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Evaluation of post-harvest maize treatment, phyto-insecticide use on maize varieties in mezam division

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Abstract

Maize is the most widely cultivated staple food crop in Sub-Saharan Africa in general and Cameroon in particular with agriculture as its back bone. Despite this, a great portion of the cultivated and harvested maize is lost during post-harvest drying and storage treatment. These loses could be attributed to the poor state of the farmers, season of cultivation or type if insecticide used. The objective of this study was to evaluate post-harvest maize treatment, phyto-insecticide use on maize varieties in Mezam Division. A simple random sample was used. It involved 640 households randomly selected; 80 from each sampling area. Eight sampling areas were selected from the seven Sub-Divisions that make up the Mezam Division. 640 semi-structured questionnaires were administered in 8 sampling areas to determine the dominant varieties of maize cultivated, season of cultivation, insecticide use and the fate of attacked maize. The results showed that, 57% of the farmers prefer both yellow and white maize varieties though 45% preferred more yellow, maize farming is predominant in the rainy season (58%). Most farmers had preference for chemical synthetic pesticides; most of which have been banned in Cameroon. Over 17 different phyto-pesticides were in common use in Mezam Division. There was serious positive intervention of both the state and its partners in maize cultivation in Mezam. The study showed that there was the need for more positive State intervention, provision of assistance to farmers and sensitization on the importance of phyto-insecticides and the dangers of chemical synthetic insecticide abuse.

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Introduction

Sub-Saharan Africa is the most vulnerable region with the average amount of food available per person per day being 1300 calories compared to the world wide average of 2,700 calories. Food security crisis in the Sahel, driven by chronic poverty, malnutrition, high food prices, drought and low agricultural production, affected 18.7 million people across the region in 2013 (FAO, 2013). Products from farming serve for on-farm consumption and generating income. Cereals are a major source of food and contributed to close to 50% of the total dietary energy supplies (Kcal) for this region for 2007-2009 (FAO, 2008). Maize is the most widely-grown staple food crop in sub-Saharan Africa (SSA) occupying more than 33 million hectares each year. In 2012, it had the best yield in Africa (70076591 tons) followed by sorghum, wheat and rice (FAOSTAT, 2015). It is a major staple food crop grown in diverse agro-ecological zones and farming systems, and consumed by people with varying food preferences and socio-economic backgrounds. Its central role as a staple food is comparable to that of rice or wheat in Asia, with consumption rates being the highest in eastern and southern Africa (Macauley, 2015).

Cameroon is a country with the backbone of its economy being agriculture. About 70% of its active population is involved in agriculture, which contributes to about 25% of the GDP (FAO, 2008). About 55% of the Cameroonian population lives in the rural environment with agriculture as main activity (Etoundi and Dia, 2008). Most of these peasant farmers however live in extremely poor conditions and their practice of agriculture is rendered difficult by the absence of farming tools, fertilizers, education, farm to market roads, drying and storage facilities and pest problems (Manu *et al.,* 2015). Maize is the first ingredient in the manufacture of cattle feed and is indispensable in aviculture accounting for 65% of the input for manufacturing poultry feed. It also contributes CFAF 5.6 billion to GDP and is regularly consumed by 12 million Cameroonians (MINADER, 2006). Although maize is cultivated in all the areas of Cameroon, the West and North-West Regions are the principal production zones; followed by the Adamawa and North Regions (AGRISTAT, 2010). Maize yields in Cameroon are estimated at 2.1 t/ha (FAOSTAT, 2014). The percentage of farm land used for maize production was 60.08% in 2014 (Manu *et al.,* 2015). According to AGRISTAT (2010),despite this high percentage of farmland used for maize farming, in 2009, maize importation rose from 3044 to 19964 (556%). In 2010 the North West Region was third in the nation with an annual output of 176,473tons. Mezam is the third Division in terms of output (AGRISTAT, 2012). Three different types of improved maize varieties (IMVs) including: ATP (yellowish and sweet), Kasai (white small grains) and Coca White (white large grains) are in current use by farmers in Mezam (Manu *et al.,* 2015). Output could really be boosted by the cultivation in farming groups, provision of affordable farmlands as well as farming credit. In the Cameroonian context, a farming group is a group of farmers who come together, organize themselves, and define goals and, work together to achieve them so as to improve their livelihoods (Lueong, 2009).

Maize is cultivated in Mezam twice a year (rainy and dry season maize). Yet despite this mass cultivation with good harvest, peasant farmers face a lot of post-harvest processing, storage and pest problems leading to huge losses. It is for this reason that we took as major objective, the investigation of post-harvest maize processing techniques in the Mezam Division, and specifically: the determination of the dominant maize variety cultivated; post-harvest drying and storage methods, phyto-insecticides in use, the dominant season of cultivation and the fate of damaged maize in Mezam Division.

Materials and methods

Study area

This study was carried out in the Mezam Division of the North West Region of Cameroon, located between latitudes 5° 20' and 6° 15'N and longitudes 09° 7' and 10° 21' East. It has an approximate land surface area of 1,841 km² and a population of about 446,000 inhabitants. The area has a tropical montane climate characterized by cold, cloudy and misty weather in areas with elevations above 1800 m and a hot and humid weather in areas with elevations below 1800 m.

The rainy season runs from mid-March to mid-November. The rest of the year is a dry season. Average annual rainfall is 2288mm.higheraltitude receives higher rainfall. The average annual temperature is 19.7°C and temperature ranges between 15°C to 32°C (Manu *et al.,* 2014).

Sampling

A simple random sample was used. It involved 640 households randomly selected; 80 from each sampling area. Eight sampling areas were selected from the seven Sub-Divisions that make up the Mezam Division as shown in Table 1.In every village visited, mindful of the educational level of the respondents, the typed and printed questionnaire sheets were either handed them or administered orally. Also, the maize varieties cultivated were inquired on the basis of colour (white/yellow). Samples were then collected and identified at the maize processing unit of IRAD, Bambui.

Data analyses

The collected data was analysed with the help of Statistical Package for Social Sciences (SPSS). The analyses process consisted of coding the questionnaires and variables so as to ease their insertion in the statistical package. Descriptive statistics such as frequencies, means, percentages, etc, were used to bring out the socio-economic characteristics of the maize and botanicals between the different sampling areas as well as the entire Division.

Results and discussion

Local names of maize and staple foods in different villages of Mezam

From Table 2 it was observed that, *achu* (pounded *Colocasia* sp.*)* was the staple food of the Mezam Division followed by corn fufu, the latter being the staple food of only the Bali and Babanki tribes.

Table 1. Sampling areas in Mezam.

Sub-Division		Sampling area	Village
Bafut	1	Bafut	Agyati/Nso/Mambu
Bali	2	Bali	Mbatmandet/Sang/Njenka/Jam-Jam/Ntanfoang
Bamenda I	3	Bamendankwe	Bamendankwe, Up-station
Bamenda II	4	Mankon	Mankon, Ngomgham, Ntsobuh
Bamenda III	5	Nkwen	Nkwen, Mbelewa
Santa	6	Santa	Mbei, Akum
Tubah	7	Bambui	Bambili, Bambui
	8	Big Babanki	Big Babanki

The only differences with the corn fufu staple were with the soup which could be vegetables, dry/fresh fish or meat. Cameroon being a nation with so many cultures explains the fact that in an area of 1,841 km² over 10 different names for maize were found in the eight sampling sites.

The choice of maize variety cultivated

More species of white maize were in wide scale cultivation (Table 3). The choice of maize variety cultivated was generally governed mainly by its colour and yield. It was found that the orange coloured were highly preferred. This was due to increasing knowledge on its anti-diabetic properties and richness in vitamin A as well as the fact that the marketability is high and fresh yellow maize is relatively sweeter. Others however, appreciate the white colour of corn fufu prepared using white maize. The maize varieties cultivated came either from IRAD and MINADER, Local Farmers' stores or seeds from previous harvests.

Table 2. The local names of maize and the staple foods of sampled villages in Mezam division.

Sub-Division	Village	Name in Dialect	Staple Food	Secondary Staple food
Bafut	Agyati/Nso/Mambu	Nsang	Achu[$]+Yellow[*]/black soup[**]	Corn Fufu+Njama-Njama[+]
Bali	Mbatmandet/Sang/Njenka/Jam-Jam/Ntanfoang	Ngwafut	Corn Fufu+Mpah[***]	Corn Fufu+Njama-Njama
Bamenda I	Bamendankwe	Ngwasang	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
Bamenda II	Mankon, Ngomgham, Ntsobuh	Ntsweh	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
Bamenda III	Nkwen, Mbelewa	Ngwasang	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
Santa	Mbei	Kwi	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
	Akum	Gesang		
Tubah	Bambili	Ngeshang	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
	Bambui	Nesang	Achu+Yellow/black soup	Corn Fufu+Njama-Njama
	Big Babanki	Asang	Corn Fufu+Njama-Njama	Achu+Yellow/soup

$: pounded cocoyam (*Colocasia* sp.), *: Yellow soup: a spiced soup composed of red palm oil, spices and limestone ('*Kangwa*'), **: Black soup: a highly spiced soup rich in roasted spices, ***: Mpah (*Nelsonia canescence*): a local vegetable, +: Njama-njama/Nightshade (*Solanum nigrum*).

There was predominance of the mixed inbred varieties (64.25%) because most farmers are either too poor to buy seedlings or resistant to leave the 'country corn' that has been cultivated in their families for generations (Table 3).

Table 3. Maize varieties in large scale cultivation in Mezam division.

Source	Variety	Common/Local name	Colour
IRAD/MINADER	CHC[*]202	ATP[£]	Yellow
	CHH[**]101	None	Yellow
	CHC201	Kassai	White
	Coca	Coca	White
	CHH105	None	White
	CHH300	None	White
	Shaba	None	White
Farmers' Stores	Varied	Chinese corn	White
	Varied	Pop-corn	Yellow
	Pannar	Pannar	White
Farmers	Mixed Interbred Varieties	'*Country corn*'	White, blue, orange, red, multi-coloured, etc

*: Cameroon Highland Hybrid, **: Cameroon Highland Composite, £: Acid Tolerant Population.

Maize varieties cultivated

As indicated in Table 3 the varieties of maize in large scale cultivation from different sources included CHC (Cameroon Highland Composite), CHH (Cameroon Highland Hibrid), Coca, Shaba, Pannar and mixed interbred varieties. These variety types were collected from the households and identified at IRAD (Institut de Recherche en Agriculture pour le Development), Bambui. Their colours also ranged from white, yellow to blue and multi-coloured (Table 3).

Phyto-insecticides in common use

Over 17 phyto-insecticides were found to be currently in common use in Mezam as shown in Table 4. A majority of them were either *Lamiaceae* or *Poaceae*. The parts used were dependent on plant used and included: leaves (fresh/dry), roots, bulbs or sap (Palm wine). These were applied as fresh, whole or powdered or burnt in the storage structure.

The most renowned of the phyto-insecticides were respectively *Cupressus sempervirens, Eucalyptus globulus* and *Cymbopogon zizanoides*. However, most of the households either were not aware that the plants could be used or were dissuaded by the inefficiency and low persistence of plant-sourced insecticides. Hence most of them had preference for the use of synthetic chemical insecticides.

Table 4. Phyto-insecticides in common use, parts used and method of preparation.

SN	Plant	Family	Common/Local name	Part(s) used	Method of application
1	*Afrostyrax lepidophyllus* Mildbr.	Huaceae	Country onion	seeds	Thrown into shelled maize
2	*Allium sativum*	Amaryllidaceae	Garlic	Bulb	Thrown into shelled maize
3	*Brugmansia suaveolens (*Humb. & Willd.)	Solanaceae	Indian/Angels' trumpet	Leaves	Dry powder
4	*Chenopodium ambrosioides* L.	Amaranthaceae	Chenopodium, *Fuh Muum*	Aerial parts	Dry powder/ crude extracts/ water extracts
5	*Chrysopogon zizanoides* (L.)	Poaceae	Vertiva grass	Leaves	Laid on barn floor
6	*Cupressus sempervirens* L.	Cupressaceae	Cypress	Leaves	Dry powder/entire fresh branches/burnt in drying fire/ laid on barn floor
7	*Cymbopogon citratus* (DC.)	Poaceae	Fever/Lemon grass	Leaves	Burnt in drying fire/laid on barn floor/dry powder
8	*Dichanthelium acuminatum* (Sw.)	Poaceae	Nyam Ngwei (Mungaka)	Fresh leaves	Laid on barn floor
9	*Eucalyptus globulus* Labill.	Myrtaceae	Eucalyptus/Forest guard	Leaves	Burnt in drying fire/dry powder
10	*Lantana camara* L.	Verbenaceae	Lantana	Leaves	Dry powder/hanged with maize on drying bamboo
11	*Piper guineense* Shumach.	Piperaceae	West African Black Pepper/ Nyusop (Mungaka)	Seeds/fruits	Dry powder
12	*Raffia sp.*	Calamoideae	Raffia	Palm wine	Fermented and sprinkled
13	*Ricinus comunis* L.	Acalyphoideae	Castor oil	Leaves	Dry powder
14	*Salvia sclarea L.*	Lamiaceae		Leaves	Dry powder
15	*Acmella caulirhiza* Delile	Asteraceae	Small eye pepper	Leaves/flowers	Dry powder
16	*Cascabela thevetia* (L.)	Apocynaceae		Leaves/flowers	Dry powder
17	*Ocimum gratissimum* (L.)	Lamiaceae	Massopo/ Sib (Mungaka)	Leaves	Dry powder/water extract/burnt in drying fire

Other pest control methods commonly in used were: burning of plastics, sunning regularly, hygienic treatment of storage structures, use of wood ash, and use of synthetic chemical insecticides.

Chemical pesticides used

Chemical pesticide usage was predominant and widespread. Pesticides used were recorded among the following:

Mocab

A granular systemic insecticide/nematicide containing 15% w/w ethoprophos, which was applied to the soil using recommended types of granule applicators for the reduction in wireworm damage and useful reduction in potato cyst nematode damage and incidence of spraying, on all varieties of potatoes. It was recommended both by the 2013 and 2014 decrees issued by MINADER (Ministère de l'agriculture et développement rurale) (MINADER, 2013, 2014).

Most farmers, however, used it for stored grain protection with the assumption that if the grains are washed before consumption three months after treatment, the consumer cannot be disposed to toxicity risk.

Actelicpowder

This is the sachet-powder insecticides. There were two types, which were differentiated mainly in the active principle present:

Antouka®: a pirimphos-methyl/permethrin based recommended pesticide (MINADER, 2013, 2014).

Poudrox®: a malathion based insecticide which has been banned in Cameroon since 2013 (MINADER, 2013). Yet it is still in wide use in the Mezam Division. Since these insecticides are either banned or poorly administered, it inadvertently leads to toxicity problems.

The use of maize groups and pesticides in Mezam

5% of the maize farmers were associated to maize cultivation groups.

Most of them (95%) preferred to farm maize only at the family level. Yet, the government (MINADER, IRAD) and its collaborators such as ACEFA preferred to interfere and help farmers working as associations and groups.

Table 5. Percentage means of severity of maize attack and fate of attacked maize in Mezam Division.

Parameter		Percentage mean ± standard error
Infestation at end of storage	Bad (too many holes and insects)	58.9±4.61
	Not bad	31.25±4.9
Fate of attacked maize	Sold	59.68±6.84
	Eaten	18.59±3.50
	Thrown away	22.81±6.19

The percentage pesticide use in Mezam division

From figure 1, a larger proportion (32%) prefered chemical treatment (A). Since over 20% of the farmers do not know (F) that plants could be used, less than 20% (B) of the farmers used only plants in the treatment of stored maize.

To compound this, there was a general feeling that plants are inefficient and present a very low persistence as insecticides. Figure 4 shows that generally, attack at the end of storage was not too bad. It is for this reason that most farmers (48%) prefer not to use any pesticide (G).

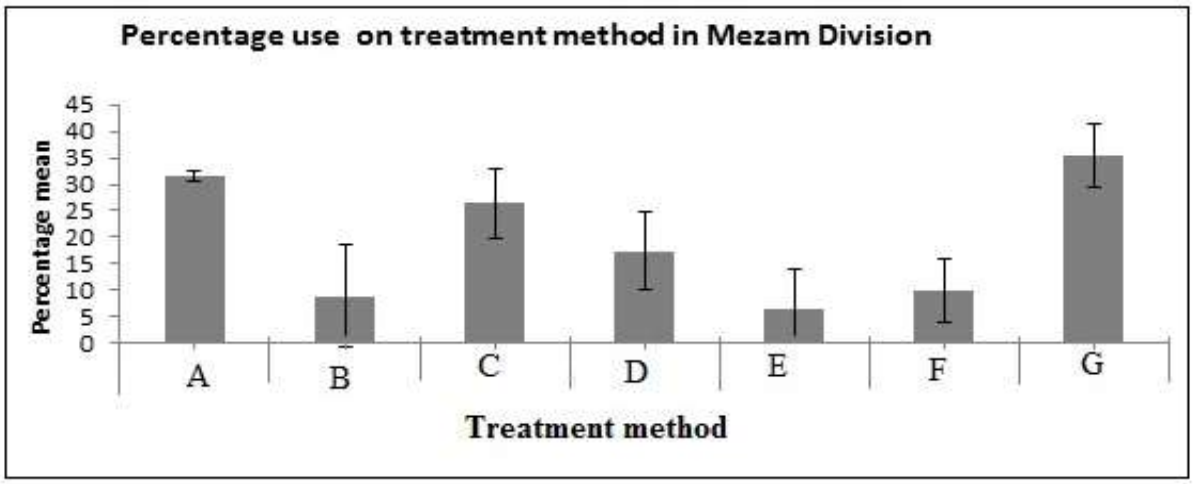

Fig. 1. Percentage use on treatment method in mezam Division.

Key: A=chemical, B=plants, C=chemical & plant, D=more chemicals, E=more plants, F=no knowledge of plants, G=no treatment.

Percentage means of maize types and season of cultivcation in mezam division

From figure 2, the rainy season (March-July) was the dominant season (I).

The maize cultivated in this season is also known as *rainy season maize* while the August-December maize (*Dry season maize*) was not cultivated by most villages (II); at least at a large scale. 50% of the farmers cultivate both in the rainy and dry seasons (III).

In almost all the villages (except Bali), farmers cultivate only in the rainy season. Less than 10% of farmers, farm only in the dry season.Dominant cultivation season and maize types cultivated. Furthermore, an equal 27% of the famers farm either only white or only yellow maize varieties. While the greatest proportion (56%) farm both varieties (C). However, 37% prefer the yellow to the white (D). This is due to growing concerns about the anti-diabetic properties and vitamin A richness of the yellow maize variety (Menkir *et al.,* 2008). Therefore, most of the yellow maize farmers (especially the elderly) prefer the cultivation and consumption of yellow maize. Some farmers however, still because of cultural ties and personal inertia prefer to cling to the white maize varieties.

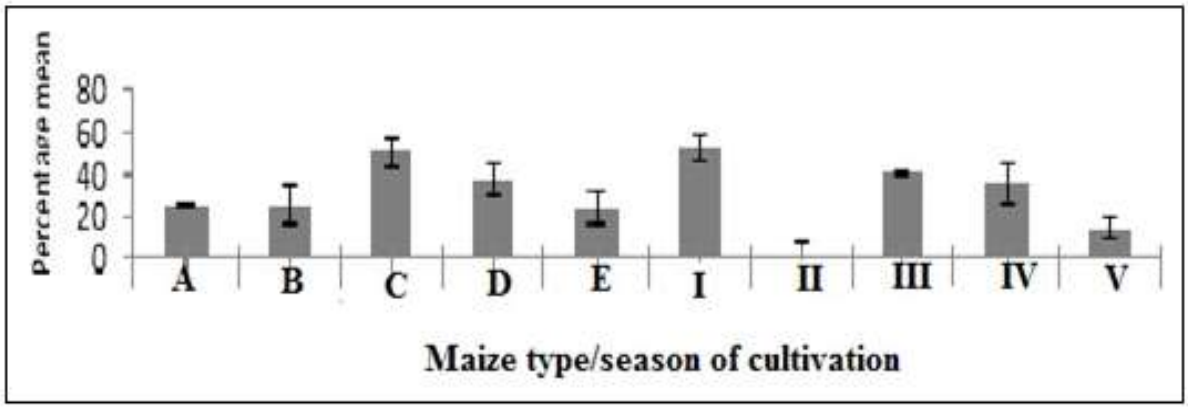

Fig. 2. Percentage maize types and seasons of cultivation in Mezam Division.
Key: A=yellow maize, B=white maize, C=both yellow and white maize, D=more yellow, E=more white, I=rainy season, II=dry season, III=both rainy and dry seasons, IV=more rainy season, V=more dry season.

Drying and storage of maize

Most households practiced rudimentary drying techniques; usually plagued with numerous flaws. Drying houses were found only with people who practiced large scale cultivation and storage. From figure 3, most farmers used only their houses; and mainly kitchens as drying/storage houses. This was mainly due to the fact that fires used for cooking were also used as drying fires. Over 80% of the farm produce were stored indoors (A). This could be due to the fact that: the rainy season was long and humidity was usually high such that improperly stored maize got mouldy within a short period of storage, the farmers also practiced small scale subsistence farming (Toussi *et al.,* 2008) The stored maize was usually done with husks (60%) (E), in a barn (52%) (G).Drying was usually done indoors in barns. Rainy season maize (harvested in June) was dried with the use of smoke from hearth fires. Hearth fire drying was marred by the scarcity of dry wood. . Some rainy season maize was shelled and sun dried on bags. Some (54%) preferred to dehusk the maize and suspend them on bamboo beams suspended from the eaves (f, h). This was known as cold drying since the cold external temperatures hampered the quick development of insect pests. In high altitude areas like Santa, Bamendankwe, Pinyin, and Akum, the eaves dried maize were either left there throughout the storage season or shelled and stored in 100 and 200 litre containers. Dry season maize (harvested in January) was left to get dry in the farm with the help of sunlight. However, this practice are usually poorly done as the maize was left for too long such that they got mouldy and infested by insect (FAO, 2003) and attacked by birds This is due to the fact that most of the stored maize lasts for less than a year (Manu *et al.,* 2015). Due to the poor insolation during the rainy season, the sun dried maize usually suffers minor weevil and fungal attacks. In the urban areas like Mankon and Nkwen, farmers preferred the yellow maize and storage was usually of shelled maize in Bags and airtight containers like 20 litres plastic gallons and clay jars. Less than 5% of the population used specialised drying and storage structures. These included a few farmers' groups, agricultural schools and IRAD. Severity of attack and use of infested maize at the end storage.

Table 5 presents the severity of attack at the end of storage as well as the fate of the attacked maize. Considering the density of holes in the attacked grains, over 63% of respondents presented the attack at end of storage as bad against 37%. The severity of the infestation usually determined the fate of the infested maize since some of the farmers would consume infested maize with low severity. This consumption was done after winnowing and seiving. Despite the poor and rudimentary storage conditions, infestation at the end of storage was not severe. This could be explained by the fact that weevils development is pertubed at low temperatures (Manu *et al.,* 2015). A majority of the infested maize was either sold to animal farmers for use as animal feed or used by the maize farmers (64%) ; who themselves also run animal farms to produce chicken and cattle feed.

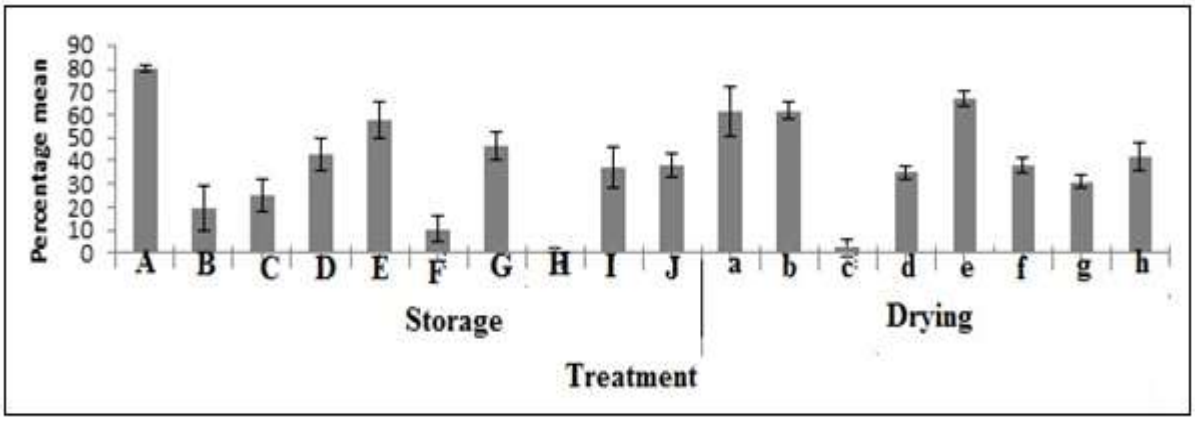

Fig. 3. Percentage treatment on storage methods in Mezam Division.
Key: A=indoors, B=outdoors, C=unhusked, D=shelled, E=with husk, F=both out/indoors, G=Barn, H=specific storage structure, I=airtight containers, J=bags. a=indoors, b=outdoors, c=specialised drying structures, d=sun, e= with husk, f= unhusked, g=shelled, h=eaves used.

Pests associated with stored maize

All the households in the study listed *Sitophilus zeamais* and *Tribolium* sp. as the dominant maize pests encountered followed by: rodents, fungi (due to too much humidity) and birds.

State and international corporations involved in maize farming/storage

IRAD (Institute of Agricultural Research for Development): a major stake holder involved with the production of new improved varieties, the multiplication and distribution of seeds. The seeds produced include cereals (rice, maize, sorghum, wheat) and pulses.

MINADER (Ministry of Agriculture and Rural Development): its Regional, Divisional and Sub-Divisional Delegations have programs that freely distribute seeds (collected from IRAD and Independent certified seed multipliers), fertilizers and farming equipment to farmers and farming associations.

AGRIC Schools: the Regional School of Agriculture (Bambili) trains its students and local farmers on techniques of maize farming. The maize cultivated was then either distributed to the farmers/students or sold at low prices to the local population.

ACEFA (Project for the Improvement of Competitive Family Agro pastoral Competitiveness): a Franco-Cameroonian Agro Pastoral corporation which provides agricultural aid to farmers. ACEFA is found in all the 7 divisions of the North West Region. It has its regional headquarter in Mezam. Its main activity in the maize sector is the construction of storage and drying houses for farmers and farmer co-operatives (CIGs). They are presently active in Santa and Akum with the construction of drying and storage houses.

Conclusion

The Mezam Division is a place where farming is still predominantly rudimentary. Farmers cultivate maize more in the rainy season than in the dry season. Yellow maize varieties are preferred over white ones. Non-recommended chemical insecticides are large scale use. Farmers prefer chemical insecticides over phyto-insecticides because of their efficiency but have little or no knowledge of their toxicities. Nevertheless, 17 phyto-insecticides are in common use in Mezam Division. Harvested maize is preferably dried and stored indoors, farmers prefer to farm as individual households rather than groups. Finally, due to low environmental temperatures, insect and fungal attacks at the end of storage are high.

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