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INTRODUCTION

The ploughers are the linch-pin of the world; they bear
Them up who other works perform, too weak its toils to share

- Thiruvalluvar

Civilization began with agriculture. When nomadic ancestors began to settle and grow their own food, human society has changed. Villages, towns and cities begin to flourish, along with knowledge, arts and the technological sciences. Human communities, no matter how sophisticated, could not ignore the importance of agriculture. Despite early emphasis on industrialization through import substitution, a first major lesson of postwar experience was that there is a close connection between the rate of growth in the output of the agricultural sector and the general rate of economic development. The growth of economy depends on the rapid expansion of agricultural output. In addition, to provide food and raw materials, agriculture also provides employment opportunities to very large percentage of population.

Agriculture in India has a significant history. India ranks second worldwide in farm output. For decades, agriculture has been associated with production of essential food crops. At present, agriculture includes forestry, dairy, fruit cultivation, poultry, bee keeping, mushroom, arbitrary, etc. Today, storage, processing, marketing and distribution of crops and livestock products etc. are all acknowledged as part of agriculture. Agriculture and allied sectors accounted for 14.1% of the GDP in 2011-12, more than 60% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. In a developing country like India where a very large proportion of income is spent on food and the population is increasing rapidly, the demand for food grains has been increasing at a faster rate.

Cereals and pulses were the first agricultural attempts by early man and it is the most important sources of food. It has a long history of use by humans. Pulses are considered as a primary source of protein. It is often referred as “poor man’s meat”, have a prominent place in the daily diet because of being a rich source of vegetable proteins. It significantly substitutes the scarce and unaffordable animal proteins in improving the nutrition of the populace. Pulses are renowned for their nitrogen fixation ability, and are able to improve and sustain soil fertility (Venugobal *et al*., 2012).

Ali and Venkatesh, (2009) view that pulses occupy an important place in global food and nutrition. In general, pulses have two to three times more protein than the cereals or any other group of crops; besides high protein content, micronutrients and minerals, consumption of pulses also offers numerous other health advantages like low fat and high content of carbohydrate, which is ideal for dieting/weight control. The energy content of most pulses has been found to be between 300 and 540 Kcal/100g. Energy is required for all metabolic processes. The energy of pulses comes from the nutrient supply of protein, fat and carbohydrate. The vitamins present in appreciable quantities in pulses are thiamin, riboflavin, pyridoxine and folic acid; vitamin E and K are also found in pulses.

The B-vitamins act as co-enzymes in biological processes where as Vitamin E is known to play a role as an antioxidant inhibiting the oxidation of vitamin A in the gastrointestinal system and of polyunsaturates in the tissues. It is also believed to maintain the stability of cell membranes. Vitamin K functions primarily in the liver where it is necessary for the formation of blood clotting factors. Ali and Agarwal, (2004) opine that pulses are nature’s precious gift to mankind. In areas where it is traditionally grown, it makes a perfect mix with other cereals and vegetables to give balanced nutrition to the population. Pulses are the preferred choice because of its age-old use as a rich source of protein and amino acid composition that makes it ideal along with rice and wheat to make the food nutritionally balanced and has special significance to people of India who are rice and wheat consumers.

Shah (2012) informs that even on a broader human dietary standing, India is lagging behind many other countries. India is ranked 94th in the Global Hunger Index (2009) by World Food Programme. Around 10-20 per cent of the population is still unable to obtain sufficient food to meet their basic energy needs. Improving food security ought to be an issue of great importance for a country like India where one - third of the population is estimated to be absolutely poor and malnourished in one way or other (Maheswari, 2012). Ali and Kumar (2007) stress that the average intake of pulses is around 29 gm per capita per day as against the recommended dietary allowance of 50gm. More specifically NSSO reported that 42 per cent of the rural and 49 per cent of the urban population receive less than the accepted norm of daily calorie intake (2200 k cal). Inadequate energy and protein in the diet of about 80 million children have caused several disorders associated with Protein Energy Malnutrition (PEM) in the form of marasmus and kwashiorkor. Thus, there is a need to increase pulses consumption to improve overall nutrition as children below 5 years age still suffer from malnutrition, more than 50 per cent of the pregnant women and children are anemic, every third child born in the country runs the risk of micro-nutrient deficiencies which can be primarily addressed through increased consumption of pulses.

Ironically, India is the largest producer and consumer of pulses in the world accounting for about 25 per cent of the global production, 27 per cent of the global consumption and about 33 per cent of world's area under pulses cultivation. According to Agricultural Situation in India (2012), pulses are grown in 22-24 million ha with 13-15 million tonnes of production and 590-630 kg/ha of productivity.

The cultivation of pulses has gradually been pushed to non-irrigated and marginal lands, thus leading pulses crop to more risk prone, as it is vulnerable to pest attacks and sensitive to weather (Sundaram, 2012). Financial Express (2011) highlights the fact during the last 15 years, the production has remained stagnant, thus, resorting to import 1.5 to 2.0 million tonnes of pulses at exorbitant prices from the international market. With ever increasing population, the per capita availability of pulses has declined at an increasing rate to 32g/day. By the end of this decade, the estimated requirement of pulses to the tune of 27.0 million tonnes seems big

challenge. The selected study area “Tamil Nadu” is one of the major pulses growing states in India. Presently, pigeon pea, black gram, green gram, chickpea, cowpea, horse gram and soybean are cultivated in Tamil Nadu over an area of 5.4 lakh ha with a production of 2.01 lakh tonnes of these pulses (Venugobal *et al.,* 2012).

Ali and Kumar (2005), Nagarajan, 2006 and Subbulakshmi *et al*., (2008) revealed that the per capita availability of pulses has declined progressively due to mismatch in population and production growths. The average productivity of pulses in the country is significantly lower than the average yield in the world. Because of the higher productivity of the major cereals like rice, wheat and maize etc., pulses are not in a position to compete them specifically in properly managed irrigated lands.

Pandya and Ali (2000) and Hazra (2011) indicate that the deteriorating pulses production is slowly becoming a major threat due to growth of exponential population and increased focus of protein based food industries. There are four ways of increasing the per capita pulses availability. One of the way is to increase the cultivable area of pulses, second is to increase the productivity of pulses, third is to control the population growth and the fourth one is to prevent post harvest losses especially during storage. Suddenly to increase the area under cultivation as well as to improve the productivity and controlling the population is indeed difficult. Considering the limited and dwindling land and water resources, decreasing productivity and ever increasing population, minimizing storage losses is one of the most effective and economic ways of increasing pulses availability. Pulses production in India is enough to feed its population, if we are able to minimize the post harvest losses in particular the storage losses.

Lal and Verma (2007) reiterate that storage is an important link in the entire procurement and distribution system of pulses. It produced seasonally but consumed all the year round. Pulses can remain in edible condition for several years, if properly stored. However, storage of pulses are difficult than cereals and suffer much greater damage from insects and microorganisms. It not only results in quantitative losses, but also in qualitative reduction of the nutritive value because of vitamin loss and deterioration of protein quality.

Storing pulses for longer period of time has always been a problem for homemakers and farmers as the stored pulses are found to be most often infested with insects and pests. As a result, small and marginal farmers who grow pulses are unable to store their produce and are forced to sell the pulses for a lower price.

Storage is associated with a range of hazards. Insect damage, mould spoilage, pest infestations and fungal attack are the main problems encountered during storage of pulses. Moisture content, temperature, relative humidity, duration of storage and storage devices used are the most important factors affecting the stability of stored pulses. Safe storage is vital to minimize the storage losses.

During storage there may be some nutritional changes to the pulses, although for dry pulses, these changes will be less even over a period of several months. If pulses are stored with higher than ideal moisture content, microbial amylases may begin to breakdown the starch, leading to a deterioration of pulses quality.

Deshpande and Singh (2001) and Kumar *et al*., (2011) disseminate the facts that post-harvest losses account for 9.5 per cent of total pulses production. Among post-harvest operations, storage account for the maximum loss (7.5 per cent). Among storage losses, pulses are most susceptible to damage due to insects (5 per cent) compared to wheat (2.5 per cent), paddy (2 per cent) and maize (3.5 per cent).

Insects are the most diverse species of animals living on earth. Insects, mites and rodent destroy the grains and cereal products quantitatively and qualitatively. Generally rice weevil, lesser grain borer, red rust, flour beetle and rats damage the stored pulses (Shirpurkar, 2005). Besides eating away the grains, the insects and mites destroy the germ portion and thus render it incapable of germination. They also cause dry grain heating and production of large quantities with objectionable mity odour of mites.

The storage loss has become the growing concern in the present situation of inadequate availability of pulses in the midst of increasing population. Kumar and Gupta (2011) mention that insect infestation during storage is a major contributor to

pulses damages both in warm and humid climates. It is estimated that 5 -10% of the world production of food grains is damaged by insects during storage which might be attributed to failure to store properly. Its sustained physical losses are a major threat to food security. Although use of synthetic insecticides may help in reducing pulses damage during storage, they pose serious health hazards to the human beings, animals and environment (Maheswari, 2012). In India, annual storage losses have been estimated as 14 million tonnes of worth of Rs. 7,000 crores in which insects alone account for nearly Rs. 1,300 crores (http://agritech.tnau.ac.in/ agriculture/agri_index.html). Sundaram (2012) reveals that if these losses can be reduced through safe storage practices, about one million tonne pulses will be available more for consumption.

The protection of stored pulses against insect attack is essential for safe and steady supply of high quality food. In the past, insect infestation was often a less serious problem because farmers cultivated varieties, which, although low yielding, generally was more resistant to attack by insects. Karthikeyan *et al*., (2006) state that the introduction of high yielding grain and pulses varieties has resulted in increased storage losses, as these varieties are usually susceptible to insect damage. Hence, storage of pulses without insect infestation is essential.

Revathy (2008) also reiterate that there is a need to reduce losses of stored pulses and to protect them from pest and other attacks by enhancing safe storage techniques. It will enable the homemakers, shop keepers and farmers to protect the pulses both quantitatively and qualitatively, to retain nutritive value of food based on pulses. It should always be recognized that undamaged pulses is essential for successful storage. Cracked or broken pulses provide an entry point for infestation by insects and moulds during storage. Damage to grains may happen due to improper application of post-harvest practices such as threshing, drying or transporting. At a small-scale farming, pulses are stored traditionally in different form of containers depending on the farmer's socio-economic status and his environment (Sallam, 2010). According to Baird *et al*., (2001) pulses in open containers are almost certain to become infested. Storage in plastic, burlap and cloth sack is poor protection against insects, mice, and moisture and is also not recommended.

Improperly dried pulses give out to more heat and moisture in storage as they respire resulting in heat buildup, mould formation, insect rapid multiplication and more dangerously the development of aflatoxins and mycotoxins. There has been a wide spread aflatoxin and mycotoxin outbreaks reported in some parts of the world because of poor post-harvest management and storage. Aflatoxin and mycotoxin are highly toxic chemicals produced by a variety of mould leading to contaminated pulses which as well goes into food and feed ingredient. They are universally poisonous both to livestock through contaminated feed and to consumers of affected animal products. In humans, the direct consumption of low concentration of contaminated grains over a long period of time can be dangerous.

The quality and quantity of pulses can be maintained only through proper storage. The quality of pulses has a direct effect on the health of the consumers. At present, there is a worldwide shortage of all pulses and it is absolutely necessary to produce to the maximum and preserve every grain that is produced to make it available to reach the ultimate consumers.

Keeping quality is a term used to indicate the length of time pulses remains safe and suitable for consumption. Proper pulses storage helps to preserve the keeping quality and maintain nutritive value of the pulses purchased or produced, and also helps to make prevention of spoilage. Proper storage extends the keeping quality of pulses, which depends on the pulses type, storage devices, storage conditions, particularly moisture content, temperature and relative humidity.

There are many ways to maintain the keeping quality of pulses and protecting stored pulses from insect and pests damage. Domestic storage of pulses depends on the responsibility of the homemakers who follow different methods and decide the type of containers to store pulses.

According to Semple (1988) the important aspect of safe pulses storage is the employment of good management practices. It includes examining stored pulses regularly for signs of heating, insect, rodent and mold activity; good housekeeping and sanitation inside and around the premises; cleaning the pulses; maintaining

uniform moisture content in the grain mass, etc. Such practices often are not followed because of the lack of knowledge on safe storage practices of pulses.

Safe storage is necessary to prevent spoilage, increase usability and durability, and also to add to monetary reasons. An effort was thus made to revitalize the indigenous practices followed by rural women for storage of pulses. The practice of using natural sources for storage of various household items was an age old method known for rural women in human history. There is evidence of botanicals used in ancient civilization and the same have also been credited with healing power for increasing storage life.

Hellpap and Dreyer (2000) point out that, farmers all over the world used simple plant preparations to protect their crops and stored products against pest damage. For example, the insecticidal properties of the neem tree have been known for many years. People in India placed neem twigs and leaves in their beds, in cupboards, among clothes and stored grains to reduce infestation by moths and bedbugs, and used neem oil as a protectant for stored pulses. The highly effective ancient methods were slowly pushed out of practice and even forgotten due to the introduction and wide distribution of synthetic insecticides during the last four decades.

Kumar and Gupta (2011) also affirm the fact that application of insecticides has become indispensable in storage of pulses to safeguard the pulses from insect and pest attack. But, today with increasing health concerns among consumers and the steep rise in price of pesticides and insecticides, effective ancient methods and cheap sources like botanicals assumes greater importance.

Increasing consciousness about conservation of environment as well as health hazards owing to high use of chemicals in food production and consumer preference to safe and hazard-free foods are the major factors that lead to the growing interest in indigenous storage practices (Saravanan, 2006). Karthikeyan.et.al (2006) reveals that indigenous knowledge is the ancient know-how that was closely embedded in the life style of rural population. Under certain circumstances, it can be equal or even superior to the know-how introduced by modern research. A proper and optimal blend of indigenous and modern wisdom would be the right answer for

good impact and better utilization of the native knowledge by the rural artisans. It has little or no cost and is readily available. Indigenous knowledge systems and techniques are found to be socially desirable, economically affordable, and sustainable and involve minimum risk to farmers.

Sarkar and Maitra (2001), Jeeva and Anusuya (2005), Jeeva *et al.,* (2005) and Jeeva *et al.,* (2006) opine that the indigenous practices of using botanicals during storage of pulses can be beneficial in improving the keeping quality thereby retaining the quality of pulses to the extent possible as it was at the time of harvest. Identification and utilization of such indigenous knowledge from the elderly people from rural and tribal belts will surely bridge the gap between the current scientific and age-old practices.

Plant materials with insecticidal properties provide small-scale farmers with a locally available, bio-degradable and inexpensive method of pest control for storage. Botanicals could, therefore, have advantages over synthetics as a cost-effective and environmentally sustainable alternative for protecting stored pulses against insect attack. However, information and scientific support on botanicals is generally inadequate, and it is often difficult to recommend particular plant materials as a replacement for chemical insecticides since the efficacy levels of botanicals can vary among storage pests, application methods, and stored products.

Nowadays inorganics are replaced either partially or totally with botanicals due to the awareness among the public on pollution and importance of preservation of land and air for their future generations. The significance of eco-friendly methods promotes ecological soundness and sustainable use of natural resources as well. It is a continuously developing broad spectrum and an interdisciplinary area of research that can be established for maintaining the quality of pulses during long period of storage.

Storage pests are controlled with the indigenous practices involving various plant species available locally and other naturally available unused products. Over the years these practices have been proved effective and widely accepted. Unfortunately, very little importance was given to further develop as a technique and establish the same, hence they vanished gradually (Lakshmanan, 2006).

Malarkodi and Srimathi (2012) assure that botanicals in the form of leaf powders with varying concentrations have been proved to catalyze chemical reactions and are efficient in retaining keeping quality. In addition, leaf powders have their own growth hormones responsible for keeping pulses quality, maintenance of vigour and viability, insecticidal property and reducing the accumulation of free radical that is responsible for pulses senescence during aging.

They also reveal that botanicals are considered as one of the safer alternatives to chemical insecticides as they are reservoirs of secondary compounds produced by selected botanicals that could be used for pest control purposes. In recent years many attempts have been made to replace synthetic pesticides by botanicals which are easily available, safer for application and more specific to control of pathogen infection and insect infestation. Botanical leaf powders of plants are known for their neutraceutical and antioxidant properties and can be used for slowing down the deterioration rate in pulses in addition to the protection rendered against storage mycoflra and insects (Malarkodi and Srimathi, 2012).

Maheswari (2012) envisage that the traditional methods of using botanicals such as *Azadirachta indica* (Neem) *Vitex nigundo* (Nochi) and *Pongamia pinnata* (Pongamiya) leaves with pest control characteristics as storage protectant have increasingly been explored and applied in many countries. Therefore, there is an urgent need for researchers, scientists and policy-makers to develop simple techniques and adopt code of practice that are economical, which can be implemented to minimize any avoidable wastage of stored products. Moreover removal of these powders from pulses before consumption is not essential as these plants are non-toxic in nature and also have medicinal properties that could aid the human well being.

Among several botanicals to prevent insect and pest attacks in stored pulses, *Azadirachta indica* (Neem) *Vitex nigundo* (nochi) and *Pongamia pinnata* (pongamiya) play an important role in preventing pulses losses in storage. All the selected botanicals contain several active chemicals, which are extremely effective against insects, even in minute quantities. For example, the active ingredient in

neem, azadirachtin consist of compounds called liminoids, which act somewhat like steroids. When insects eat neem-coated foliage, the liminoids disrupt normal hormone production and processing, causing a loss of appetite in some insects and interfering with normal reproduction, maturation, and molting patterns in others. Suri and Mehrotra, (2008) also reiterates that azadirachtin and other limonoids such as meliantriol and salannim are also detrimental to insect and pests. Azadirachtin repels insects, inhibits their feeding practices and affects their hormonal balance by mimicking as insect hormone and thereby preventing it to cause the damage to the pulses.

Indeed, neem is reported to be antifeedant, repellent, insecticide, nematicide, growth disruptor and antimicrobial. It is also noted that preparation of these botanicals are easy and can effectively be used in storage to prevent insect pest damage. They are environmentally safe and also not harmful to humans and animals. The performance of neem leaf powder is due to antifeedancy and blockage of choromosome for further reproduction that resulted in loss of fitness of insects for further feeding. The neem leaf powder acted as antioxidant during storage and helped in preservation of pulses for longer duration (Malarkodi, Srimathi, 2012).

Following Neem, Nochi (*Vitex nigundo*) leaves are added to stored grains to protect from insect and pest attacks (The Hindu, 16/4/2013). The nochi leaf powder has repellant and insecticidal property that prevents the insect attack in storage and the presence of active ingredient nishidine inhibits the oviposition of bruchids and safeguards the pulses from bruchid infestation.

Pongamia pinnata (Pongamiya) is also fast growing multi-purpose tree. It grows in humid and subtropical environment in almost all soil types. Dried leaves of *Pongamia pinnata* are used as an insect repellent in stored grains (Bobade and Khyade, 2012). Reena *et al.*, 2012 also state that different parts of *Pongamia pinnata* (*viz.,* leaves, root, bark, flowers and seeds) containing a number of furano-flavonoid compounds and known to possess pesticidal activity.

According to Malarkodi and Srimathi (2012) the use of botanicals not only prevents insect and damage on pulses in storage and also retains keeping quality of pulses. Botanicals are considered as one of the safer alternatives to insecticides. Feng and Isman (1995) opined that insect's resistance weakens with crude forms like powders and mixtures. Paul *et al* (2009) also stated that if plant materials are readily available, it will be easy for farmers to prepare the pulverized form as this is the simplest and cheapest method for preparing botanicals. *Azadirachta indica* (Neem) leaf powder and *Vitex nigundo* (Nochi) leaf powder have excellent pest repellant property that prevents insect attack on storage. Similar effect is also exhibited by *Pongamia pinnata* (Pongamiya).

The above discussed use of botanicals in storage of pulses for extending the keeping quality of pulses are comprehensive and easy to implement, however there is no proper dissemination of information to homemakers, shop keepers and farmers regarding safe storage techniques of pulses, and they are often ignorant about the same.

Sharing knowledge through training is the best way to take full advantage of the knowledge gained. Training helps to transfer the techniques for improving the existing knowledge and enhancing skills and capabilities. Training of homemakers is important to make use of the neutral and potential capabilities of women. Educating women helps in a big way as the knowledge is passed on through many generations. Hence, a woman is the focal point of the training programme. If they are imparted with necessary education, training and skills needed, no doubt it would result in prevention of pulses loss in storage. There is need for intensive efforts in pushing up the safe storage practices of pulses with special reference to botanicals.

It has to be reinforced that time honoured methods like use of natural botanicals are very effective. This study would help to bring back life to the use of highly effective method of using botanicals in storage. Moreover when good storage practices are combined with good hygiene, adequate drying and all other safety measures, it will be more effective in preventing storage losses.

Therefore, **this study is an attempt to prevent losses in stored pulses through introduction of locally available botanical leaf powders and to educate the homemakers and shop keepers on safe storage techniques in improving the keeping quality and to develop the procedure of using selected botanicals during storage of pulses in the respective households and shops**.

Against this background, the implementation of these techniques in pulses storage practice for its advantages and eco-friendly nature attains significance. Thus, there is a need to experiment on the insecticidal qualities of different botanicals and impart training on safe storage techniques and the use of different botanicals to prevent pulses damage during storage due to insect and pest attack. Hence, the study has been undertaken with the following objectives.

Objectives : to

- elicit information on socio-economic background of the selected households analyse the purchasing behaviour and consumption pattern of households with special reference to pulses
- study the existing pulses storage practices and problems faced during storage in the selected households
- find out the market trend, selling pattern and storage practices of pulses in the selected provision shops
- assess the keeping quality of selected pulses stored with different botanicals
- educate homemakers and shop keepers on the use of different botanicals during storage of pulses
- evaluate the impact of the training programme conducted
- Know the association between levels of knowledge, attitude, adoption and socio-demographic characteristics of homemakers and shop keepers

The Hypothesis framed for the study

- Storing pulses with selected botanicals does not help in retaining the keeping quality of pulses.
- Training on the use of different botanicals during pulses storage does not improve the knowledge and attitude of homemakers and shop keepers.
- Adopting the method of using different botanicals during pulses storage may not solve storage problems.
- There is no significant association between the levels of knowledge, attitude and adoption and demographic characteristics of homemakers.
- There is no significant association between the levels of knowledge, attitude and adoption and demographic characteristics of shop keepers.

It is believed that this study will help the homemakers and shop keepers to improve their storage practices, preventing insect and pest damage during storage of pulses using botanicals that will enhance the keeping quality of pulses.

"Ancient techniques for modern times"