Storage systems for maize (*Zea mays* L.) in Nigeria from five agro-ecological zones

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Abstract

An international project to assess the extent of aflatoxin contamination of maize in West Africa has begun in Nigeria. A survey was conducted from October 1992 to July 1993 to identify maize storage systems used by farmers in five major agro-ecological zones in Nigeria and the problems associated with such systems. The zones were: humid forest, mid-altitude, southern Guinea savanna, northern Guinea savanna, and Sudan savanna. Five villages within each zone were selected and five farmers within each village interviewed. Eight storage structures were described, including raised platforms, synthetic fertiliser bags, cribs, traditional clay silos known as 'rhumbus', and 'obas'—a woven basket made from guinea corn stalks and glass bottles. Just over 20% of the farmers complained of problems with fungi, the majority of complaints coming from the southern Guinea savanna zone, and use of fertiliser bags as a storage method. Farmers' practices to avoid storage pests included spraying the stored maize with ash and pepper, use of pesticides such as actellic dust, gastosin, aldrex 20, frequent smoking of the storage structure and use of leaves from local plants.

Introduction

Maize (*Zea mays* L.) is one of the most important cereals grown and eaten in Nigeria. In the past, its cultivation was mainly in the southern part of the country, millet and sorghum being the predominant cereal crops of the north (Opadokun et al. 1979). However, because of the demand for maize for food and animal feed, maize is now grown practically throughout the country. Maize is Nigeria's third most important cereal crop, after sorghum and millet (FAO 1991). In 1991, national maize production was on 1.5 million ha with an estimated grain yield of 1.2 t/ha or a total production of 1.9 million t (FAO 1991).

Despite the importance of maize in the country, little is known about the various types of storage systems used by farmers in the major agro-ecological zones in the country, nor is there a database on treatments used by farmers in trying to solve their storage problems such as insects and fungal attack.

Meretiwon (1981) conducted a survey in the Oyo Local Government Area, which lies in the southern Guinea savanna zone of Nigeria. He identified four types of maize storage systems and these were (1) the traditional crib, (2) modern ventilated crib, (3) storage in bags, and (4) room storage in which the grains are piled on the floor in a room. He also reported that insecticides being used in storage were gammalin 20 (lindane hexachlorocyclohexane), gammalin A dust (lindane), lindane dust, actellic 25 (pirimiphos-methyl), phostoxin (aluminium phosphide) and andrex 40 (aldrin). However, no traditional or local storage treatments were reported.

Nigeria has five major agro-ecological zones which are identified by rainfall and vegetation patterns (Iloeje 1981).

1. The Humid Forest zone stretches from the western boundary of Nigeria south-eastwards to Cameroon and lies between 7°22'N and 3°48'E and 5°12'N and 7°4'N. The annual rainfall of 130–150 cm in the West and over 200 cm in the East, the high humidity (generally over 80%) and the long wet season (8–10 months) ensure an adequate supply of water and continuous presence of moisture in the air.
2. The Southern Guinea Savanna lies between 2°E and 12°E and 9°N to 8°N. Over most of this zone, the annual rainfall varies from 100 cm–150 cm and the dry season lasts from four to six months.
3. The Northern Guinea Savanna lies between 4°E and 14°E and 11°N and 9°N. The distribution of rainfall is unimodal with annual levels of about 90–120cm. There is a distinct wet season of about three to four months and a dry season of four to five months when rainfall levels go below 25 mm.
4. The Sudan Savanna is found in the far northern part of the country. It lies between 4°E and 14°E and 12°N. It has an annual rainfall of less than 100 cm and the relative humidity is constantly below 40% except in the few wet months when it sometimes goes up to an average of 60%. The dry season is about 6–8 months.
5. Mid-Altitude: The plateau is a pear-shaped upland area approximately 104 km from east to west lying between 9°53'E and 8°5'N. It rises by a 600 m scarpment from a height of 130 m to a height of 750 m above sea level. The plateau is one of the coolest parts in the country. The temperatures range between a minimum of 21°C and a maximum temperature of 25°C. It has an annual rainfall of between 140–143 cm.

A survey was conducted to identify the various maize storage systems and the associated storage problems found in the five major agro-ecological zones in the country and also to identify the various types of storage treatments used by the farmers.

Materials and Methods

In each agro-ecological zone, five villages where maize production is predominant were selected. Five farmers were interviewed in each village based on a stratified sample design (Steel and Torie 1960). In the interviews, farmers were asked questions on the type of storage method they used, the storage problems they experienced and the storage treatments they

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used in controlling the problems. Frequencies of responses were calculated and tabulated below.

Results and Discussion

The largest variation in types of storage structure was observed in the Humid Forest and the Mid-Altitude zone with seven different storage types, the Southern Guinea Savanna with six, while the Northern Guinea and Sudan Savanna zones each had three different maize storage types (Table 1). In the Humid Forest zone, the most common storage system used (40.0%) was storage in synthetic bags (Table 1). Of the farmers using bags, 43.7% reported having problems with insects (Fig. 1), while 37.5% reported having fungal attack on their stored maize (Table 2). Despite the problems, large-scale farmers still store their maize in bags because the bags can hold a large quantity of grain. Twenty-four per cent of the farmers stored their maize on raised platforms on their farms (Fig. 2). In this type of storage structure, bamboo sticks are tied together to form a platform and the maize still with the husks on is placed on these in layers. Maize cobs stored this way are exposed to insect attack, rainfall, and high humidity which could lead to a rapid deterioration of the crop. Maize stored in the husks over the fireplace was employed by 8% of farmers. The smoke from the fire helps to keep the cobs dry and repel insects. However, when the fire goes out, the cobs reabsorb moisture and 33.3% of the farmers reported observing damage caused by rats (Table 2). This method of storage is usually used by very small scale farmers who want to avoid additional expenditures. Eight percent of farmers stored their maize on the ceiling in a room in their homes (Fig. 3). Of these farmers, 66.7% reported having problems caused by insects with this type of storage while 33.3% of them observed fungal attack (Table 2). Farmers who stored their maize in the husks believed the husks offered some form of protection from insects. Eight per cent of farmers in some areas of the Humid Forest zone stored dehusked maize in clay pots (Fig. 4).

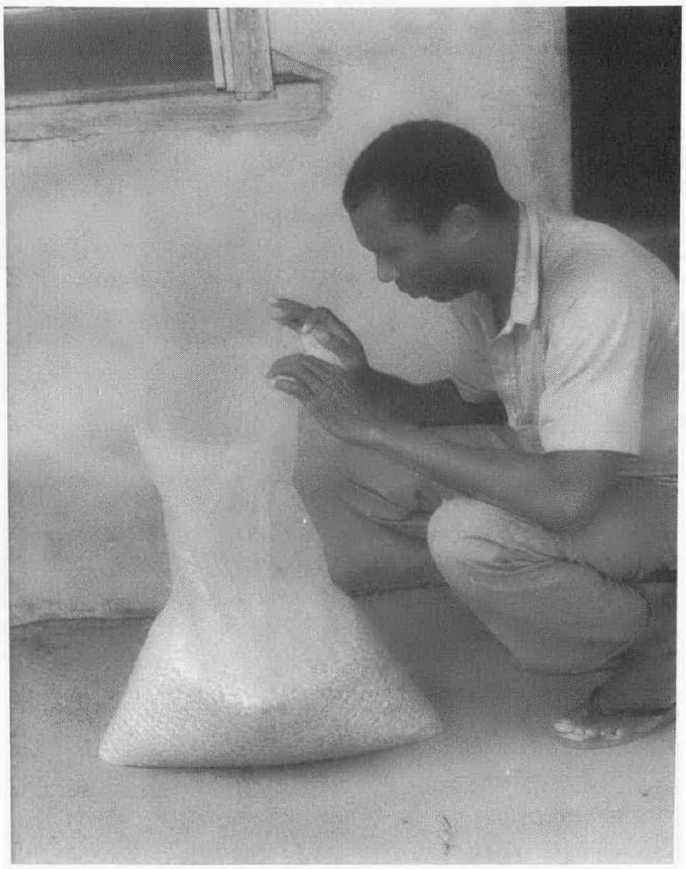

Fig. 1. Farmer observing insects from maize stored in fertiliser bags.

The pots are then covered with a piece of cloth and placed over a fire-place. The farmers believe that the smoke from the fire helps keep the maize dry and free from storage problems. However, 33.3% of them still reported having problems due to insects (Table 2).

Table 1. Distribution of maize storage systems in the five agro-ecological zones of Nigeria.

Type of storage	Respondents adopting the system(%)				
	HF[a]	SGS	NGS	SS	MA
In synthetic fertilizer bags	40	44	76	64	48
On a raised platform on the farm	24	0	0	0	
Over the fire-place	8	12	0	0	0
In a constructed crib	0	8	0	0	0
On the ceiling	8	4	0	0	0
In a clay pot	8	0	0	0	0
In a rhumbu	0	20	8	32	28
In an oba	0	12	0	0	0
In bottles	4	0	0	0	0
In baskets	8	0	0	0	0
On a bare floor	0	0	16	4	8
In a drum	0	0	0	0	4
On a tree	0	0	0	0	4
In a room open to the sun	0	0	0	0	4
On the ceiling	8	4	0	0	0

[a]HF = Humid Forest, SGS = Southern Guinea Savanna, NGS = Northern Guinea Savanna, SS = Sudan Savanna, MA = Mid-Altitude

Fig. 2. Maize with husks stored on an elevated platform on the farm.

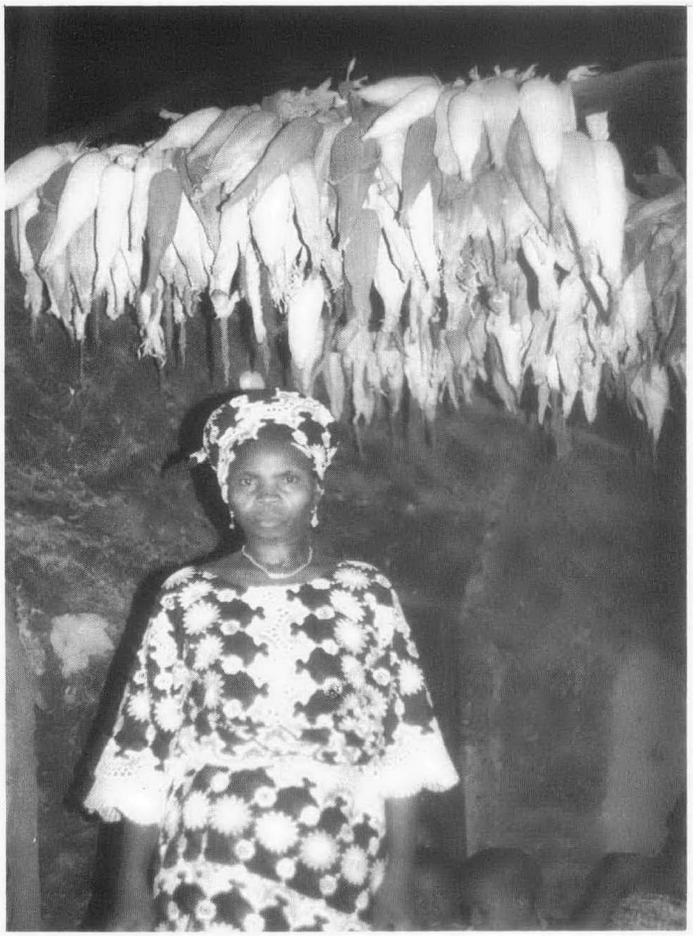

Fig. 3. Maize stored on ceiling

In the Southern Guinea Savanna, 44% of the farmers stored maize in bags, 12% stored over the fire-place and in an oba and 4% stored on the ceiling (Table 1). The same storage problems encountered by farmers in the Humid Forest zone were also reported by the farmers in the Southern Guinea Savanna i.e. insects, mice, rates and fungi. Constructed cribs (Figs 5a and b)

Fig. 4. Dehusked maize stored in clay pot.

were also used by 8% of the farmers to store their maize (Table 1). The cribs were constructed using wood with rat guards attached to the base of the posts, wire-mesh and corrugated iron sheets (Fig. 5a) or by using thinly split bamboo sticks (Figure 5b). The open nature of this storage structure allows for free flow of air which helps in keeping the maize cobs dry. However, this open type of storage structure has its disadvantages in that there are problems arising from insects and mice (Table 2) as reported by 33.3% of farmers.

Twenty per cent of the farmers stored their maize in structures known as rhumbu (Table 1). These are traditional silos made of mud mixed with grass (to strengthen the structure). The rhumbu is elevated with the aid of stones to guard against attacks by rodents, and completely sealed with a thatch roof placed over it to protect it against rain (Fig. 6a).

There are some slight variations in the structure of the rhumbu. In some, the whole structure is not completely sealed

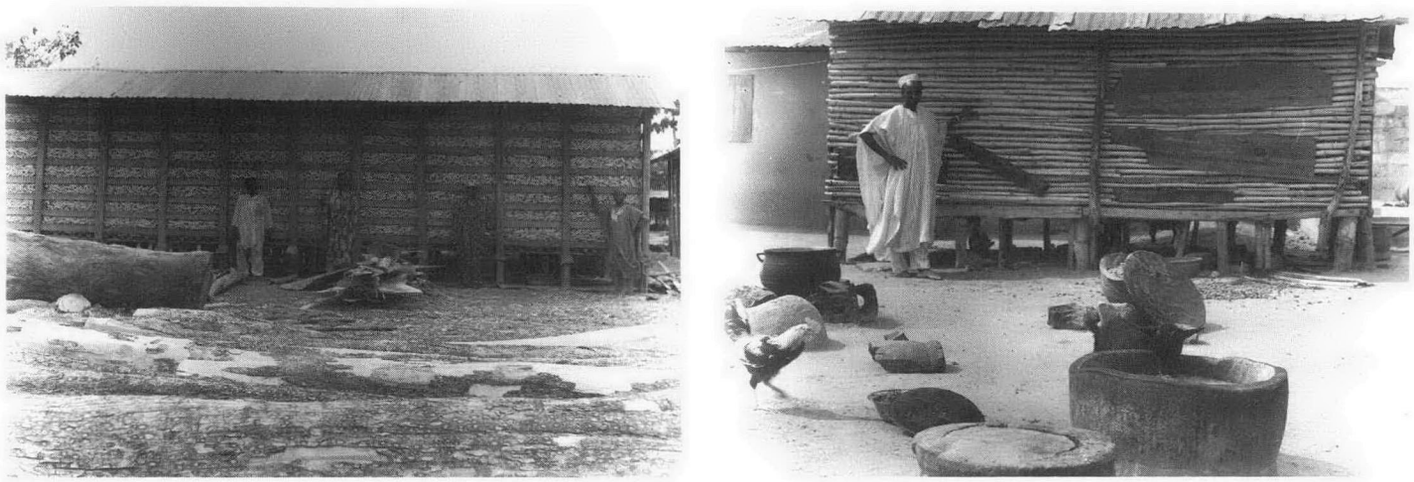

Fig. 5. (a) Left: dehusked maize stored in crib constructed with wood and wire mesh provided with rat guards. (b) Right: crib constructed from bamboo. (No rat guard, not open to ventilation.)

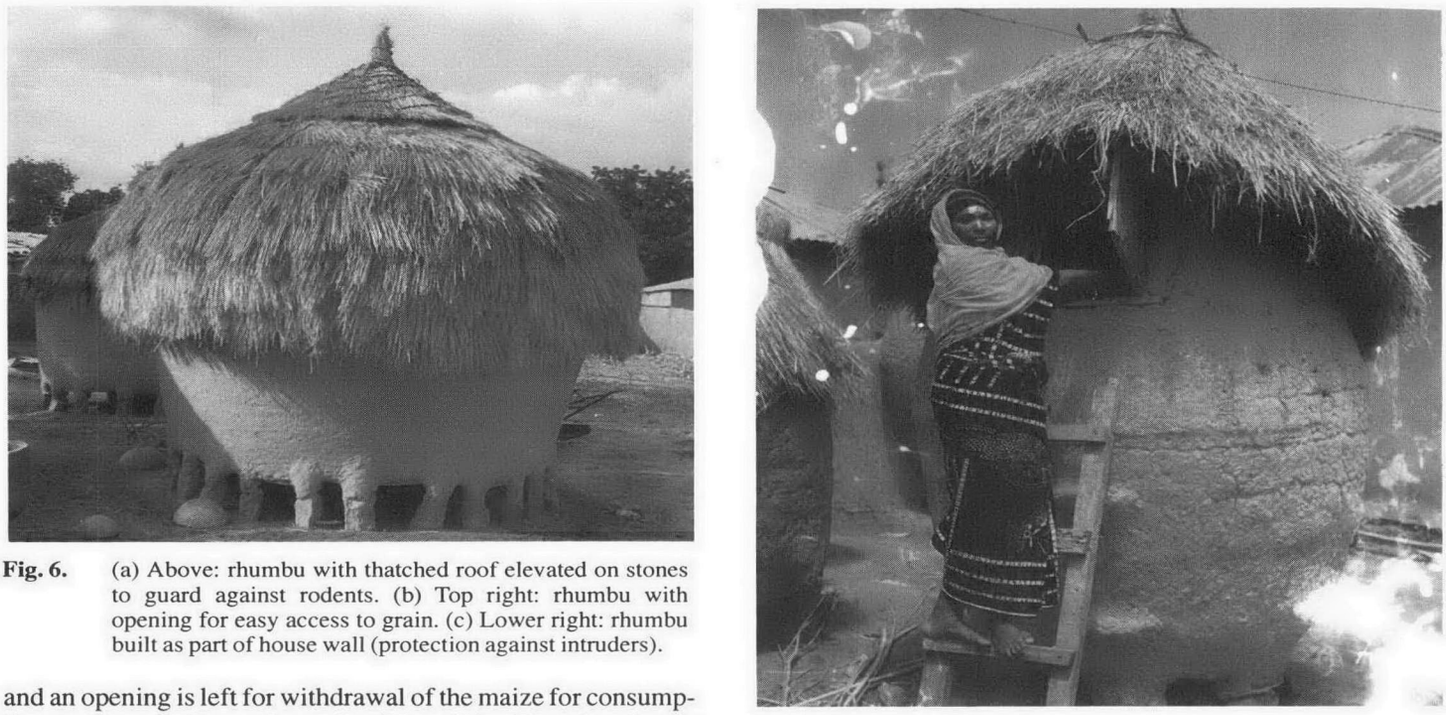

Fig. 6. (a) Above: rhumbu with thatched roof elevated on stones to guard against rodents. (b) Top right: rhumbu with opening for easy access to grain. (c) Lower right: rhumbu built as part of house wall (protection against intruders).

and an opening is left for withdrawal of the maize for consumption and sometimes for sale (Fig. 6b). The rhumbu is sometimes attached to the wall of the family house (Fig. 6c). This is done as a security measure against intruders and theft of the grain. This type of storage is still attached by insects as reported by 50% of the farmers, rates (37.5%), and fungi (12.5%) (Table 2).

There is also a maize storage structure similar to the rhumbu known as the oba which is used by 12.0% of the farmers in the Southern Guinea Savanna. This structure is made out of woven grass (Fig. 7a) or of dry sorghum stalks (Fig. 7b) elevated on tree stumps. Two or more different types of crops such as sorghum and millet are usually also stored in their structure. Forty per cent of the farmers reported having storage problems caused by insects and mice while 20% reported observing problems caused by fungi (Table 2).

Farmer perception about storage pests has the same trend across storage systems, and agro-ecological zones. Farmers perceive problems of insects and rodents more often than fungi (Table 2). Only in the Humid Forest zone and in the Mid-Altitude, when grain is stored in bags, were storage fungi of more concern.

Table 2. Problems identified by respondents for each storage system in the agro-ecological zones.

Type of storage	Problems reported	Respondents (%)				
		HF[a]	SGS	NGS	SS	MA
In synthetic fertiliser bags	Insects	43.7	37.8	34.4	44.4	22.2
	Mice/rats	18.8	40.5	46.9	51.9	44.5
	Fungi	37.5	21.7	3.2	3.7	33.3
	Termites	–	–	12.5	–	–
On a raised platform on the farm	Insects	66.7	–	–	–	50.0
	Mice/rats	22.2	–	–	–	50.0
	Fungi	11.1	–	–	–	–
Over the fire-place	Insects	33.3	20.0	–	–	–
	Mice/rats	66.7	60.0	–	–	–
	Fungi		–	20.0	–	–
In a constructed crib	Insects	–	33.3	–	–	–
	Mice/rats	–	33.3	–	–	–
	Fungi		–	33.4	–	–
On the ceiling	Insects	66.7	50.0	–	–	–
	Mice/rats	–	50.0	–	–	–
	Fungi		33.3	–	–	–
In a clay pot	Insects	33.7	–	–	–	–
	Mice/rats	66.7	–	–	–	–
	Fungi		–	–	–	–
In a rhumbu	Insects	–	50.0	33.3	50.0	40.0
	Mice/rats	–	37.5	66.7	50.0	40.0
	Fungi	–	12.5		–	20.0
In an oba	Insects	–	40.0	–	–	–
	Mice/rats	–	40.0	–	–	–
	Fungi		–	20.0	–	–
In bottles	Insects	50.0	–	–	–	–
	Mice/rats	50.0	–	–	–	–
In baskets	Insects	50.0	–	–	–	–
	Mice/rats	50.0	–	–	–	–
On a bare floor	Insects	–	50.0	–	–	–
	Mice/rats	100.0	50.0	–	–	–
In a drum	Mice/rats	100.0	–	–	–	–
On a tree	Insects	100.0	–	–	–	–
In a sunny room	Insects	100.0	–	–	–	100.0

[a]HF = Humid Forest, SGS = Southern Guinea Savanna, NGS = Northern Guinea Savanna, SS = Sudan Savanna, MA = Mid-Altitude

In view of the various storage problems being mentioned by farmers, data were also collected on practices used to protect maize grains. The type of pest control treatments used in each of the agro-ecological zones is shown in Table 3. It was observed that 53.8% of the farmers in the Humid Forest zone, 52.0% in the Southern Guinea Savanna zone, 12.1% in the Northern Guinea Savanna, 35.5% in the Sudan Savanna and 42.3% in the Mid-Altitude zones did not use any treatment for their maize while in storage (Table 3). Only 20%, 24.2%, 9.7% and 19.2% of the farmers in the Southern Guinea Savanna, Northern Guinea Savanna, Sudan Savanna and the Mid-Altitude zones respectively used pirimiphosmethyl (actellic) which is the recommended insecticide for use with grains. The farmers reported that actellic and other recommended chemicals were not always available. The highest incidence of the use of actellic (24.2%) was observed in the Northern Guinea Savanna. The resultant effect of the unavailability of this storage chemical is that farmers resort to the use of other chemicals such as aldrex, gastosin, etc. which are not recommended for produce stored for consumption. It was quite alarming to observe that 22.6% of the farmers in the Sudan Savanna still use aldrex.

Apart from unavailability of the appropriate chemical, adesida (1983) reported that other factors which might affect misuse of chemicals are unawareness, high cost of the recommended chemicals and extension agents sometimes recommending wrong ones. She also reported that except in the Humid Forest zone where chemical companies made recommendations to users as regards the use of appropriate chemicals, in all the other zones there was no such dissemination of information. This could be partly responsible for the wrong use of aldrex in the Sudan Savanna.

Table 3. Control measures applied.

Treatments applied	% of respondents adopting the measures applied				
	HF[a]	SGS	NGS	SS	MA
Physical					
Smoke	11.6	12.0	6.1	3.2	11.5
Ash	11.6	12.0	42.5	22.6	11.5
Local plant leaves	–	–	–	3.2	7.9
Use of chemicals					
Actellic dust	–	20.0	24.2	9.7	19.2
Gammalin	7.7	–	6.1	–	3.8
Aldrex 20	3.8	–	9.0	22.6	–
Gastosin	–	4.0	–	3.2	–
Disinfectant	–	–	–	–	3.8
No treatment	53.8	52.0	12.1	35.5	42.3

[a]HF = Humid Forest, SGS = Southern Guinea Savanna, NGS = Northern Guinea Savanna, SS = Sudan Savanna, MA = Mid-Altitude

Fig. 7. (a) Left: oba constructed from woven grass/palm fronds, supported on tree stumps. (b) Right: oba constructed with dry sorghum stalks.

Spraying of the cobs with ash and pepper, smoking the storage structure and use of leaves of local plants were the most common methods employed by farmers to combat storage problems. In the use of ash and pepper, the pepper is ground very finely and the ash mixed with it then a small quantity of water is added and the mixture is then sprayed/-sprinkled over the maize cobs. This type of storage treatment is believed by farmers to be very effective against rats and other rodents. The leaves of certain local plants, e.g. bitter leaf (*Vernonia amygdalina* Delile.), are usually placed in alternate layers of the corn with a final covering layer over the cobs. The leaves are changed periodically when they are dried. The farmers believe the leaves contain compounds which are harmful to insects and rats.

Conclusion and Recommendations

Although the crib has been suggested as being the most practical method of storing maize, farmers are still not eager to accept the method because they believe it is not cost effective to construct one. This is usually the reason given by small-scale farmers in the Humid Forest zone. Work needs to be done to determine the efficacy of the traditional systems of storage used by the farmers and on the socioeconomic implications of changing the systems. In addition, efforts should be geared towards ensuring that farmers have access to the recommended chemicals at an affordable price and the chemical companies could also extend dissemination of information on the use of their storage chemicals to all of the agro-ecological zones in the country.

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