Odunayo C. Adebooye (Autor)
Kehinde A. Taiwo (Autor)

Biotechnology Development and threat of Climate Change in Africa

The Case of Nigeria - VOLUME 2

https://cuvillier.de/de/shop/publications/699

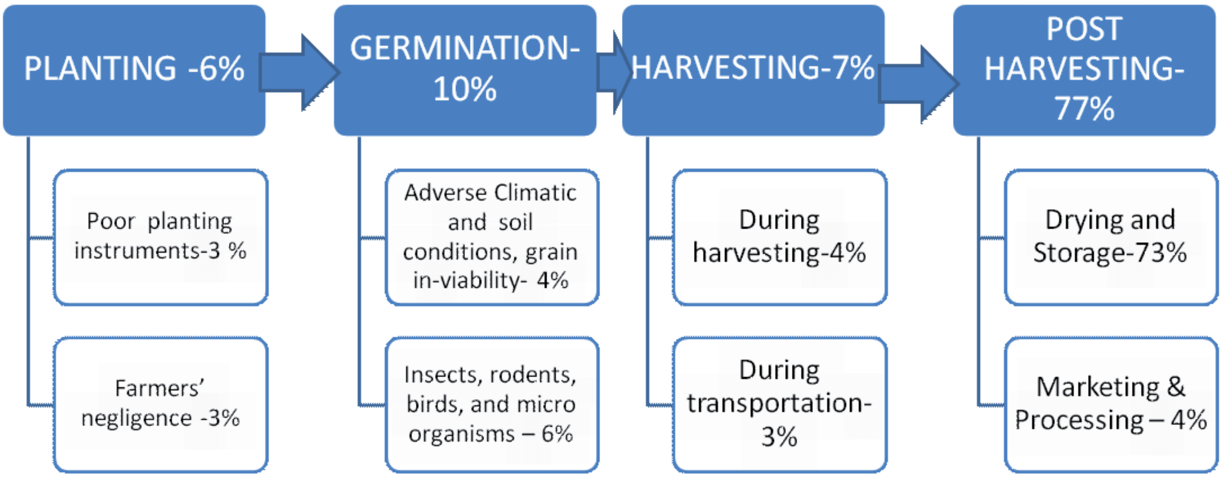

Figure 1: Hypothetical Model Showing the Distribution of Loss Experienced by Nigerian Farmers along the Crop Production Chain (Deji, 2008a).

CONVENTIONAL GRAIN DRYING AND STORAGE SYSTEMS AMONG NIGERIAN FARMERS

Most of the postharvest grain handling in Nigeria is carried out at the farm and household levels, which is the focus of this paper. There is low level of industrial postharvest grain handling in Nigeria, compared to the developed countries.The most common conventional grain drying method among Nigerian farmers is sun drying. Grains are dried under the sun on the field before harvesting, and after harvesting. Sun drying becomes more popular among the farmers in the tropics because it is cheap and readily available over a longer period of time annually. Chancellor (1965) and, Soetoyo and Soemardi (1979) demonstrated that paddy can be dried from 24-26% moisture to 14% moisture at depths of 50-100 mm at a rate of 3.3 kg/m².h for stirred paddy and 1.9 kg/m².h for unstirred paddy. To minimize cracking and over heating of the grains during extremely hot weather, the paddy can be covered with a transparent but good heat permissive sacks or at best sun drying can be done under a shady platform; although longer period will be required for desirable drying.

Grains are also sun- dried on a concrete platform or raised platform (crib) under the sun. Traditionally, a specific location is cleared and leveled, around the farmland for the purpose of drying crops and other farm produce on yearly basis. During the dry season, the grain is left on the ground for days with regular turning and raking on a daily basis to enhance uniform heat distribution required for maximum and uniform drying. Regular uses of an area for sun-drying smoothened the ground and reduce level of contamination of the crop with unwanted materials. Cribs are often used for secondary drying and storage of the grains after it has been removed from the open smoothened ground. Drying is mostly through solar radiation and depends on the intensity and availability of solar energy. Conventional sun-drying methods in Nigeria expose the grains to contamination by insect pests, micro-organisms, and dockages that influence insect infestation and grain deterioration. Other traditional grain disinfestations practices among Nigerian farmers include; storing the grain with dried whole or grinded pepper, and use of chemical fumigants, such as Methyl Bromide, Phosphine, etc.

Okereke and Nwosu (1987) reported the regional variation in conventional grain drying and storage strategies among Nigerian farmers. Maize grains in South Eastern part of Nigeria are traditionally stored in tree trunks, on platforms or vertical poles, or heaped on the bare floor at one corner of the living apartment with no additional care. Platforms are constructed over the fire places to hasten drying and ward off insects, rodents, and micro-organisms infestations. In the North, grains are stored traditionally in the underground pits and in a rhombus. The rhombus is a cylinder bowl made of clay and grasses with a dome shaped top. It rests on large stones to minimise direct contact with the ground. It is fairly cheap to construct, simple, and relatively effective.

The general problem associated with the conventional grain storage methods in Nigeria is that they do not totally eliminate deterioration and subsequent loss (Okereke and Nwosu, 1987). In addition, the interaction of the grain bulk, thermal properties of the storage facilities, and ambient temperature fluctuation, cause unequal moisture distribution within the grain mass. This condition generates thermal gradient within the grain mass. If there is no outlet for the accumulated moisture within the grain mass, condensation will occur. Moisture condenses when the dew point is reached leading to deterioration of the stored grain and consequently invasion by fungi and insects (Okereke and Nwosu, 1987). Pre-storage moisture content of the grain influences the effectiveness of storage facility or method adopted.

The microbial deterioration of cereal grains are relatively high in the Southern Nigeria where such crops are harvested during the wet/rainy months of the year (Oyeniran, 1973; 1978). At the time of harvesting, the moisture content of corn is about 25% which is well above the safe moisture level of 13% (Adesuyi, 1970). The level of solar energy needed to bring freshly harvested grains to the safe moisture level of less than 14% is usually not easily available. Even when the farmers succeeded in reducing the moisture level of the harvested crops to the safe level through a combination of conventional drying systems, the grains are susceptible to attack by insects, rodents, and micro-organisms during storage in the poor storage facilities available to the farmers. Hence, both drying and storage are significant in determining effective postharvest grain handling.

Grains are highly susceptible to mould infestation when not sufficiently dried before storage, especially during the wet season of the year, when relative humidity is usually high. The specific way by which moisture plays its role in microbial deterioration were suggested by Oyeniran (1978) as condensation and moisture migration. Formation of water as a result of condensation of moisture migration in stored dry products encourages attacks by moulds, some of which causes discoloration of the products, loss of flavour and production of aflatoxin (Oyeniran, 1978). Oyeniran *et al.* (1983) in their microbiological studies on maize isolated the following, moulds from maize stored in miniature silos: *Aspergillus flavus, A. niger, A. famari, Fusarium moniliforme, Paecillomyce varioti, Penicillium spp*. and *Rhizopus arrhizus. A. flavus* was most abundant of the fungi and the most serious storage fungus of grain, especially corn. *A. Flavus* is the organism that produces aflatoxin in mouldy grains. Oyeniran (1977) reported that aflatoxin and mould content of corn increased with increasing moisture content. Morris (1962) has shown that certain relationships exist between the water activity (a_w), temperature, and nutrition. First at any temperature, the ability of micro organisms to grow is reduced as the a_w is lowered. Secondly, the range of a_w over which growth occurs is greatest at the optimum temperature for growth; and thirdly the presence of nutrients increase the range of a_w which the organisms can survive. Thus a change in temperature or nutrient content might permit growth at lower values of a_w. Investigations by Marth and Calonog (1976) showed that the optimum temperature for aflatoxin production appears to be at 24-28 ^oC, which is the normal ambient temperature of grain storage in Nigeria. Aflatoxin production can occur under any and all conditions that allow for good fungal growth.

Among human conditions believed to result from aflatoxin ingestion is the EFDV syndrome of Thailand, Reye's syndrome of Newzealand (Butler, 1974) and acute hepatome observed in South African Bantus who consume mouldy grains. Deger (1976) has shown that two men who worked with purified aflatoxin developed colon carcinoma. Thus the danger concerning mould infestation of grains is not only with the quantity and quality loss of nutrients but also with the possible harmful effects of the toxic metabolic by-products of their activities in the grains on human beings.

BIOTECHNOLOGIES, CLIMATE CHANGE, AND WOMEN FARMERS' EMPOWERMENT

Insects infested 11% of grain stored in a temperate region such as Germany in 1976 but declined to 1.2% in 1986 because of better storage management, indicating that effective techniques are available for pest control in developed countries (Stein, 1991). The current modern postharvest technologies for grain drying and storage include the use of electromagnetic radiation such as radio frequency and microwave energy. Microwave and radio frequency energy can be used to control insects in stored cereals and cereal products (Vadivambal *et al*. 2007).

Postharvest biotechnological development such as radio frequency and microwave grain disinfestations systems are products of biosystems engineering research and are currently at the research stage in most developed countries; however the knowledge is yet to be popular in most developing countries. Women farmers are the majority of the agricultural workforce in most developing countries, especially at the postharvest stage in Nigeria. They participate actively at all stages of agricultural production, but most prominently at the postharvest stage. Hence, they are positioned as significant stakeholders and beneficiaries in the interplay between climate change, agriculture, and postharvest biotechnologies (Fig. 2).

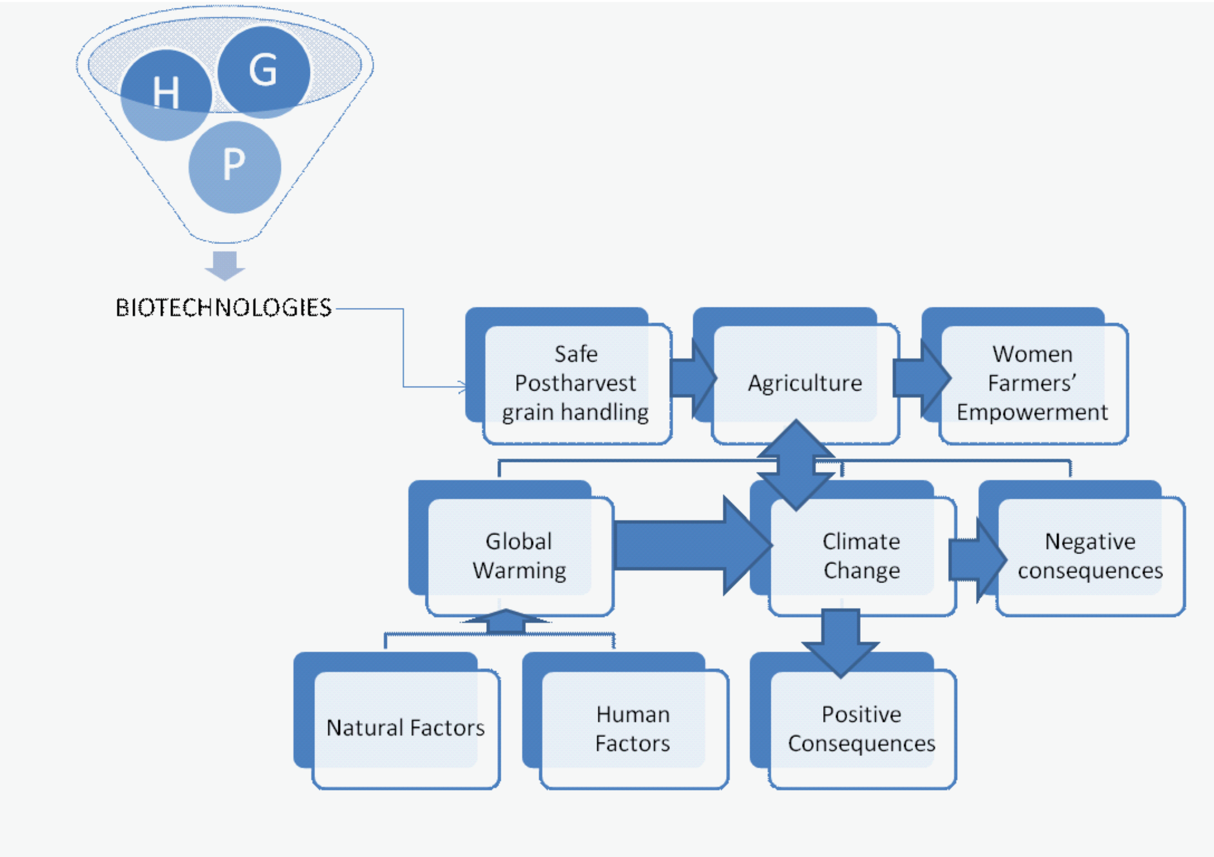

Figure 2: Relationship between Biotechnologies, Climate Change, Agriculture, and Women Farmers' Empowerment (Source: Deji, 2008b)

Keys to the Figure: G = Germination; H = Harvesting; P = Post-harvesting

Small-scale farming provides most of the food produced in Africa, as well as employment for 70 percent of working people (Maxwell, 2001). Higher proportion of the losses encountered by Nigerian farmers (due to climate change and other causes) during crop production, feature prominently at postharvest stage. Harvesting and postharvest activities are traditionally women's roles in Nigeria. All these activities are conventionally and manually performed by women. The conventional and traditional practices sap women's energy, are labor intensive, and most of the times are with little or no economic returns.

Postharvest biotechnologies such as radio frequency and microwave heating are environmentally and culturally sustainable. Adoption of postharvest biotechnologies can be tried at small scale at the industrial and nationally levels in Nigeria, because of its high cost. If it is found cost effective storage bins of large capacity with either radio frequency or microwave heat source can be established in strategic locations of large grain cultivation, accessible to grain farmers in Nigeria. Postharvest bioengineering research can be encouraged to produce the on-farm prototypes of such storage bins at the farming community level in Nigeria. Adoption of postharvest biotechnologies will contribute to the alleviation of climate change, and reduce agricultural production losses in Nigeria. It will significantly empower the women farmers socially (creating time to attend to other social activities during the harvesting season) and economically (by improving the net returns from grain cultivation), and also improves their health (stress usually incurred during postharvesting grain handling will be drastically reduced). Hence, adoption of postharvest biotechnologies will reduce the risk and ill-health often associated with the use of most conventional systems of postharvest grain handling, as well as enhances food security in Nigeria.

PRACTICAL GUIDING PRINCIPLES FOR EFFECTIVE ON-FARM GRAIN STORAGE

The best model for grain disinfestations is the one that comprises both the drying and the storage compartments. However the following practical steps are important for effective grain storage, especially in the tropical regions:

i. Properly clean the storage bin and leave empty for some days before loading the fresh grain;

ii. Keep the distance between the drying and storage points as minimum as possible to disallow contamination by agents of insect infestation, such as contact with water, dockages, etc especially during rain season;

iii. The temperature of the storage facility should be maintained at the lethal temperature levels for the less susceptible insect pest of the grain;

iv. The storage facility should be raised a little bit above the soil surface to disallow temperature gradient between the soil and the stored grain;

v. Vertically positioned storage facility is preferred to the horizontal for easy loading and offloading, uniform temperature distribution, and easy control of insect re-infestation;

vi. Loading should be done once, as much as possible, to reduce the probability of contamination by insect pests;

vii. The storage bin should be water proof coated, with internal layer of heat insulator;

viii. The storage bin should be properly closed after uploading the grains and remain closed until when ready to be offloaded;

ix. If there is any cause to open the storage bin during the storage period other than offloading the grains, heat up the storage bin to the lethal temperature of the less susceptible insect pest of the grain before and immediately after re-opening;

x. For long term storage, heat disinfestations should be combined with other methods such as cooling, or complete sealed storage (e.g. use of Wise Joseph bags), to reduce re-infestation;

xi. The stored-grain temperature should be kept as uniform as possible within the storage bin;

xii. Never add freshly harvested grains into the previous year’s grain in the storage bin without properly assessing the soundness of older grain.