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Post-Harvest Losses of Cereals in Developing Countries: A Review

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Abstract:

Cereals are the main food on this earth planet. The losses of produced cereals are very big issue globally. Post-harvest losses are more severe in developing countries at food chain level and very high at retailing and consumption level in developed countries. Due to high post-harvest loss, major part of African countries suffers with malnutrition. The economic value of this amount of food loss and waste is estimated at about USD $936 billion, regardless of the social and environmental costs of the wastage that are compensated by society. In developing countries both quality and quantity losses are the main issue of post-harvest crops. These are needed to develop advance and cost-effective storage methods to reduce post-harvest losses. It is also important to use IoT in supply chain, hermetic storage techniques, synthetic insecticides, pesticides, fungicides and natural fumigants to control insect pest attack on stored grains. With all these integrated precise techniques we can minimise post-harvest losses at both supply chain processes and consumption level and can fulfil the increase demand of cereals around the world.

Keywords: Post harvest losses, Storage, IoT, Insect/pest, Developing Countries

Shortage of food continues to be a severe problem in India. The yearly production of food is more than consumption, but we lose many lived due to starvation. The economic value of this amount of food loss and waste is estimated at about USD $936 billion, regardless of the social and environmental costs of the wastage that are compensated by society [1]. Even government take many steps for management of waste crops which only adds up to the expenses of the losses [1]. Every year in the world, 1/3 of the produced food for human consumption is lost or wasted. In 2050, world population has been predicted to reach 9·1 billion and there is need of 70 per cent increase in food production [2].

After harvest, losses like calories loss, storage loss, and quality loss were faced due to lack of proper storage facilities. With appropriate storage methods, we can reduce these losses up to 1-2 per cent [3, 4]. Interrelated activities like crop processing, storage marketing etc. results in quantitative and qualitative loss of food in various post-harvest operations [5, 6, 7]. The loss of quality and quantity after harvest of crops is very common in both developed and developing countries. Loss of product quantity is considered as quantity losses and it is more

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common in developing countries than developed countries [8]. On the other hand, loss of calorie content, nutritional composition, acceptability and digestibility of food product is considered as quality loss [5, 8].

With increase in food demand, the factors like climate change, progressive urbanization affect production of food therefore post-harvest losses are a litigious and crucial issue [9, 10, 11, 12]. Due to post harvest treatments and operations, about 1.4 billion tons (around 1 trillion USD) is lost annually [13]. The food available for human consumption but not consumed is considered as "food loss" [14, 15]. To decrease post-harvest losses, different proposals and solutions are required with less investment and high results. Loss of quality, nutritional value and deterioration, loss of viability and commercial losses are generally considered as post-harvest losses [16, 17]. Crop type, type of economy, geographical areas, and marketing strategies affect size of losses after harvest however, major part of produce usually lost in lack of knowledge, inappropriate or poor harvest technology, poor handling and transport facilities, poor processing and infrastructure. Due to advance technology in developed countries, middle stage supply chain losses are low than developing countries but large part is lost at the end of supply chain. In USA in 2010, about 31 per cent of total available food (estimated as 133 billion pound of food) was wasted at retail and consumer level [12]. For strengthening food security, reducing the agricultural land needed for production, sustainably combating hunger, rural development, and improving farmers' livelihoods there is need of minimizing cereals losses in resource efficient way. In this paper, the main emphasis is to discuss technology interventions for decreasing post-harvest losses at different stage of supply chain of cereals.

METHODOLOGY

The study is based on post-harvest losses and management of cereals in developing countries. The motive of the study is to understand post-harvest losses at different levels of supply chain and precise methods to control or minimise these losses. For this study, different studies were cited related to post harvest losses, storage technology, role of IoT in agriculture, hermetic storage techniques and use of appropriate fungicides, insecticides and pesticides.

Supply Chain of Grains

In the process of transporting cereal seed from farm to consumer, cereal seed must experience chain of supply chain operations such as preparation for harvesting, harvesting, threshing, cleaning, drying, storage, processing, packaging and transport. During these supply chain processes, inefficient processing equipment, improper handling, biodegradation etc. causes yield loss [18, 19]. It is important to understand factor of food losses at different stages of harvest.

Post-harvest Losses of Cereals in Developing Countries

In developing countries, main cereal grains are rice, wheat and corn. Rice accounts about 70 per cent of calorie intake and over 90 per cent of food produced in Bangladesh [6]. With annual production of rice around 3.3 million tons, Nigeria is currently the largest producer in West Africa [20]. As Bangladesh is

the 4th largest rice producer but due to post harvest losses, every year it imports more than 1 million of tonnes of rice and in Nigeria number of people are undernourished despite of large production of rice. In India in 1999, World Bank reported 7 to 10 per cent grain loss at the time of post-harvest operations in the field and 4 to 5 per cent of losses at the time of marketing and distribution [21, 22]. In India, the loss of food grains every year is equal to the food demand of 1/3 population of India which is 12-16 million metric tonnes [23]. These is need of constant and accurate data on post-harvest losses around the world and need of significant research of assessment of food loss as carried out in India, China, and Brazil [17]. In Nigeria 24.9 percent and in India 3.5 per cent of rice loss was recorded [24]. The estimated loss of rice in Nigeria during food supply chain was 56.7 billion Nigerian naira (NGN). In Bangladesh the total loss of rice from in value chain was reported from 10.74 to 11.70 per cent. Majority i.e., 85.3 to 87.8 percent of the total is related to poor or inadequate storage and 22.92 to 40.99 percent losses at farm level [25]. In South - East Asia the rice losses were recorded as 10 to 37 per cent [8]. In China, the rice losses range from 8 to 26 per cent [17, 26]. In Europe, Asia and North America wheat is a basic food and post-harvest losses in wheat is very high as in rice crop. American National Academy of Sciences reported that the wheat losses in Sudan and Zimbabwe before 1978 were estimated at 6 to 19 per cent and 10 per cent respectively [27]. Very high storage loss of wheat in Bangladesh was reported as 42 per cent. In India, total losses in wheat supply chain were estimated as 4.3 per cent [25]. Out of all losses in wheat, operations in the field contributed to 75.9 per cent of total losses [27]. In Sub-Saharan Africa corn is a major part of the diet and provides approximately 36 per cent of daily calorie intake. For six months storage in traditional granaries in Togo, the estimated weight due to insect invasion was 0.2 to 11.8 per cent [28]. In Guatemala, the estimated loss in maize as much as 40 to 40 percent due to lack to good storage facilities, improper handling and high humidity in this region. Out of all loses, the main cause of losses was considered as insect infection [29]. In three Sub-Saharan African countries Uganda, Tanzania and Malawi, insect pest was considered as main source of grain loss during storage and at farm level the loss was estimated at 1.4 to 5.9 per cent [30]. In ASEAN countries (Association of Southeast Asian Nations), the average loss in maize supply chain is 23 per cent with maximum losses taking place during drying process. In Philippines, most of the corm dried along the sides of the road. In Vietnam, rodents and fungal disease during storage is the main cause of post-harvest losses in maize [8]. Out of total loss of maize in Ghana, about 50 per cent loss of maize is due to insect infestation [35]. According to an economic model by Compton *et al.,* 0.6 per cent to 1 per cent reduction in the value of maize is due to insect infestation [32, 36].

Management to Reduce Losses

With effective storage technology, we can reduce losses associated with storage of plant raw material. The updated infrastructure, good storage practices and proper handling of raw material decreases losses. With the help of governments and NGO's, World Food Programme was carried out operational trials to

demonstrate the improved impact of post-harvest management practices in Uganda and Burkina Faso [31]. New technologies and use of improved practices of storage reducing the food loss by around 98 per cent [6]. In order to promote the adaptability among customers, it is important to technical effectiveness, and limitation of usefulness of new approach. Natural insecticides, chemical fumigation and hermetic storage can help to reduce losses [32, 33]. In warehouses, super and hypermarkets, technological advanced interventions and storage structures can reduce losses [9, 24, 34]. There is need of information and training to adapt and proper use of new technologies [12, 33, 34]. In last few years for effective storage, various hermetic storage options such as purdue improved cowpea storage, super grain bags, metallic soils etc. has been widely promoted which is cost-effective storage technology and popular in several countries [44]. For long distance international shipments, hermetic storage has been noted to be very efficient (losses less than 1 per cent) in avoiding the losses [45]. Smart farming techniques like IoT is very helpful to decrease post-harvest losses in supply chain as well as storage [37]. From seeding to harvest, IoT can help to collect data for monitor and manage practices to decrease losses [38]. Precise use of IoT can help in understanding weather and other climatic conditions and also process data for remote farms [11]. In 2010, IoT was introduced in agriculture and showed incredible potential and growth as compare to other sectors [39]. In many developed countries, synthetic insecticides like Methyl bromide and phosphine are used for controlling pest attack during storage of grains [40]. If in maize gains moisture content is less than 13 per cent (sufficiently dry) then use phostoxin can control larger grain borer. Most of the African farmers use prostoxin, mixture of pirimiphos-methyl, permethrin etc. for avoiding post-harvest losses [41]. To avoid pest infestation for a few months of storage, polypropylene bags after proper application of Actellic Super can successfully use and it is reported that more than 93 per cent of farmers in Tanzania used this method [41, 42]. In India, farmers use oil extract and leaves of Chenopodium ambrosioides Linn. (Chenopodiaceae) for effective control from insect attack while storage [43]. It is studies that pure and crude cotton seed oils, pure soybean oil, crude palm kernel oil, crude rice bran oil as fumigants in wheat and beans against common insects [40].

CONCLUSION

Post-harvest losses greatly impact food grains available for consumption. In developing countries, due to poor economy the management practices for handling, processing and storage of cereals are not as good as in developed countries which results in loss of agricultural produce in large amount. There is need to adopt cost effective methods for storage of cereals which decrease infestation of insect pest, loss of moisture, calories loss, deterioration of food grains. Also, IoT is one of the best opportunities to supervise or control the supply chain processes of cereals to decrease quality and quantity losses of agricultural produce. It is also important to use hermetic storage techniques, synthetic insecticides, pesticides, fungicides and natural fumigants to control insect pest attack on stored grains. With integrated precise techniques we can minimise

post-harvest losses and can fulfil the increase demand of cereals around the world.

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