of above-ground parts and collection of roots have to be done manually. To date, there are no commercial root lifters and some farmers have attempted to construct their own. It is, therefore, worthwhile to highlight three (3) important factors to be considered in a mechanically-aided harvesting system for cassava.

1. Cultivar Characteristics

The size, shape and distribution of the roots in the soil determine the ease with which mechanical harvesting can be achieved with minimum physical damage. Varieties with shallow roots that are compact and cone-shaped are easy to harvest, e.g. MCOL 22, an imported variety (Plate 6). However, varieties with long spreading roots which penetrate deep into the soil are difficult to harvest. Examples are the two local varieties, Maracas Black Stick and White Stick already seen in Plates 1 and 2.

2. Soil Condition

The type of soil and moisture content also affect the ease of mechanical harvesting. The heavy clay soils common in Trinidad are difficult to operate. In the wet season they become waterlogged with impeded drainage whilst in the dry season they dry out slowly and shrink developing high penetration resistance. Therefore, it is essential to use appropriate cultural practices to develop free-draining soils.

3. Implement's Efficiency

The assessment of the efficiency of the harvesting implement must be in terms of the work rate as well as the quality of the harvested product. In evaluating the work rate, the percentage leavings should be considered. Leavings are the roots which remain covered in the soil after the operation. Additional labour is required to uncover and gather these roots. With respect to root quality, the total percentage of broken, cut, skinned and bruised harvested roots must be noted. High percentages of such damage would greatly reduce the shelf life and lower the marketability of the roots, thus, rendering the implement unsuitable.

4.0 FIELD HANDLING

Once the roots are harvested with minimum physical damage, it is critical to maintain this high quality during the field handling operations.

4.1 Field Packing

Cassava roots should be packed in a sturdy container in order to minimize physical damage especially breaking and bruising. The plastic stackable crate is ideal as it has a long life (5 - 6 years) and can be easily handled (Plate 7). Field packing, in batches, allows for quick removal of the roots from the field.

4.2 Shade/Temperature Management

The harvested root should not be left exposed to long periods of direct sunlight since water loss and spoilage will occur. This can be avoided by:

1. Arranging for all field operations to be done in the cool periods of the day.

2. Providing field shade. A simple shed from natural materials is quite adequate (Plate 8).

5.0 PACKING-SHED OPERATIONS

The following post harvest operations should be carried out immediately after harvest, especially if roots are destined for storage.

5.1 Washing and Selection

The less abrasive, low pressure water-hoses should be used to remove soil and other debris, which may harbour rot-causing organisms.

Plate 7 - *Use stackable plastic crates for field handling*

Plate 8 - *Field shed using natural material*

Only roots with minimum physical damage should be selected for storage. With respect to the root size, producers must know their market as different consumers have different size preferences, e.g. housewives vs. processors.

5.2 Fungicidal Treatment

Fungicidal treatment reduces rotting in cassava roots. The most commonly used fungicide is Benomyl (Trade Name: Benlate, Rate 20 gm/100 litre). CIAT* has recently recommended the use of thiobendazole (Trade Name: Mertect) for cassava roots. This fungicide was effective on the two (2) local varieties. Roots were dipped for five (5) minutes in 0 .4% Mertect solution. The use of the plastic crates and a trough is quite convenient for this operation.

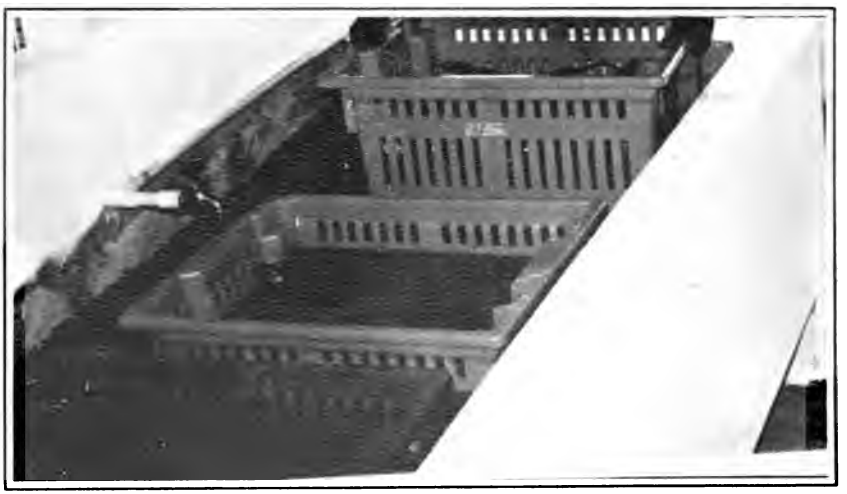


Plate 9 - *Applying fungicidal dip using crates and troughs*

*Centro Internacional de Agriculture Tropical, Cali, Colombia

5.3 Drying

Treated roots should be placed on raised surfaces for quick drying either with natural ventilation or forced air (fan). It is important to remove free water from roots before storage in order to avoid microbial activity.

6.0 STORAGE TECHNIQUES

The storage environment for cassava roots must minimize deterioration resulting from the wound reaction that is manifested in blue black discolourations and pathological attack (diseases). This can be achieved by maintaining a high relative humidity and reducing the amount of oxygen in contact with roots. Pathological attack can be reduced by the use of fungicides.

6.1 Polyethylene Bag Storage (14-21 days storage life)

Post harvest operations 5.1, 5.2, 5.3, should be carried out on roots within eight hours after harvest. Treated roots should be packed in sealed polyethylene bags and stored in a well ventilated room at ambient temperature (27-29°C). This creates an atmosphere of high relative humidity and reduced oxygen content as a result of respiratory activity of the roots.

Both local varieties responded positively to this storage technique and up to 21 days cassava flesh lacked the characteristic blue black discolouration (Plate 10). Quantities stored in bags can vary between 1 kg. to 20 kg. depending on the level of operation, i.e. wholesale or retail.

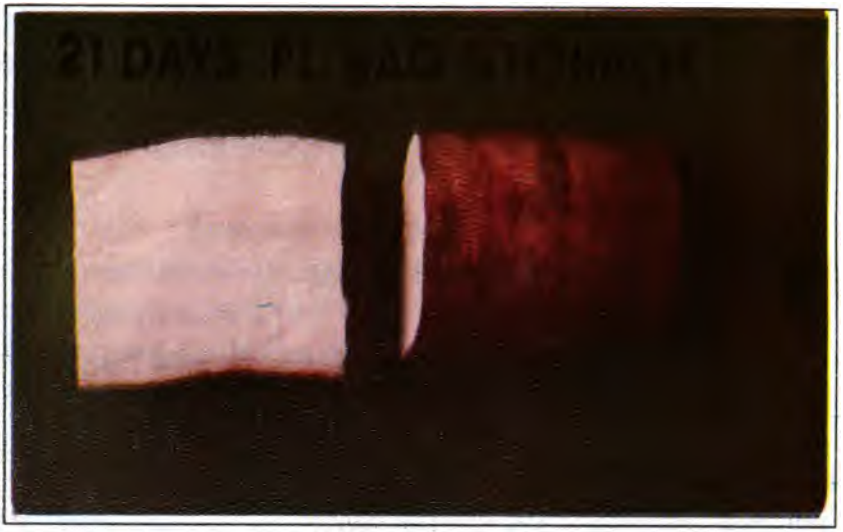


Plate 10 - *High quality flesh of white stick variety after 21 days polyethylene (PL) bag storage.*

Plate11 - *Polyethylene consumer packages of frozen cassava.*

6.2 Freezing (21-35 days storage life)

The cassava root stores well under deep freeze conditions (<0°C). Within eight (8) hours after harvest, the selected roots should be peeled, cut into appropriate pieces and packed in polyethylene bags. It is important to maintain the temperature during transport to the marketing outlets. Thawing should only be done before preparation for consumption. In Trinidad and Tobago there is an increased demand for this product. Examples of consumer packages are seen in (Plate 11).

6.3 Waxing (21-35 days storage life)

Waxing is an effective storage technique as water loss is restricted and the oxygen content is reduced around root surfaces. In addition, there is increased appeal to the consumers. Both local varieties stored well, up to thirty (30) days with good cooking quality after waxing (Plate 12). Post harvest operations 5.1, 5.3, should be carried out on roots within eight hours

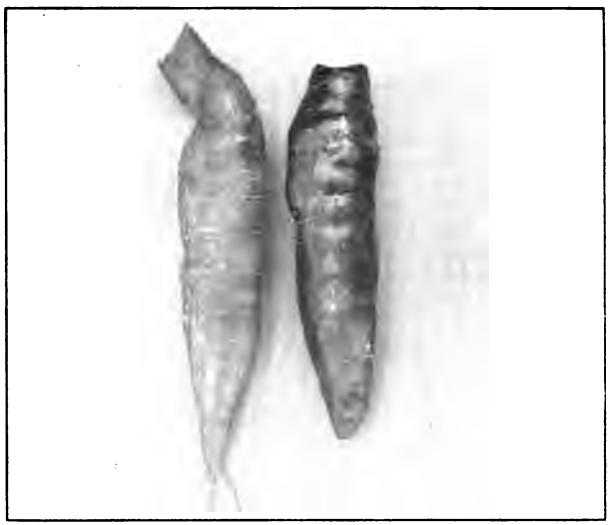


Plate 12 - *Left: Freshly harvested root (Maracas Black Stick); Right:Waxed root after 30 days.*

after harvest. Roots are then dipped in paraffin wax at 90-95°C for 45 seconds and stored in a well ventilated room under ambient conditions (temperature 27-29°C).

7.0 POST HARVEST PROBLEMS

The major post harvest problems the cassava producers and handlers will encounter can be classified as physical injury, physiological deterioration, microbial deterioration and pest injury.

7.1 Physical Injury

This occurs mainly at the harvest stage and during transit from farm to consumer. Harvest injuries are mainly broken and cut roots with bruises, abrasions and punctures (Plate 13).

Crushing and compression injuries are common during transit.

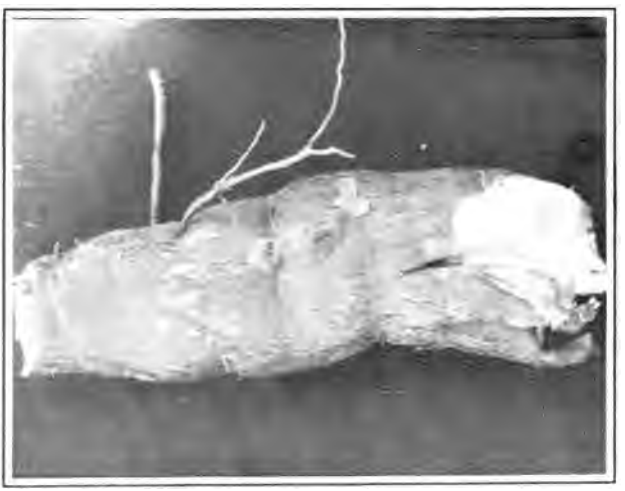


Plate 13 - *Physical injury during harvesting*

Recommendations:

1. Harvest only mature roots

2. Make clean cuts to remove roots from base of stem

3. Only use mechanically aided implement when percentage damage is low

4. Use sturdy field and transit containers

5. Do not sit on roots during transit

7.2 Physiological Deterioration

This is commonly known as vascular streaking and symptoms are bluish, brown or black discolouration of vascular tissue found below the peel of the root (Plates 14 and 15). It occurs within two (2) or three (3) days after harvest especially with damaged roots and roots which were not given proper post harvest treatments. It is related to a wound response reaction within the root, which is enhanced by water loss and the presence of oxygen.

Recommendations:

1. Minimize physical damage to roots - keep peel intact

2. Handle roots in the cool periods of day

3. Avoid contact of roots with oxygen during storage, e.g. use of sealed

Plate 14 - *Peeled root showing vascular streaking – initial stage*

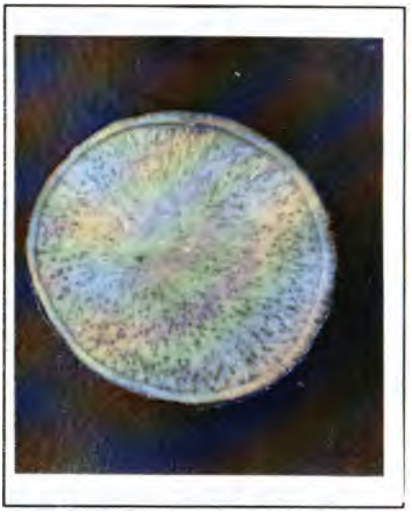


Plate 15 - *Cross section of root showing vascular streaking – advanced stage*

plastic bags, waxing

7.3 Microbial Deterioration

Microbial deterioration normally occurs after vascular streaking. Within seven (7) days signs are mainly blue, black or brown discolouration throughout the fleshy part of the root, with soft spots and fermentation occuring (Plate 16). Organisms of major concern are the fungi (e.g. *Rhizopus* spp., *Penicillium* spp, *Fusarium* spp.); others are bacteria and yeasts.

Recommendations:

1. Use fungicides
2. Keep protected from adverse weather conditions – excess rain and sun

Plate 16 - *Microbial deterioration – rotting and fermentation of root*

3. Keep storage room sanitary

7.4 Pest Injury

Cydnid bugs (*Cyrtomenus bergi*) attack roots in soil by puncturing, resulting in ports of entry for disease organisms which cause secondary infection (Plate 17).

Recommendations:

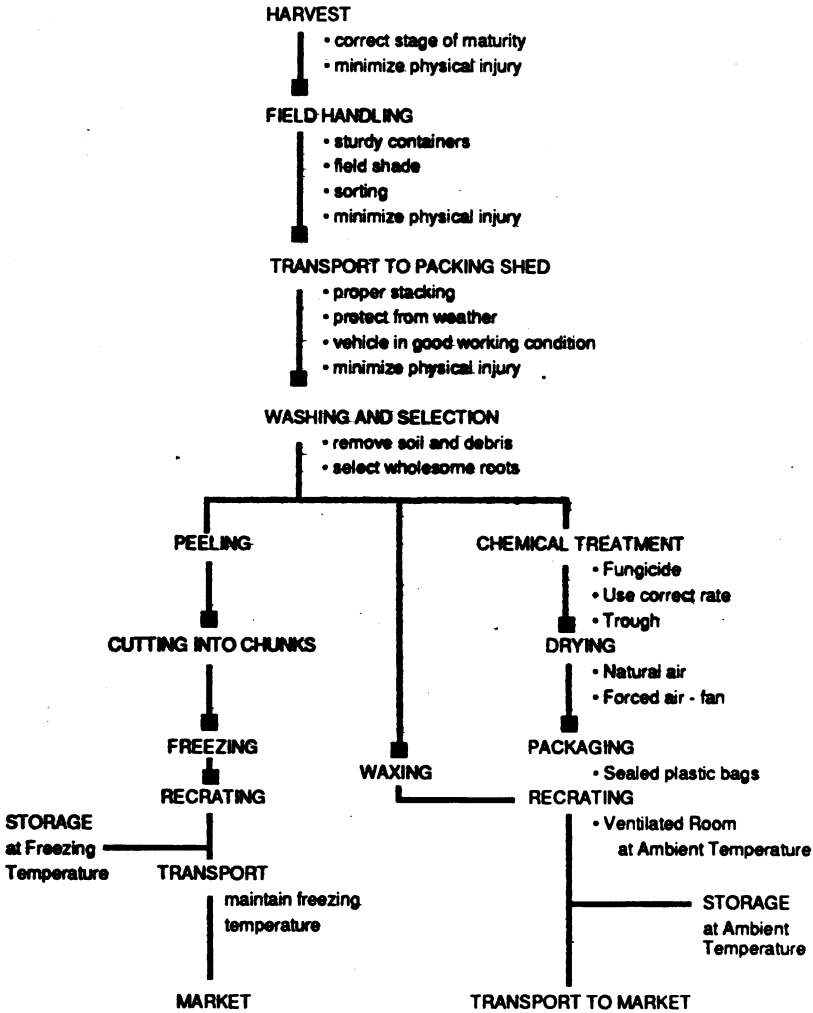
1. Phytosanitation in fields

Plate 17 - *Puncturing due to Cyrtomenus bergi attack*

2. Crop rotation (it is also pest of chive, onion, maize, beans)

3. Fallow fields for 12-18 months

8.0 A RECOMMENDED HANDLING SYSTEM



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