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Indigenous Techniques of Grain Storage: The Dawanau Grain Market Experience

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Abstract
The paper attempts to document and assess the indigenous techniques of storing grains in one of the largest West African Grain Market; the Dawanau market in Kano metropolis. The methods used include: Field inventory; Focus Group Discussion (FGD); In-depth interviews; and Entomological identification of specimen. The result shows that indigenous techniques are vehemently used in storing grains as against the conventional modern techniques. These include: indigenous biological pest control (*Gwargwadoma*); herbs (wild sorrel); hot-pepper; and air-tired containers (drums). The use of *Gwargwadoma* appeared to be the most dominant and common method of large scale grain storage. The *Gwargwadoma* insects are now being raised and sold out as a commodity. It is therefore recommended that the technique of *Gwargwadoma* usage should be improved and the biological properties of the *Gwargwadoma* insects should be fully researched.
Keywords: Indigenous; Grain; Storage; Techniques

Introduction

Storage facility is one of the major constraints that affect agricultural development especially in the developing countries of the world. As a result of inadequate and/or inefficient storage facility, it has been estimated that between one quarter and one third of the world grain crop is lost each year during storage. Much of this is due to insect attack. In addition, grain which is not lost is severely reduced in quality by insect damage (**Emery** and **Cousins, 2013).** This to say the least greatly affects the food security state of the developing countries in particular and the world in general. This has been attributed largely to the delicate nature of grains; they are among the most important staple foods but yet, are in most cases produced on a seasonal basis and mostly with only one harvest a year, which is also subject to failure. Thus, this peculiar nature of crops depicted that 'for the world's ever growing population to be well fed, the global production of maize, wheat, rice, sorghum and millet must be held in storage for periods varying from one month up to more than a year' (FAO, 1994). Therefore it could be stressed that grain storage occupies a vital place in the world's economy. This is well exemplified from its enormous functions as in evening out fluctuations in market supply, both seasonal and inter annual; by taking produce off the market in surplus seasons, and releasing it back onto the market when the demand is high; and smoothes out fluctuations in market prices. It is in line with this that famers, traders and government partake in grain storage at different level and in varying forms and magnitude. The levels at which traders are involved in grains storage, however, vary enormously between different parts of the world and between different crops. The conventional literature revealed that 'in most African countries traders carried out very little inter-seasonal storage of coarse grains, but buy and sell quickly, earning a moderate profit on each transaction. Most storage is carried out by farmers and to a lesser degree by Government marketing boards and consumers who buy in anticipation of future household needs (FAO, 1994). Contrary to the FAO (1994) claim that 'given a general situation of capital shortage, long-term storage of staple grains is insufficiently profitable to attract the interest of traders, who can earn more money by investing in fast moving consumer goods,' the grain traders of Dawanau grain market in Kano metropolis have devised indigenous techniques of grain storage that allow them to store numerous tones of different grains for several years and as well maximizes huge profit. The aim of this work therefore is to document and assess the efficacy of these indigenous grain storage techniques employed by the grain traders of Dawanau Grain Market in Kano Metropolis.

Materials and Methods

The Dawanau grain market is one of the major single commodity markets in Kano metropolis. It is an international market, probably the largest grain market in West Africa, that deals mainly with buying and selling of crops such as maize, wheat, rice, cowpea, pea-nut, sesame, locust-been, sorghum, and millet, among others. It therefore occupies strategic position in the economic development of Kano State in particular and Nigeria in general. Although most of the activities of the market are in form of informal economic activities, the market is a major outlet of export storing of staple food to other parts of Nigeria; West African countries such as Benin Republic, Cameroon, Central Africa, Chad, Ghana, Libya, Mali, and Niger republic; and the world over. The market occupied a total land area of 624,826m^2 (Maigari, 2014a); accommodated over 9,000 stores, about 80 standard warehouses, and hundreds of ordinary ware houses own by individual marketers (Deenu, 2014). It is organized in six different sections, namely: i) Section A for Cowpeas, Soya Beans, Hibiscus, Sesame, and Locust

Bean; ii) Section B for Cassava Chips and flower, Groundnut, Bambara nuts, and Local wheat; iii) Section C for Yam Tubers, Sugarcane, and Local Chickens; iv) Section D for retailing of all kinds of food items; v) Section E for transport companies and agents, mechanics, spare parts, Chile Pepper, and Slaughtered animals; vi) Section F for Warehouses and Machineries (cleaning, loading and offloading). All these sections operate on daily basis.

The methods used include: Field inventory; Focus Group Discussion (FGD); In-depth interviews; and Entomological identification of specimen. Respondents were drawn from all the six sections of the market for a focus group discussion. In each of the Sections a focus group discussion session was held and the consensus views were noted. In the Cowpea Section (A), Retail Section (D), and Warehouse Section (F), in-depth interview sessions were also held with key individuals and officials of Dawanau Market Development Association (DMDA). Specimen of *Gwargwadoma* was collected in cellophane bags (as suggested by the respondents) for entomological identification. A total of 51 respondents were used for the survey aged from 32 to 65 and with varying years of experience in grain trade (5 to 30 years) and level of educational attainment (Primary and above). Table 1 shows the distribution of the respondents and schedules for FGD and In-depth interview.

Table 1: Distribution of Respondents for FGD and Interview Sessions

Section	Focus Group Discussion				In-depth Interviews			
	No. Resp	Age Group	Education Status	No. Session	No. Resp	Age Group	Education Status	No. Session
A	8	> 40	Pri. & Above	1	2	60-65	HND	2
B	6	< 40	Pri. & Above	1	-	-	-	-
C	8	> 40	Pri. & Above	1	-	-	-	-
D	10	> 40	Pri. & Above	1	1	53	NCE	1
E	6	< 40	Pri. & Above	1	-	-	-	-
F	9	> 40	Pri. & Above	1	1	51	OND	1
Total	47	-	-	6	4	-	-	4

Source: Field Work, 2014 < less than; > greater than

Result and Discussion

Stock, Types and Sources

Respondents maintained that there are about 25 grains and related commodities with different stock capacity and source origin in the Dawanau grain market. The dominant, however, in the order of stock volume are: Cowpea; Millet; Sorghum; Maize; Peanuts; Soya beans; Cassava; locust bean; and Hot pepper. Respondents estimated the annual stock of these commodities to have been almost stable for the past five years (2008 to 2013) and are sourced mostly from all parts of Northern Nigeria and some parts of middle belt. Apart from the internal sources, cowpea in particular, is brought to Dawanau market from Niger, Cameroon, Chad, and to some extent from Mali. The average derived from all the FGD sessions shows that annually, Dawanau market is stocked with about 2.8 million bags (100Kg each) of cowpea; 2.3 million bags of millet; 2 million bags of sorghum; and 1.7 million bags of peanuts. The detail is presented in Table 2.

Table 2: Estimated Annual Commodity Stock in Dawanau Market

Type	Quantity Supplied 100kg\sack	Quantity Sold 100kg\sack	Left Over
Bambara Nut	0.1 million	75%	25%
Cassava	1.0 million	80%	20%
Cowpea	2.8 million	65%	35%
Hibiscus	1.2 million	76%	24%
Hot pepper	0.6 million	85%	15%
locust bean	0.5 million	70%	30%
Maize	1.4 million	85%	15%
Millet	2.3 million	90%	10%
Peanuts	1.7 million	85%	15%
Sesame	1.0 million	90%	10%
Sorghum	2.0 million	90%	10%
Soya beans	0.2 million	75%	25%
Wheat	0.1 million	90%	10%
Total	14.9 million	1056	244
Average	1.45	81.23%	18.77%

Source: Field Work, 2014

From Table 2 above, it can be observed that on average about 80% of the stocked commodities are usually sold out while the remains of about 20% are left unsold for either reasons of market glut or speculative tendencies. Cowpea, for example, which appeared to be on top of the quantity stock also happen to be the least in terms of volume of sales (about 65%). Thus, considering the high susceptibility of cowpea to pest attack, of less than one month if untreated, the remaining 35% left over must be taken care of, if the traders are to break even. This situation among others made the traders in Dawanau grain market to devise or adopt a number of indigenous strategies of storing their fragile asserts. Malam Anas, a trader in the retail section (D), maintained that 'the grains are his assert, as such he can only protect its physical quality and market price through good storage; according to him, *Gwargwadoma* provided him with such facility'.

In another direction, Table 2 depicts the volume of food items stocked in the market annually (about 15 million sacks), which to some extent suggest the non disappearance of pyramids (groundnut) in Kano metropolis as assumed by most scholars (Martin 1992; Falola and Ngom 2009; Nwanko 2010; Richmond 2012; Obasi 2013), but rather a radical change in the architecture and construction mechanism of 'groundnut pyramid'. Modernization has now makes it possible to stock commodities in stores and warehouses as against the traditional way of stocking commodities such as cotton, groundnuts etc, on open space (Maigari, 2014b). Mishili *et al.* (2007) reported that cowpea storage capacity in Dawanau Market exceeds 200,000 metric tons.

Gain Pest

Insects and rodents such as mice and rats are the common pest affecting grains in Dawanau market. The insects according to the respondents either come with grains from the source areas or from the stores where they are kept, while mice and rats are mostly from the surrounding areas. The insects affecting grains (pests) are mainly of three types. They are: i) *Kakici*; ii) *Kwaro-Maidoro*; and iii) *Tsutsa*. *Kakici* and *Kwaro-Maidoro* mainly affect cowpea and maize respectively while *Tsutsa* usually affects millet, sorghum, cassava, ground nut and wheat. However, under chronic pest attack, respondents maintained that all the three types could appear in a single grain. Moreover, consensus views from all the FGD sessions stressed that *Tsutsa* is a larva form of *Kakici* and *Kwaro-Maidoro*. Thus the reason why they are mainly seen in softer grains such as millet, sorghum and the likes is because they are not strong enough to feed on hard or coarse grains such as maize and cowpeas, but the moment they mature to adult, they can launch an attack on any available crop. Entomologically, *Kakici* and *Kwaro-Maidoro* belongs to the primary grain pests family, thus they were identified as 'Lesser grain borer' (*Rhyzopertha dominica*) and 'Granary weevil' (*Sitophilus granarius*) respectively.

Mice and rats, on the other hand, are the common rodents found around build up areas or settlement; they are not unique only to Dawanau market. They usually destroy all kinds of food stuff that are accessible and palatable to them. Respondents maintained that, the food stuff mostly affected by mice and rats in order of high rate of damage include: groundnuts; millet; sorghum; maize; cowpea; and cassava.

Inventory of Storage Facilities

Field inventory shows that there are two major ways of storing grains employed by grain traders in Dawanau market. These are: the indigenous means and the modern conventional techniques. An inventory of all the grain storage devices in use by grain traders in Dawanau market shows a total number of 8 treatment devices; 4 indigenous and 4 modern treatment devices. A careful study of all the two major treatment ways shows they are all centered towards controlling the damaging agents rather than curing the actual damage when occurred. The indigenous treatments include: the use of *Gwargwadoma* insects; hot pepper; concoction of wild sorrel; and metal or plastic containers. While the modern treatment devices include three different chemical substances; locally known as *bom* (Molded Pesticide), *fiyafiya* (Liquid Pesticide), and *hoda* (Powdered Pesticide), and improved air-tied water proof sacks. Respondents maintained that the indigenous treatments were in practice even before the establishment of Dawanau market and they are still in use by the grain traders even outside the market. The *Gwargwadoma* treatment is mainly used in large scale grain storage followed by the use of drums, while hot pepper and wild sorrel concoction are mainly used for small scale storage (mostly less than 100 sacks). Consensus views from all the FGD sessions revealed that all forms of grains can be treated by using any of the four indigenous treatment devices. As a result of dangers associated with the use of chemical pesticides, respondents maintained that their usage is gradually declining and are mainly used in treating cowpeas and the stores or warehouses where grains are stored instead of all sort of grains. Among the all 8 inventoried treatment devices, the use of *Gwargwadoma* was ranked first in terms of preference followed by the use of drums, while the use of powdered insecticides and improved air-tied sacks were ranked least respectively. Long period of efficient storage (over 3 years); low cost; and easy maintenance and accessibly were the reasons attributed for the common use and choice of *Gwargwadoma* treatment. On the other hand, high cost and non easy access were the reasons for rating improved air-tied sack least among the grain treatment devices in Dawanau market. The detail is presented in Table 3 below.

Table 3: Inventoried Storage Treatment Devices

Type	Source	No. Years	Magnitude of Use	Preference Ranking
	Indigenous Treatments			
Drums	Re-use	Over 20	Moderate	2
Gwargwadoma	Niger	About 30	Very High	1
Hot Pepper	Locally	Over 50	Low	5
Wild Sorrel	Locally	Over 50	Low	6
Modern Treatments				
Molded Pesticide	Chemical Factory	About 25	Moderate	4
Powdered Pesticide	Chemical Factory	Over 30	Low	7
Liquid Pesticide	Chemical Factory	About 15	Moderate	3
Improved Sacks	Agro-allied Indus	About 3	Low	8

Source: Field work, 2014

***Gwargwadoma* Treatment**

The *Gwargwadoma* treatment involves application of live tiny whitish and at times brownish insects locally known as *Gwargwadoma* in the grains to be stored or inside stores and warehouses. The insects according to respondents predate on all grain pests and also repel rodents from getting near to the treated grains or stores. After *Gwargwadoma* treatment, the store or warehouse are kept ceiled, up to the required storing period. Such situation according to respondents provides excellent avenue for *Gwargwadoma* to grow and multiply; since it requires warm and air-tied condition. Respondents maintained that *Gwargwadoma* only feed on grain pest and its associates such as eggs and larva, and other edible stains on grains but never damages the actual grains no matter how long it stays. A study by Mukhtar et al (2010) revealed that some stored grains in Dawanau market are heavily contaminated with numerous species of fungus namely; *Rhizopus* species, *Mucor* species, *Aspergillus niger*, Aspergillus flavus, *Aspergillus fumigatus, Penicillium* species and *Fusarium speciesIso*. However, in contrast to that a consensus views from all the FGD sessions indicated that *Gwargwadoma* treatment improve the physical appearance of grain; by making it very bright (See Plate 1). Thus, this suggests either *Gwargwadoma* also repels fungus and fungal remnants or facilities in fungal contamination. Although the study conducted by Mukhtar et al (2010) has not clearly indicated whether the sampled grains were taken from those treated with *Gwargwadoma* or not, still this un-known fact need to be investigated. This is because about 60% of the stored grains in Dawanau market are treated with *Gwargwadoma*.

Plate 1a: A 1.8 year old Stored Cowpea 1b: 3 years Old Stored Cowpea

Entomological identification indicated that *Gwargwadoma* belongs to the centipede family (*Chilopoda*: Class); small fast-moving invertebrate with a long slender body divided into many segments, most of which bear one pair of legs. Respondents maintained that the *Gwargwadoma* specie was brought to Dawanau market from Niger Republic by one Malam Dandiyayi who was said to be an old cowpea trader. An in-depth interview with his close relation by name Alhaji Ibrahim Dandiyayi explains that '*Gwargwadoma* treatment is the best means of storing grains more especially cowpea'. However, it has the disadvantage of causing skin rushes, body irritation

and skin fading if one is exposed to it for about an hour or more. It also produces unpleasant smell that high exposure to it can cause coughing and induces flu and Asthma. Moreover, it is very sensitive to pesticides and does not require moist or cold places. In spite of that *Gwargwadoma* is now being cultured and sold as a commodity; mostly by casual laborers. One *Mudu* of it (clean, without trash) cost =N=150.00 to =N=200.00 while a *Mudu* with trash cost =N=80.00 to =N=100.00. Plates 2 - 3 show images of *Gwargwadoma* and the store treated with it.

Plate 2a: A Colony of *Gwargwadoma* 2b: Hidden in Pods

Plate 3: Sacks of Stored Grains Treated with Gwargwadoma

Wild Sorrel and Hot-pepper Treatments

Wild sorrel in most northern parts of Nigeria is regarded as weed mostly found in bush or fallow farmlands. Its leaves and steam are very sour in test. After the leaves and steams of wild sorrel are dried, the stuff is then grind up to produce a powdered concoction, which if applied to grains makes them to bear a sour test. The sour test according to respondents discourage grain pest to feed on grains, thereby making the treated grains safe from pest attract. Consensus views from all the FGD sessions indicated that the wild sorrel treatment is a very old device; about 100 years old or more, but it is still in use in Dawanau market for small scale storage. Female casual workers who often offer the services of trashing and sieving of grains and associated stuffs are those who usually produce wild sorrel concoction and sale. A *Mudu* of the concoction cost =N=80.00 to =N=100.00.

The hot-pepper treatment is also similar to the wild sorrel concoction. It involves the application (mixing) of grinded hot-pepper powder with the grains to be stored. The hot-pepper by its nature is very hot and irritating and as such grain pest are not in harmony with it. Respondent indicated that it kills and repels pest from damaging any grain or food stuff treated with it. It is also an old grain treatment device; over 50 years old or more, and still in use in Dawanau market for small scale storage. A *Mudu* of the grinded hot-pepper powder cost about =N=500.00 (See Access to the Treatments)

Drum Treatment

The drum treatment provides an air-tied condition in which pest and other living organism find it difficult to survive for a long period of time. Respondents indicated that in the olden days before metal drums were available, giant ceiled pots were used in storing grains which were now substituted with drums. This device is mostly used in storing cowpea by small scale traders in Dawanau market. The unit cost price of metal drum ranges between =N=1,800.00 to =N=2,500.00 depending on the quality (mutilated or otherwise). The advantage of using drums treatment is that it can be reused for several years if not damaged by rust or develop holes.

The Efficacy of the Inventoried Storage Treatment Devices

Consensus views from all the FGD and In-depth Interview sessions rated indigenous treatment devices as more efficient over the conventional modern treatments in terms of long period of storage; cost of procurement and maintenance; easy accessibility of the treatments; consumer's preference; and perceived health hazards. Thus, all the 4 inventoried indigenous treatment devices, according to the respondents can last for up to 3 years and as well safeguard the quality of the stored commodity. However, in contrast to that, apart from improved air-tied sack, the other 3 modern treatment devices (chemicals) cannot last for over one year and the quality of the stored commodity is not guaranteed. In terms of procurement, the indigenous treatment devices are less costly compared with the modern chemical devices. Respondents maintained that with only =N=5,000.00 one could treat about 100 sacks of grains with *Gwargwadoma*, and wild sorrel treatments whereas the same amount would not cover the cost of treating 10 sacks with modern treatment devices including used drums. Moreover, in terms of consumer preferences and health related hazards, the grains treated with indigenous treatment devices are most preferred and relatively have no health implication compared with those treated with modern chemical devices. Table 4 below portrays the detail of the finding.

Table 4: Efficiency Rating of the Inventoried Treatment Devices

Type	Expiree	Procurement	Maintenance	C. preference	H. Hazard
	Indigenous Treatments				
Drums	> 3 yrs	Costly	Zero	Most Pre.	None
Gwargwadoma	> 3 yrs	V. Cheap	Zero	Most Pre.	None
Hot Pepper	< 2 yrs	Moderate	Zero	Most Preferred	None
Wild Sorrel	< 2 yrs	V. Cheap	Zero	Most Preferred	None
Type	Modern Treatments				
Molded Pesticide	2-5 months	Costly	P. Checking	Last option	Risky
Powdered Pesticide	1 year	Costly	P. Checking	Last option	Risky
Liquid Pesticide	< 4 months	Costly	P. Checking	Last option	Risky
Improved Sacks	> 3 yrs	Costly	P. Checking	Most Preferred	None

Source: Fieldwork; 2014

Access to the Treatment Devices

As all the 8 inventoried treatments have economic value, access to them, therefore, involves purchase from the owners or manufactures. However, the financial commitments vary. Access to the modern treatment devices attracts more money, about 10 times higher than the cost of indigenous treatment devices. Access to *Gwargwadoma* and wild sorrel are the easiest, which apart from their low cost, one can have access to them

through gift from their respective owners. An assessment based on the cost implication of treating 10 sacks of cowpea with each of the 8 inventoried treatment devices shows it require about =N=1,500.00 to treat 10 sacks of cowpea with *Gwargwadoma* and =N=1,300.00 with wild sorrel concoction. On the other hand, it cost about =N=22,000.00 and =N=18,000.00 to treat the same 10 sacks of cowpea with liquid and powdered pesticides respectively. However, it should be noted that Drums and *Gwargwadoma* (after separated from the mixed up grains) can be reused. The detail is presented in Table 5 below.

Table 5: Cost Implication of Treating 10 Sacks of Cowpea

Treatment	Qt/sack	Unit Cost	Total	Labour	Sum Total
	Indigenous Treatments				
Drums	1/2.5	2,000.00	X 4	None	8,000.00
Gwargwadoma	1*Mudu /1*	150.00	X10	None	1,500.00
Hot Pepper	1*Mudu /1*	500.00	X 10	1,000	6,000.00
Wild Sorrel	1*Mudu /1*	80.00	X10	500	1,300.00
Treatment	Modern Treatments				
Molded Pesticide	1pack/2	2,000.00	X 5	1,500.00	11,500.00
Powdered Pesticide	1pack/3	4,500.00	X 3.3	3,000.00	17,985.00
Liquid Pesticide	1gallon/4	7,550.00	X 2.5	3,000.00	21,875.00
Improved Sacks	-	-	-	-	-

Source: Fieldwork, 2014

Sustainability and Challenges

A system or action is said to be sustainable if it is economically viable, environmentally friendly, culturally acceptable, and socially justifiable. Therefore, the forgoing study of indigenous techniques of grain storage has adequately demonstrated that, all the 4 grain storage treatments are cost effective; very cheap; easily accessible; low maintenance cost; and provides high chances of reuse. From the environmental aspect, the indigenous grain storage techniques are contributing to agricultural ecology in terms of crops storage, marketing and biological pest control which is nature friendly as against the use of modern chemical treatments. Culturally, the indigenous treatments could also said to be accepted as they are the dominant storage treatment devices in use by grain traders, in Dawanau market in particular, and are as well the by-product of indigenous cultural innovation. Neither the norms nor the value of the metropolitan communities prohibits, segregates, expulses, or subjugates their practice; consumer preference and other economic tentacles. Similarly, the indigenous treatment devices are socially justifiable; they are regarded as indigenous prototypes (*Kayan Gargajiya*) and provide means of sustenance (livelihood) to many people even outside the studied market.

This sustainable background, therefore, apparently suggests that the inventoried indigenous grain treatment devices employed by the Dawanau grains traders are to a large extent efficient. The only perceived challenges cannot be divorced away from their practical operational implications and in particular those related to application and separations of *Gwargwadoma* and hot pepper treatments. These treatments as indicated earlier are liable to human health injuries such as skin rushes and irritation; sneezing; flu; and cough. The most vulnerable are the casual laborers who often work directly with them. Therefore, if these operational challenges are adequately taken care of, the efficacy of indigenous grains treatment devices would be improved and as well their full benefits would be realized.

Conclusion

From the foregoing study of the indigenous grains storage techniques based on Dawanau grain market experience; it can be concluded that grain traders also have a stake in the general grain storage systems in the same magnitudes; commitments; and innovative tendencies with farmers and government agencies. Therefore it has been recommended that grain trader should as well be involved in all grain storage schemes, planning, and investments. The efficacy of *Gwargwadoma* treatment device should be fully researched and the associated limitations should be minimized. The personnel directly involved in working and culturing it should always make use of safety and protective kits such as hand gloves and nose-mask.

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