Assessment of Indigenous Knowledge Strategies on Post Harvest Food Crops Storage in Belo Sub Division

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Abstract: **Much food crops are cultivated in rural areas but farmers still suffer from food shortages due to increasing post-harvest losses. This is as a result of insufficient and or absent of conventional food processing, preservation and storage facilities. This has led to increasing and alternatively use of indigenous knowledge (IK) strategies for food crop preservation and storage. However, this research meant to enumerates the different food crops varieties and the distinct IKs strategies applied on post-harvest food crops, difficulties and the way forward. The study sampled nine out of the nineteen villages that make up Belo Sub Division. A three-stage sampling techniques were employed: purposive sampling in other to select the study villages and random and snowball sampling methods to equally arrive at the sample size of 150 and also ensure that respondents with exemplified IKs characteristics were identified and included in the study. Questionnaires, focus groups, interviews, and field observations were employed for data collection and the data was further analysed using Excel to transform it into tables and photos were equally taken to portrays the field reality. The results shows that a total of twenty-four different types of IKs in food storage were identified, ten to prevent weevils, five in preventing mould and rotting, four in maintaining freshness and five to prevent rodents, with the main preservation and storage facility being *ikaŋ*. Despite the available IKs, farmers still suffer enormous losses of food crops ranging from 20 to 43% due to limited space, limited storage facilities and above all limited fuel wood. We therefore recommend the integration of IKs with scientific knowledge of post harvest management and training, and provision of integrated post-harvest management facilities in the study area.**

Keywords: **IKs strategies, Food crops, Food storage, Belo Subdivision**

I. INTRODUCTION

Africa is faced with dire food security challenge despite the fact that she remains the continent with greater arable land to feed it growing population and beyond, yet the continent remain the most impoverished in food security [1]. The continent was left behind during the green revolution and the average crop yield per acre in many African countries remaining far below that in Asia or the West [2]. Food security have remain a major concern in developing countries and requires urgent attention and collaborative effort from all stakeholders [2]. As the human population continues to increase, the demand for food becomes far greater than the supply can meet. There is a need to cultivate more indigenous food crops and to diversify into new products by using processing and preservation techniques to ensure that more people have access to good quality, nutritious foods [2]. According [3], the agricultural sector as the mainstay of most African economies accounts for about 60% of the total labour force, 20% of the total exports and 17% of the GDP and provide livelihoods to over 70% of the population and still, Africa spends between US$15 and 20,000 million on food imports annually, in addition to the US$2,000 million it receives in food aid annually. To [1], nearly 240 million people in sub-Saharan Africa lack adequate food for a healthy and active life and Africa is blessed with various types of food produce and also possesses diverse indigenous knowledge systems for their preservation and storage.

Cameroon regarded as Africa in miniature produces a variety of food crops for export and for domestic consumption viz: millet, sorghum, groundnuts, plantains, sweet potatoes, maize, potatoes, beans, cocoyams and cassava, yams, soybeans, and rice [4]. Despite these varieties of food crops cultivated, approximately 615,000 people are food insecure in the North and Far North regions, about 173,000 Littoral region compared to about 86, 000 in Yaounde and 77, 000 in other regional capitals [5]. This is partly associated with absent or inadequate processing, preservation and storage facilities and poor road infrastructure in rural areas to aid shield-life extension of food crops and the transportation of the available food crops to towns with minimal damages. This has led to post harvest loses and increasing use of indigenous knowledge strategies for food crop processing, preservation, and storage in rural areas of Cameroon. According to [6], Indigenous knowledge is the knowledge that people in a given community have developed over time and continues to develop which is the basis for local-level decision-making in

agriculture, health care, food preparation, education, and natural resource management. According to [7], these technique adopted for agricultural practices are locally acquired knowledge accumulated from past experiences, inherited and passed on to successive generations along the succession line.

In the North West region of Cameroon, especially in Belo Sub Division, a variety of food crop are produced and indigenous knowledge (IKs) practices are the bedrock of post-harvest management which alone does not guaranteed large scale extension of food storage. Farmers suffer enormous losses both in quality and quantity since they do not have a good technology for processing, preserving and storing these food crops couple with the fact that the same house use in storing yields is at the same time use for cooking and sleeping. In view with [8], the standard of living in rural communities depends not only on the range of food grown and the capacity to grow in large quantities but also on the facilities for efficient handling, drying, and storage and since their indigenous methods alone cannot permit them to store large quantities of food for a length of time, they are prone to produce below their required capacities. Sometimes farmers are force to remove what is in their granaries and sell even when prices are low because they want to free space for new harvest. Most food production villages are located either in the valleys or in mountainous areas and at the heart of the rainy seasons, accessibility to market centres becomes challenging due to poor roads network. This further increases post-harvest loses as they are unable to process, preserve, store or take it to the market. Therefore, using IKs in improving food security therefore remains the main focus of this research work

1.1 Study area

Belo sub division is located 50km away from the regional headquarter, Bamenda. It is the gateway administrative sub division into Boyo Division. It is located between latitude $6^{\circ}12`0"$ and $6^{\circ}20`0"$ North of the equator and longitude $10^{\circ}1^{"}$ and $10^{\circ}27^{"}$ East of the Green Witch Meridian (fig 1). Belo sub division covers a total surface area of about 46,068Km^2 and a total population of over 40,757 inhabitants unevenly distributed in both the hills and valleys [9]. Besides the human landscape, lies a multitudes of projected highlands whose relief intensity reduces south-eastward from Anyajua down to the Mejang valley with prominent streams and river courses such as river Mughom, Mufua and Mejang, taking their rise all at the Ijim mountain forest. These heterogeneous landscape only helps to exacerbate post-harvest losses.

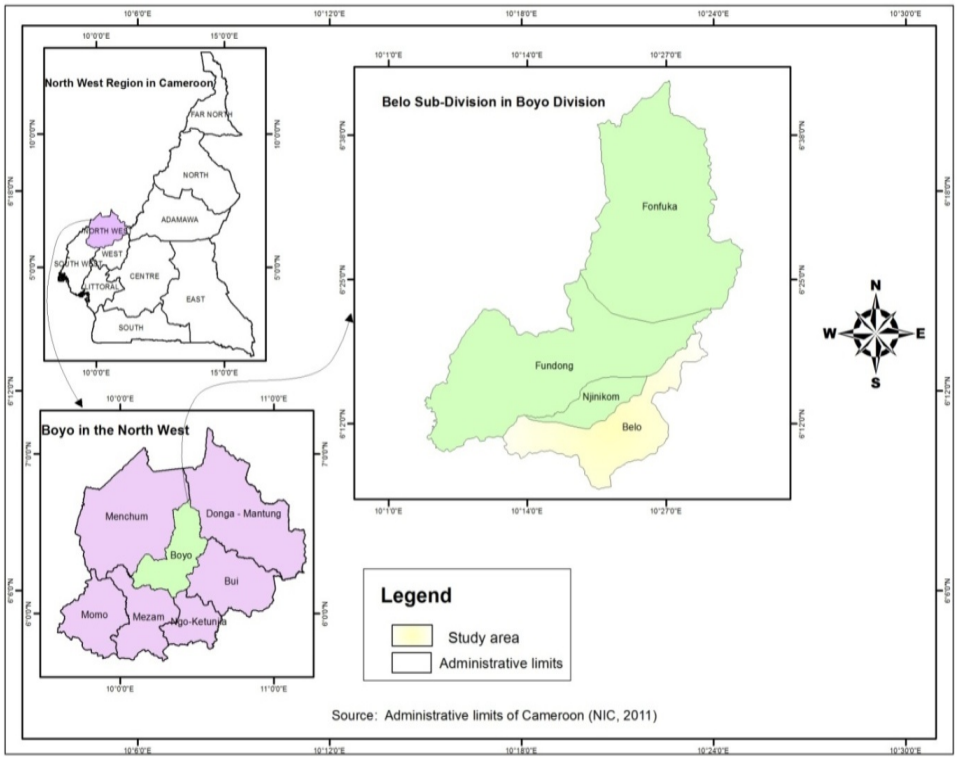

Figure1: location of Belo Sub Division

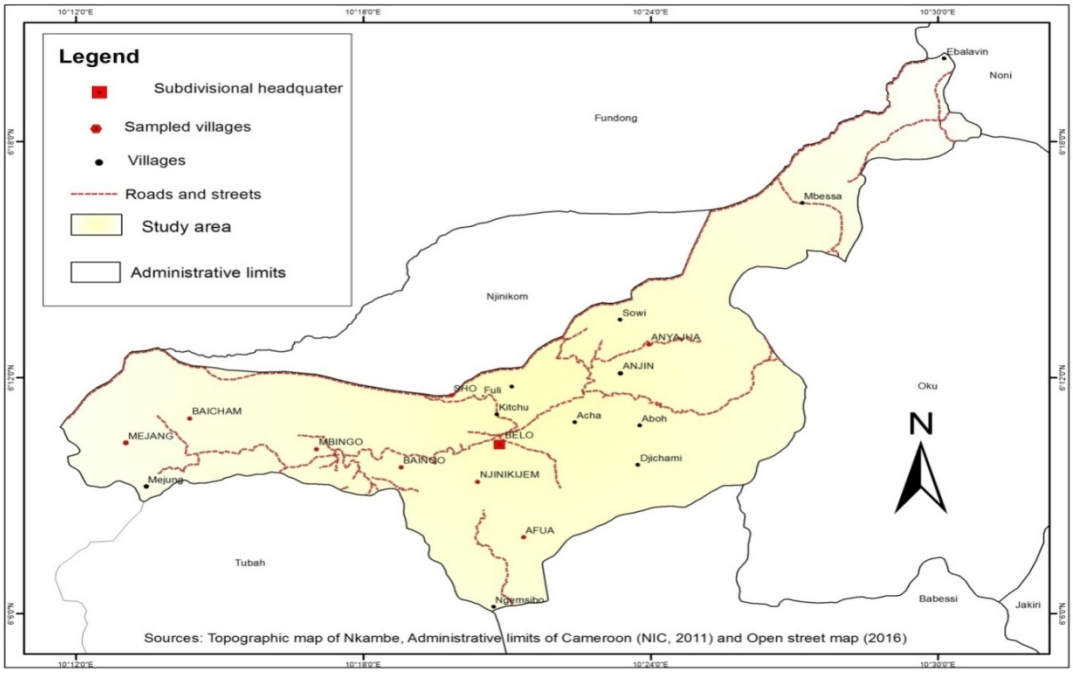

Figure 2: distribution of the study villages in Belo Sub Division

1.2 Materials and Methods

The target population was made up of food crop producers within the active age group alongside the older persons. The study employs a three-fold sampling approach viz: two preliminaries field visits were made and contacts collected to further identify the main farming villages and the types of indigenous food crop preservations practice, a purposive sampling technique was use to select nine villages (Mejang, Afua, Mbingo, Baingo, Sho, Anyajua, Anjin, Njinikejem and Baicham) due to their involvement in food crop production and the presence of seasonal roads, and 150 semi structured and structured questionnaires were randomly chosen and administered randomly from a base population of 13839 inhabitants; census results by [9] in the study area. The retained and analyzed questionnaires gave a proportion of 27.6% men and 72.4% women. Further inquiries were acquired through focus group discussions (FGDs) and key informant interviews with village chiefs and agricultural extension workers. IKs is self acquired and inherited experiences of indigenes which are transferred to successive generations [7]. As such, focus group participants were purposively chosen amongst men and with ages raging from 35 years and above with a believe that they have well grown up knowledge in IKs. Statistical analyses was done with the help of excel version 2010 while open questionnaires were sorted and analyzed manually and cartographic work to carve out the study area was with QGIS version 2.18.

II. RESULT AND DISCUSSION

2.1. Typology of food crops produce in the study area

The variety of food crops cultivated and preserve by the indigenous farmers are varied and many (table 1).

Table 1: Different types of food crops produce in the study area.

Category	Common Names	Scientific Names
Food Crops	Cassava	*manih esculenta*
	Coco yams	*xanthosoma sp*
	Peanuts	*apios tuberosa*
	Groundnuts	*arachis hypogaea*
	Maize	*zea mays*
	White yam	*dioscorea alata*
	Beans	*phaseolus lunatus*
	Potatoes	*solanum tuberosum*
	Guinea corn	*sorghum bicolor*
	Soya beans	*glycine max*
	Pumpkin seeds	*cucurbita maxima*
	Rice	*oryza sativa*
	Sweet potatoes	*Ipomoea batatas*
Vegetables	Pumpkins	*Cucurbita maxima*
	Okra	*Ablmoschus esculentus*
	Huckleberry	*Pyrus*
	Cowpea	*Vigna unguiculata*
	bitter leaf	*Vernonia amygdalina*

Source: Fieldwork (2016); and [11]

These variety of food crops species according to key informant discussions, are cultivated in multiple geographical landscape. Crops such as rice are cultivated uniquely in the Mejang and Baicham Valleys while potatoes are largely favoured by the gentle and cold slopes of Afua, Anjin and Anyajua.

From the field inquiries, the IKs strategies were identified and classified in four categories: preventing weevils attack, preventing mould and rotting, preventing destruction caused by rats and maintaining freshness of harvest.

2.2. Indigenous knowledge strategies of preventing weevils in post harvest food crops

2.2.1. Corn

Corn which is a staple food crop in this locality is grown, preserve and stored indigenously almost by all households. This crop is preserved and stored indigenously using two methods; firstly, *ikaŋ* (kitchen shelves above the fireplace) and secondly on hung bamboos. The *ikaŋ* is usually swept with the use of an old broom and smoked by burning leaves of insecticidal plant such as baster-perdepis (*Clausena anisata*) locally called *fibòm* before newly harvested maize are kept. During the smoking process, all windows and doors are close. This is to make sure that the smoke filters into all the corners of the *ikaŋ*. The smell of the smoke helps to either kill or repels the weevils (*Prostephanus truncates* and *Sitophilus granarius*) present in the *ikaŋ*. One week after, the corn is harvested and place on the *ikaŋ* after keeping some of this insecticidal leaves on the floor of the *ikaŋ* and on gabble walls. At this level, some additional kinds of insecticidal plants are added. These are Eucalyptus leaves (*Eucaryptus globu*) and Crab wood leaves *(Carapa guianensis*) locally called *ivɨyn*. These different repellents are applied in order to kill or stop the action of the weevils which might have been brought alongside crop yields from the farms especially stalk borer or caterpillar (*Busseola fusca*) and equally to prevent further infestation. It should be noted that smaller sized corn and open heads corn are usually peeled and kept directly over the fireside in the houses or sun- dried on elevated platforms or using thatched mats. This is for it to get dry faster so that they can start preparing it as corn-fufu. This is slightly in accordance with [10]**,** which pointed out that majority of the households in Mukungwe sub-county in Nigeria store their food in Granary, others keep their food in locally made sacks, kitchen shelves above the fireplace, in pots and or baskets in order to prevent weevils.

Besides, raffia bamboos or Indian bamboos are hung under the *ikaŋ* (indoors) or hung closer to the gable wall (outdoors) using fabric ropes from the bark of immature raffia bamboos. To this effects, larger corn cobs with shorter heads are selected, fasten at the base and hung on the bamboos while those with long heads are fastened at the heads before hanging them. According to household respondents and further confirmation by the researcher after a kin observation affirms that corn fastened at the upper ends take a longer time to weevil than those fastened at the base. This is because fastening corn cobs at upper ends reduces the rate of air circulation within the cobs. Plate :1 presents corn cobs in a smoke house fastened at the base and that which is fastened at the upper ends. These methods of storing corn cobs are familiar with villages such as Mejang, Baicham, Mbingo, Baingo and Sho where are varied with seasons, rainy season (24^{o}c- 25^{o}c) and dry season (25^{o}c- 30^{o}c) [11].

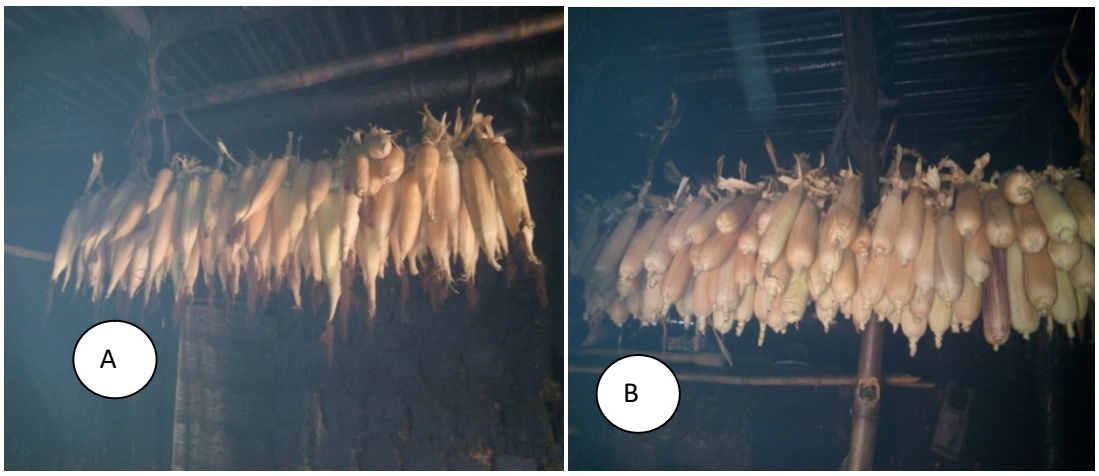

Plate 1: Hung corn cobs fasten at the base (A) and at the upper end (B) in a smoke kitchen in-door

Spatially, in cold villages like Anjin and Anyajua, respondents through focus group discusions argured out that corn cobs are completely peeled, fastened and hung on bamboos at the veranda of houses to be air-dried (photo: 1). This is because the variety of corn cultivated here takes a longer time before it matures and due to this, rain water uaually starts infiltrated into corn still in the field before harvesting is been programed. Drying and storing this corn in *ikaŋ* with inadequate firewood to produce enough heat will easily lead to mould attack. Only smaller corn and those that can not be fastened are kept at *ikaŋ* while using the same insecticidal plant's leaves as the foregoing especially baster-perdepis because it availability. In

the other hand, bee hives traditionally made with raffia bamboos are also used in this area to store corn.

Photo 1: Peeled corn cobs hung on bamboo out- door

2.2.2. Beans

Equally, beans cultivation is another most inportant food crop grown in the study area reffers locally to them as "*brown goal*". It is cultivated in large quantities mostly in moderate and cool areas of Anyajua, Ajin and Afua. When harvested in the rainy season from May to July, it is either preserve indigenously along side its stalks in *ikaŋ* or hung on bamboos and rafters both in-doors and out-doors for a month or a little over. This is for it to get dried before threshing (photo :2). Drying it this way is because of limited hours of sun shine and high rainfall intensity between july and august. At times it is peeled manually before drying off. When the beans in *ikaŋ* is properly dried or when corn harvesting period is near, it will be removed, threshed and stored in fibre bags (bags woved with threads from raffia bamboo leaflets and offers mostly to mother-in-laws during traditional marriages). To some with limited access to these bags, the thrashed beens are spread on thatched mats on floors for it to get dry under the conditions of the room temperatures.

Photo 2: Beans hung with stalks on a bamboo

Results shows that 11.54% of the farmers are using insecticidal plant (baster-perdepis) leaves to store their beans by inserting the fresh leaves in fibre bags or woven baskets containing the beans and 7.69% of the farmers are mixing their beans seeds with ground pepper while 26.92% of the farmers prefer putting their beans in fibre bags and keeping it on a cool dried place in the house or spreading it on cool-dried floors on mats and sun after every month. Also, the results further shows that 3.85% of the farmers insert peeled garlic in their beans for its smell to repeled weevils during storage period and replacing it every after one months when the smell must have expired meanwhile 7.69% rubbed their beans with red oil (half a litre of red oil for a bag of beans equivalent to 50-60 kilograms) and sun- drying for two days before storing as they indigenes believes that palm oil contains a chemical that is not absorbed by weevils. Beans seeds were stored by 7.69% of the farmers by mixing wood ash (burning the beans peeling and using the ash) in their beans before storing while 34.62% of the farmers grow beans in small quantities and thus had no specific storing method.

2.2.3. Guinea corn

This is one of the food crop highly valued in the studied community. It is used in performing most traditional rites. It is usually process as traditional corn beer localy called *mecall* and store in a calabash (*mboh* in kom language) and

clay pots. In other to store this food crop indigenously for a long duration without weevil's attack, farmers harvest it when properly matured. It is sun-dried and stored in woven baskets kept at one corner of the *ikaŋ*. When threshed, the seeds are seperated from the grains and kept for processing. The remaining grains kept for consumption are superficially fried in order to prevent it from weevils attack. The seed are put in fibre bags and hung on ropes attached to *ikaŋ* to maximise space and and void equally of rats destruction.

2.2.4. Groundnut and soya beans

These food crops are cultivated mostly in villages like Baicham, Mejang, Mbingo, Bingo, Njinikejem and Sho. Harvest from groundnut are mostly sold fresh because of high demand and only the seeds are being preserved. In order to store the seeds, they are sun-dried or dried on *ikaŋ*, put in fibre bags and hung on ropes under *ikaŋ*. They farmers also store it in woven baskets and clay pots and their main problem storing this crop is the destuction cause by rats and even little children in the house. Soya beans is stored indigenously like groundnut but only that in the rainy season, seeds are fasten with stalks and hung on bamboos either indoors or outdoors.

2.2.5. Pumpkin seed

From the field results, 76.92% of the farmers are producing egusi (pumpkin seeds) and the indigenous method of preserving it is unique to the study area. In order to store this crop for a reasonable period of time, the pumpkin fruits are cut into two halve, the seedlings are remove and mix with wood ash and wash a day after and these seedlings are usually removed while they are still slippery so that the acid from the wood ash should stick to it. The pumpkin seeds are sun-dried for atleast four days before storing. With this, the pumpkin seeds are believed to be having a waterproof-skin and can be stored for more than a year without any mould or weevil attack. It is stored indigenously in a dried pumpkin-fruit-versel locally known as *antrung* (calabash) in kom and kept in one corner at *ikaŋ,isi*, and *nguôh*. The *antrung* is gotten from a well mature pumpkin fruit, dried for a given period of time and is screpted at the head to have a small opening where grains and seedlings can be send in to the versel (plate: 2). The antrung are sometimes smoked deliberately to further expels weevils boring throuh it.

Plate 2: A= Sample pumpkin seeds remove from *antrung,* B= smoke calabash with cocked pumpkin seeds

2.2.6. Rice

In this sub division, rice (upland rice) is cultivated by 23% of the farmers in relatively warm areas like Mejang and Baicham. When harvested, it is being threshed, sun- dried for about a two weeks, winnored and put in fibre bags and woven baskets and stored in cool dried places for atleast one year for it to become stiffen so that during holling it will not be breaking. Prevention of weevil against this crop is by making sure that it is properly dried and also storing it in a dried place.

2.2.7. Sweet potatoes

This is one of the food crop that is grown in all the nine sampled villages. It does extreamly well in all villages and under all the varied climatic conditions. Information from the household respondents revealed that in order to prevent weevils from attacking tubers, they harvest it when it is properly matured.This was not the same thing in Mejang, Baicham and Mbingo where the farmers explains that this crop usually start to weevil only in the farm if allow to properly matured due to the approachment of the dry season that provides favourable conditions for ground insects to trive on. For this reason, they carried out timely harvestng but indigenously the storing method in all these villages remains unique and the same. To some, a hole is dugged under a tree in the farm or near the home gadern and Wood ash is sprinkled on the floor and the walls of the dug hole and dry banana *(Musca spp*) leaves spread on it. The harvested sweet potatoes are filled to a half level of the hole and wood ash sprinkle on it again. After, the hole become commpletely

filled the sweet potatoes and wood ash is again sprinkled on it top. At this stage, dried banana leaves or dried vetiver grass are used to cover the hole followed by dried banana stems. With this the potatoes can be stored for four-six months without spoilage. It should be noted that the size of the hole and quantity of wood ash depends on the quantity of the sweet potatoes and also that vetiver and dried banana leaves are used because they do not easily decay and more to that their smell repel insects. This disagrees with [10] observation in Mukungwe Sub- County in Nigeria that farmers bury fresh food like yams and sweet potatoes in moistened soil so that it last for five to seven days. As in the study area, the method of preservation is slightly different while the duration of storage can last for up to six month.

2.3. Indigenous strategies of preventing mould and rotting on food crops

2.3.1. Preservation of grains

Generally, most farmers practise timely harvesting especially in maize and other grain in order to prevent rain water contaminating them in the field. They believed that mould attack starts in when the crops are still in the farm. When these grain crops are harvested and transported back at home and kept at *ikaŋ*, the fire is arrange normally but steadily for one to two weeks before increasing the intensity of the heat until they yields are dried. According to them, if the intensity of the fire is high for the first weeks, it will instead cook the crops or make them to start fermenting especially those harvested with particles of water on it pealings as this will stimulate mould attack. The heat from fire and sun- drying are the main ways they used to prevent mould attack on grain food crops. Equally, when produce are kept on *ikaŋ*, there is frequent stiring so that all the surfaces can be expose to the heat equally.

2.3.2. Preservation of yams

In order to prevent rotting in potatoes, there is continues turning weekly any where they are kept. Yams *(Dioscorea spp*) for storage are carefully harvested when properly matured and kept on space planks or sticks placed close to each other horrizontally on the floor and the yams thrown over it for preservation. The yams are kept on these while allowing spoted spaces within them. They allowed spaces are to ensure free circulation of air between the yams in order to prevent decaying. If in the process of harvesting the yams they were injured, they sprinkled wood ash on the spots before storing. This wood ash acts as a fungicide preventing the growth of mould on these damage areas. In the other hand, crops like cocoyams and taro *(Xanthosoma sp* and *Colocasia esculenta*) are stored in arrange- dugged holes just like sweet potatoes above. One unique thing with this crop is that it is carefully harvested without detatchement of the smaller ones and just partially removing the dirts on it in order to avoid bruises. Also it is stored on planks indoors and on veranda of houses making sure that the storing places are not too cold or too hot or else they will start rotting, germinating or drying.

2.3.3. preservation of vegetable crops (Okra, Bitterleaf and cowpea)

Okra *(Abelmoschus esculentus*) which is mostly eaten with pounded cocoyams is chopped into pieces and sun-dried, pounded in a wooden mortar using a wooden pistle and stored in *antrung* for future consumption. Cowpea (*Vigna unguiculata*) and bitterleaf (*Vernonia amygdalina*) are parboiled, sun-dried and stored in *ifuh* (small-woven baskets hung at *isi* above the fireside) and also in *antrung* in order to maintain the nutritional value, flavour and to equally prevent the growth of mould. This is in line with the study of [12] in Tsitas Nek and Mabeskraal Village which finds out that vegetables like *morogo wa, dinawa, theepe, tenane, rothwe* and cowpea were cooked, crushed, sun-dried and stored in bags or in clay pots in order to control pest and the build-up of mould.

2.3.4. Potatoes

Potato is one of the cash crop that is given an upperhand now in this sub division because it gets mature ealier compared to other crops thus reducing farmers' lengthy period- food needs. This crop is produce largely in Anjin and Anyajua and farmers in these villages complained that they are unable to store the new varieties (MODIAL, SPRUNTA and CIPIRA) indigenously. This is because these new varieties easily get rotten during preservation eventhough they are high yielding thus causing the farmers to be selling the crops at give-away prices immediately after harvest. Results show that farmers are highly involved in potatoes production and according to these farmers, potatoes intended for long time preservation is harvested when properly matured and the leaves and the stem withered, that is atleast three and a half months. At home they are spread on the sun for two to three hours so that the humid patches found on them can dry soil particles fall off and also for the surface layer to thicken and get rid of mechanical injuries. During this process, the potatoes with buises are removed and the good ones spread in dark rooms on cool- dried floors (photo: 3) in order to prevent them becoming greenish in colour.The potatoes are being turned weekly while removing shoots on them and the rotten ones in order to prevent further rotting and germination meanwhile 7.69% of the farmers store their potatoes on the second *ikaŋ* locally call *ikaŋ abeh (*kitchen shelve close to the roof: at first, houses were constructed with two kitchen shelves ,the first one where things are stored temporally and the second one for long term storage). In order to do this, they spread dried banana leaves on the *ikaŋ* and after they cover the leaves with dried soil or with wood shaving and then keep the potatoes on it. This was to prevent the heat from the fireside from reaching the stored crops, to keep the house warm since they spread leaves,soil or wood shavings block the heat from escaping to the surroundings and to facilitate the preservation of food crops on the first shelve.

Photo 3: Potatoes stored by spreading on the floor

2.4. Indigenous methods of preventing of rodents

Information from households and key informant, the availabilty of rats in area seems not to be good news to them. Rats are farmers' main problem to food preservation and storage because they consume every food stuff compared to those destroyed by weevils where their left over can still be used or sells as feed to animals breeders.

Table 2: Types of indigenous knowledge in rodent preventions

Types of IK in preventing roddents	Frequency	Percentage (%)
Clay pots	23	15.3
Antrung	21	14
Cats and dogs	62	41.3
Poisonous plants	39	26
Natural glue	5	3.4
Total	150	100.0

From table 2, it mayby adduced that 15.3% of the farmers are storing their produce in clay pots when they are properly dried in *ikaŋ* and hung bamboo in order to prevent them from rats. It should be noted that these clay pots were formally used for cooking and had the following inconviencies; very heavy to uplift, requires a lot of heat before it can starts boiling and therefore much firewood was needed to cook with it couple with the time taken to cook. The adoption of the alluminium pots which are efficient for this purpose has altered the initial motive of these clay pots as a cooking facility to a storage facility by the rural farmers. These clay pots are usually covered with a lid locally called *limih* (plate; 3). *Antrung* kept at one corner of the *ikaŋ* or *nguoh* are used by 14% of the farmers to store their dried produce like egusi, groundnut, soya beans and corn seeds because their outer surfaces are slippery and rats can not climb or burst a hole on them.

Plate 3: Closed and opened clay pots

Also, farmers had developed their own indigenous ways of catching rats by tying or fastening a rope at the smaller end of the *antrung* containing stored food and passing it through a haft calabash cut in the form of a funnel. The rope with the antrung and the funnel- shaped calabash are hung under the *ikaŋ* while keeping an opened bucket of water directly under where the jars are hung. Due to the scent of the stored food in the calabash, rats will be following the hung rope to the *antrung* and when they reach the haft-funnel- shaped calabash, there will be no way for them to pass. As they are struggling to pass this haft calabash, they will end up sliding and falling in to the bucket of water kept under the calabash and are left with nothing else rather than drowning. This is done especially when there are not more crumbs of iddle food stuffs in the house or when all the food stuffs in the house are well secured. In villages like Anjin and Anyajua where peeled corn is usually hung on raffia and indian bamboos, the farmers passed the ropes which these bamboos are hung-on through half calabash 40 (forty) centimters form the bamboos. This is to prevent rats having access to the peeled corn (photo: 4).

Photo 4 : half calabash and a flat object use in preventing rat passages

Further inquiries have also shown that farmers use natural glue locally called *ndwam* (in kom language) to trap rats. This natural glue which is a sticky substance extracted from plants is spread on flat stones or pieces of flat wood and at the middle of it, they placed a grain of groundnut, corn or dried fish. The stones or the pieces of wood are position at the corners of the house and at popular tracks frequented by rats at *ikaŋ.* Then, rats trying to get to the middle of these objects to eat what ever is placed there, get adhered to this glue and they are being removed and killed manually by houesholds.

Poisonous plants like cactus and spear thistle (plate: 4) are also used to control rats from destroying stored food crops. Cactus (*Cereus hildmannianus*) locally called *alaɨn* is chopped into smaller pieces and sun-dried. It is then pounded in a mortal until it becomes fine-powder. This powder is used as rat poison by mixing a tea-spoon of it with a tea-spoon of corn floor or ground fish and kept for rats to feeds on. Spear thistle *(Cirsium vulgare)* locally called *mɨnjîmɨ chwokû* (kom language) is a thorny wings plant found mostly in hilly areas. Matured- dried ones are carefully cut and spread round and even on baskets and bags of food stuffs. Information from focus groups reveals that If the poisonous and sharp pointed thorns on these plant pierce a rat, it will urinate immidiately, thus, its appelation, *mɨnjîmɨ chwokû* (rat's urine). This poisonous plant therefore scares away rats from stored produce. The use of plants to control rat is similar to the study of [13] in Mua Hill which stated that farmers crash a mixture of lantana sp (*Camara vulgaris*) and Tithonia (*Tithonia diversifolia*) leaves into powder and then mix it with seeds to control pests and rats.

Plate 4: Cactus sp (*Cereus hildmannianus*)

Spear thistle (*Circium vulgare*)

The farmers in this sub division also carry out biological control method by using cats and dogs to control rodents. The results show that 41.33% of the farmers had cats in their homes which help them in catching rats. Those who had farm houses like in Mejang and in Baicham, had dogs in order to control rat moulds. Other farmers said their own way of controlling rodents is by keeping their surroundings clean, that is clearing their surroundings since these rodents are from the nearby bushes. They believed that killing the ones in the house without cleaning the surrounds will not help since the rats will still be leaving the bush and entering the house as there is common saying that *"it is only the rat in the house that will tell the one in the bush that there is food in the house"*. These results are in comfirmity with a similar study conducted in Mua Hill, Eastern Kenya by [13] in which the researcher found out that cats were used to protect stored maize against rats and dogs to guide the homes.

2.5. Indigenous methods of maintaining crop freshness

The results show that freshness in some harvested crops like cassava roots (*Manihot esculenta*) are maintained indigenously in this sub division in two ways;- burring in wet –dug– holes and storing under water. The farmers especially in Mejang, Baicham and Mbingo where cassava is mostly grown said they harvest their cassava a few centimeters away from the tubers if they want to use it few days after harvesting. When transported back home, it is stored in wet-dugged-holes under trees and with this the unpeeled cassava can be stored for 4-7 days with the freshness maintained. In the dry season, cassava tubers that are harvested not to be used immediately, are put in sacks unpeeled and kept under water at the banks of rivers and streams and with this it can stay for 2 weeks before it gets darkend. When the tubers are removed, they are peeled, soaked in clean water for 4-6 days, after the cassava is seperated from the fibres, squeeze to drain out the water in it. At this end, it is sun-dried and store in sacks as *cumcum*. Some farmers prefer gratering theirs and frying as garri before storing, while others, grater their own, fry as *macra* or cooked and store as *meniodong*, meanwhile others store theirs as waterfufu.

Underground storage (unharvested food crops) is equally practised by the rural farmers. These farmers delayed in the harvesting of crops likes cocoyams, cassava roots and potatoes until when the crops are required or when conditions of storing them are out of hand. This deleberate delayance is as a result of limited space and storage facilities, low market prices and poor road network especially in the harvesting season. Justifiation by farmers shows that they are divided in their view points as others holds that it delays the planting in the next croping season on that same piece of landwhile others wholes into it that the stored crops are sometimes stolen.

2.6. Difficulties farmers encountered using indigenous knowledge

Majority of the farmers (60%) said and it was further confirmed through field observation that they have a problem of limited space since houses are constructed nowadays only with one *ikaŋ (kitchen shelve above the fireplace)* and some without the *ikaŋ*. It should be noted that from the earl 1920 up till 1990s, houses in this Sub Division and the entire division were constructed with two *ikaŋ* (double barn) since it was their main storage facility but today, because of the increasing population, most of the forests (both natural and man made) have being cut down for constructions and agricultural purpses thus limiting the raw materials for the construction of this *ikaŋ* thereby leading to insufficient storage space. The *ikaŋ* and hung bamboos are usually used for storing corn, beans, soya beans, and potatoes in the entire Sub Division.

In villages like Sho and Njinikejem which are found in concentrated areas, farmers had a problem of limited access to fuelwood in addition to that of space. In order to have sufficient firewood to dry their produce, they have to trek for far distances. Those that had money purchase their firewood while those with limited finances, man power and time end up using firewood from mango tree (*Mangifera indica*) since it is easily accessible but not recommended for corn drying. This is further confirm by 20% of farmers who asserted that corn dried using firewood from mangoes weeviled earlier than corn dried using firewood from other tree species.

In the rainy season, especially in the months of June, July and August, where the people can go for three-seven days and some times for weeks without sunshine, produce like fresh beans and egusi end up rotting in barns or partially dried and can not be stored for a long duration. In Anjin and Anyajua, where beans and peeled corn are mostly stored on hung bamboos on veranda of houses, one farmer lamented: *we used to hang our produce outdoors without any problem but these recent years, stealing is at the rise. Also, we were not use to having weevils on these produce hung outdoors but now some weeviled after a short period of time. We believed that since these food crops are exposed, this problem is linked to wichcraft.* In these villages, stealing have become rampant. The corn and beans hung outdoors are some time removed at night by thieves and farmers have this superficial believed that their grains are also taken away through wichcraft in the form of weevils and rats since they are expose removed at night by thieves and farmers have this superficial believed that their grains are also taken away through wichcraft in the form of weevils and rats since they are expose.

Majority of the farmers said they are unable to store their produce especially inorganically produced food crops indigenously. According to these farmers, inorganically produced food crops are less resistance to pest attack and as a results, about 43% of what the produced usually gets spoil especially potatoes which easily get rotten and maize and beans which are attack by weevils. According to [14] and [15], weevils account for 10-40% of the total loss in grains while the Large Grain Borers (LGB) account for more than half of the lost recorded for maize. In a similar manner [16] added that prevention of attack by fungi, insects and other pests is of prime importance in post- harvest storage. Finally,

absent or limited modern processing, preservation, and storage facilities in most villages further aggravate the food spoilage situation especially in moments when they are disconnected from the markets since they are unable to preserve or store them so that when the roads are good they can take them to market.

2.7 Indigenous knowledge and challenges of globalisation

Results from household survey shows that women in this community at first, used to receive firewood from their son in-laws during periods of corn harvesting in order to dry their corn but now with modernity, this culture is gradually going extinct. Only few people now especially those in the interior villages practice this culture while some give it in kind (cash) while others do not even give at all, posing a problem of food preservation and storage for those who have been acustomed to.

Also, there is this believe that corn from *ikaŋ* or from bamboos hung over the fireplace test better when cooked as corn fufu or corn beer compared to that dried completely using the sun and equally that bought from the market which may have been preserved with poisonous chemicals. As a result, farmers prefer keeping corn dry from other sources again at *ikaŋ* for some days or weeks before consuming it. Also, farmers believes that corn stored in *ikaŋ* when cooked, moulds (swells) as compared to those stored outside or dried under the sun. Furthermore they believe that cornfufu prepared from corn from *ikaŋ* draws thus they enjoy eating it than cornfufu from other sources.

III. CONCLUSION AND RECOMMENDATIONS

Indigenous knowledge has proven successful in agriculture and the sustenance of local livelihoods [7]. In Belo subdivision, food crop production are varied and many and harvesting is usually done in the rainy season especially between the month of June and September. These harvesting season corresponds with the period of high rainfall which renders both harvesting and yields preservation very difficult for the rural farmers. In responds to this, farmers have resorted to post-harvest indigenous preservation and storage methods. These IKs varies greatly with food crop typology and from one geographical landscape to another. The use of these IKs proved to be successful as farmers confirm that through careful and kin application on food stuffs, yields lasted as long as they were required. Today, adequate access to fuel wood in this locality remains challenging. Certain aspects of indigenous knowledge of food storage are peculiar to this community, but some indigenes are not aware. The construction of modern houses have spilled from towns and the trickledown effects are fell right down to the rural areas. Thus, the construction of these modern houses should be done alongside traditional houses with double barn to increase the storing space of food crops. Cultural practices performed yester yes by the son-in-laws should be revamp. Issues concerning IKs especially those unfamiliar to some of the farmers should be discuss in village gatherings viz; tontines, Common Initiative Groups (CIGs) and cooperatives in order to improve on the skills of farmers indigenous post-harvest management strategies and equally, the documentation of these IKs for posterity will help in expanding the threshold of indigenous knowledge practices. Participatory approach should be encouraged when it concern improvement in food preservation and storage facilities in villages so that the views of farmers can be integrated in the process and by so doing, some will be motivated to adopt or use the facilities. We equally supplements that the above IKs strategies though having its own weaknesses are integral part of the rural society and should be harness and modify, and integrated into modern scientific knowledge by extension worker inorder to improve on post- harvest management of food crops. With the most use IKs here been *ikaŋ*, others such as woven baskets, *antrung*, clay pots, indian and raffia bamboos should also be improved.

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