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Quantifying the Correlation between Seed Moisture Content and Seed Weight Across Diverse Crop Varieties: A Comprehensive Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Seeds, possessing inherent hygroscopic characteristics, undergo the processes of moisture absorption and desorption until a point of equilibrium moisture content (EMC) is reached, wherein the moisture levels in the seeds align with those in the surrounding environment. To investigate the intricate relationship between seed moisture content and weight, a comprehensive study spanning 10 months was conducted, employing diverse crop seeds (Paddy, Maize, Soybean, Groundnut, Redgram and Greengram). Notably, variations in equilibrium moisture content (EMC) were identified, with cereals and pulses exhibiting higher EMC than oilseeds. Robust positive correlations (0.71 to 0.88) between seed moisture and weight were established, underscoring the economic

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implications of drying losses. Economic losses were quantified, revealing substantial financial impacts in all crops. For instance, paddy seeds stored at 20% moisture experienced drying losses of 15.83%, translating to an economic loss of ₹579.39. Similar patterns were observed in maize, redgram, greengram, soybean, and groundnut, emphasizing the critical role of seed moisture considerations in storage management and the substantial economic losses incurred across diverse crops.

Keywords: Seed moisture content; equilibrium moisture content; drying loss; economic loss; correlation; regression analysis.

1. INTRODUCTION

A seed is a living entity, made up of the embryo or miniature plant, the endosperm and other food reserves, protected by the seed coat. Seeds are hygroscopic in nature; it lose or gains moisture, when there is fluctuation in the surrounding atmosphere (McDonald & Stanwood, 1989). A small change in seed moisture content has large effect on the storage life of the seeds. In view of seed quality, a reduction in seed moisture content is desirable, which increases seed longevity and maintains the seed quality. However, in the view of seed storage, the weight of seeds will be reduced due to moisture loss and quantification of this loss is required for accountability in seed units and warehouses. This weight loss is called drying loss or invisible loss.

Following harvest, a seed grower usually supplies the seed at a higher moisture content during non-congenial weather, which can't allow for drying. Upon arrival of seeds, it must be dried to a safe moisture level or else seeds will reach equilibrium moisture content (EMC). One of the effects involved in the drying of seed/grain is the weight loss that occurs during the drying process. This weight loss by drying is referred to as "shrink" and is expressed as a percentage of the original weight in order to accurately determine the total cost.

Seed/grain buyers use a number of different procedures to calculate how much grain they will actually have after the grain they buy is dried. The calculation process is called "pencil shrink." Grain weight shrinkage due to drying or moisture loss includes weight loss due to the removal of both water and dry matter. Water shrinkage is the major component of total shrinkage and the easiest to calculate. Calculated dry matter losses tend to be variable due to different pencil shrink procedures used within the grain industry. In order to accurately compare custom drying quotes or grain sale alternatives, we should determine the shrinkage costs associated with moisture content (Anon., 2001).

While universal formulas exist for calculating seed/grain loss, they often lack precision and fail to account for crop-specific characteristics. This study aims to address this gap by establishing absolute correlations between seed moisture loss and seed weight loss across six diverse crop types: paddy, maize, soybean, groundnut, redgram, and greengram. By quantifying the correlations between moisture levels and weight loss, and translating these into tangible economic impacts, this study aims to inform more effective moisture management strategies, ultimately contributing to enhanced seed longevity and reduced financial risks in seed storage operations.

2. MATERIALS AND METHODS

Seed Source: The study utilised seeds from six diverse crop varieties, including paddy (KRH-4), maize (HEMA), soybean (JSS-335), groundnut (KCG-6), redgram (BRG-5), and greengram (KKM-3). Specifically selected for their agricultural significance and varying moisture content characteristics. These seeds were sourced from certified seed production plots at the National Seed Project, GKVK, University of Agricultural Sciences, Bangalore. The selection of seeds from these plots ensured that the initial moisture content was approximately uniform and representative of typical field conditions. This sourcing method is crucial for maintaining the integrity of the experimental results, as it minimizes variability in seed quality and moisture content due to environmental factors.

Storage Conditions: The seeds were stored in cloth bags under controlled conditions to facilitate accurate measurement of moisture absorption and desorption over time. The storage environment was maintained at a room temperature of **25°C** with a relative humidity of approximately **60%**. This setting simulates typical storage conditions experienced by farmers and seed producers. To ensure seed protection from pest incidence, seeds were treated with insecticide *viz*., Spinosad @0.04ml/L of H_2O.

Experimental Design: The study employed a Completely Randomized Design (CRD) to evaluate the effects of varying moisture contents on seed weight loss. The experimental setup included thirteen treatment levels (T1 to T13), each representing different moisture content percentages ranging from **8% to 20%**.

Moisture Content Treatments: To achieve the desired moisture content levels, seeds were subjected to a humidity chamber maintained at 21°C and 99% relative humidity for a period of 24 hours. This process allowed the seeds to equilibrate with the surrounding humidity, facilitating accurate assessment of their hygroscopic properties. Each treatment level was carefully monitored, and monthly observations were conducted to record changes in seed weight corresponding to variations in moisture content.

Seed moisture content was estimated by using the destructive oven method (ISTA, 1985).

a. **Destructive method:** high constant temperature method (130 ^{0}C) was used for maize (4hr), paddy (2hr), redgram (1hr), and greengram (1hr). Low constant temperature method (103 ^{0}C) was adopted for soybean (17 hr) and groundnut (17 hr).

b. Moisture content was calculated using the formula;

$$M = \frac{m_2 - m_3}{m_2 - m_1} \times 100$$

Where,

M = Seed moisture content
m_1 = Weight of the empty container with its cover
m_2= Weight of the container with its cover and seeds before drying
m_3 = Weight of the container with its cover and seeds after drying

Seed weight (g): The average weight of 100 seeds (soybean, redgram, maize and groundnut) and 1000 seeds (paddy and greengram) was measured using a digital balance by randomly picking seeds from the lot and the average values are presented.

Seed drying loss (%): The percentage loss in seed weight due to loss in seed moisture content during storage was calculated by using the formula given by AOAC (slightly altered), 1984 for the determination of moisture content (Shalini et al, 2017);

$$\text{Drying loss (\%)} = \frac{\text{ISW}-\text{FSW}}{\text{ISW}} \text{x } 100$$

Where,

ISW= Initial seed weight (g),
FSW= Final seed weight (g)

Economic loss: Economic loss due to drying is calculated by assessing the financial impact of weight loss on seed sales. This assessment considers the minimum support price (MSP) (Anon., 2020) for each crop, which is the price at which the government purchases crops from farmers to ensure they receive fair compensation. The formula for calculating economic loss can be expressed as:

EL= DL×ISW×MSP
Where:

- **EL** = Economic Loss (Rs)
- **DL** = Drying Loss (%)
- **ISW** = Initial Seed Weight (kg)
- **MSP** = Minimum Support Price (Rs/kg)

Statistical Analysis:

Data were statistically analysed using ANOVA appropriate for Completely Randomized Design (CRD) at a significance level of **1%** (Sundarajet al., 1972). In this study, different moisture content levels (ranging from 8% to 20%) were treated as independent variables, while seed weight was the dependent variable.
The statistical model used in CRD can be expressed as:

$$\mathbf{Y_{ij}=\mu+\tau_i+\epsilon_{ij}}$$

Where:

- Y_{ij} = Observed value for the jth replicate of treatment i_i
- μ = Overall mean
- τ_i = Effect of the ith treatment (moisture content level)
- ϵ_{ij} = Random error associated with the jth replicate of treatment i_i

In addition, to quantify the relationship between seed moisture content and seed weight, **correlation and simple linear regression** analysis was performed using data analysis tools in MS Excel.

The regression model can be represented as:

W = a + bM

Where:

- W= Seed weight (g)
- M = Seed moisture content (%)
- a = Intercept (the estimated weight when moisture content is zero)
- b = Slope (the change in seed weight for each 1% change in moisture content)

The regression coefficients were estimated using the least squares method, which minimizes the sum of the squared differences between observed and predicted values.

3. RESULTS AND DISCUSSION

The study revealed significant relationships between seed moisture content, seed weight, and economic losses across various crop types during a 10-month storage period. The findings can be summarized and discussed as follows:

3.1 Equilibrium Moisture Content

Seeds of different crops achieved varying levels of EMC. Cereals (paddy and maize) and pulses (redgram and greengram) exhibited higher EMC compared to oilseeds (soybean and groundnut). Table 1 represents the EMC of different crops used for the study and it is observed that the seeds of paddy, maize, redgram, greengram, soybean and groundnut attained an equilibrium moisture content of 12.5, 12.6, 13.0, 13.0, 10.0 and 8.8 *per cent,* respectively at storage temperature of ±25 ^{0}C and relative humidity of ± 60 per cent. Whereas, a slight increase in relative humidity to 65% around stored seeds increased the equilibrium moisture content of paddy, maize, redgram, green gram, soybean and groundnut to 13.5, 13.2, 14, 14, 11 and 9.6 *per cent,* respectively.

This indicates the influence of storage atmospheric conditions *viz*., temperature and relative humidity, on the moisture content of the seeds. As relative humidity increases, the capacity of the air to hold moisture also increases, leading to higher EMC in seeds. As EMC of the seeds depends on seed maturity, chemical composition and genotype, along with temperature and humidity of the air, as well as sample history, processing method and other storage conditions (McDonald, 2007 and Delouche, 1968). This variation can be attributed to the chemical composition of the seeds. Seeds with higher starch and protein content, such as cereals and pulses, have a greater affinity for water due to the presence of hydrogen bonding sites in these compounds. In contrast, oilseeds, which are rich in lipids, have fewer polar groups and thus less attraction for water. The higher EMC in cereals and pulses compared to oilseeds might be a result of their chemical composition. Seeds containing starch and protein as storage compounds are ideal for hydrogen bonding with water because of zwitter ions of aminoacids in proteins (Bhagavan, 2002) and α-1,4,6 bonds & amylopectin in starch (Zhao Ming et al., 2018) provide hydroxyl groups for hydrogen bonding with water consequently, seeds with large amounts of proteins and starch will adsorb large quantities of water (McDonald, 2007).

3.2 Correlation and Regression Analysis

Here the correlation and regression models were used to explain the functional relationship between seed moisture and seed weight (*Fig* 1). The correlation analysis indicates the significant and positive correlation between seed moisture and its weight in paddy, maize, soybean, groundnut, redgram and greengram with correlation coefficient (r) of 0.71, 0.86, 0.71, 0.88, 0.71 and 0.82, respectively and the regression model supports the results of correlation. Regression analysis revealed that for every 1 per cent change in moisture content, an average of 0.34 g, 0.56 g,0.30g, 0.45g, 0.34g and 0.63g of seed weight (g/kg) gets altered significantly in paddy, maize, soybean, groundnut, redgram and greengram respectively, which is indicated by its regression co-efficient values (Fig 1). The positive association between seed moisture content and seed weight is due to the hygroscopic nature of seeds, which allows them to absorb moisture from their environment. This absorption results in an increase in weight as water molecules bind to the internal structures of the seeds (Shaykewich, 1973).

R-squared value indicates 50.7, 74.5, 50.9, 86.4, 50.7 and 79.3*per cent* of variation in seed weight due to variation in seed moisture content in paddy, maize, soybean, groundnut, redgram and greengram, respectively by keeping other variables constant. Here scatter plot (*Fig* 1) drawn through regression model indicates the higher seed weight variation in paddy, maize, redgram, greengram, groundnut and soybean at its respective equilibrium moisture contents *viz*., 12.75, 12.87, 13, 13, 11, 9.1 *per cent* respectively and these might be due to reduction of further absorption and desorption of moisture content from surrounding air when seeds reach EMC (Stanwood & McDonald, 1989; Alsadon, 2001).

3.3 Influence of seed Moisture Content on Seed Weight

The lab experiment was conducted using various seed crops to study the relationship between seed moisture content and its seed weight during storage and the results of the analysis of present study are discussed as below.

3.4 Paddy

In paddy, seeds with varying moisture content (8-20%) were found to achieve equilibrium moisture content (EMC) from the 2nd month of storage. Notably, the seeds stabilize at an average EMC of 12.65%, 12.60%, 12.59%, 12.65%, and 12.82% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively (Table 2). Within various seed moisture treatments (from 8 to 20 %), maximum reduction in seed weight from initial seed weight of 16.93 g to 15.21, 14.94, 14.73, 14.48 and 14.25 g accompanied by higher drying loss of 10.16, 11.76, 12.99, 14.47 and 15.83 *per cent* was recorded in seeds stored at moisture content of 20 % during 2nd, 4th, 6th,8th and 10th month of seed storage respectively. While seeds stored at a lower moisture content of 8 % showed a gain in seed weight by 3.48, 3.63, 3.78, 2.34 and 1.21 *per cent* during 2nd, 4th, 6th,8th and 10th month of seed storage, respectively, followed by moisture content of 9 and 10 % (Table 2). While, the seeds stored at moisture content of 13 % showed minimum variation in seed weight from14.67 g (initial) to 14.65, 14.61, 14.53, 14.49 and 14.24 g with least drying loss of 0.14, 0.41, 0.95, 1.23 and 2.93 % during 2nd, 4th, 6th,8th and 10th month of seed storage respectively as at this moisture content seeds attained equilibrium (Table 1 and Fig 1) with surrounding air.

3.5 Maize

The effect of seed moisture content on maize seed weight throughout the 10-month storage period is summarized in Table 3. Maize seeds, spanning moisture levels from 8% to 20%, achieve equilibrium moisture content (EMC) from the 2nd month of storage. Notably, the seeds stabilise at an average EMC of 12.88%, 12.72%, 12.52%, 12.59%, and 12.69% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively.

Across various seed moisture treatments (ranging from 8% to 20%), the highest reduction in seed weight occurred in seeds stored at 20%, decreasing from an initial weight of 34.07 g to 31.93 g, 31.32 g, 31.09 g, 30.79 g, and 30.35 g during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. This was accompanied by higher drying losses of 6.28%, 8.07%, 8.75%, 9.63%, and 10.92%, respectively. Conversely, seeds stored at a lower moisture content of 8% exhibited an increase in seed weight by 3.99%, 4.17%, 4.52%, 2.10%, and 1.12% during the corresponding months. Seeds stored at 13% moisture content showed minimal variation in seed weight, ranging from the initial 30.78 g to 30.65 g, 30.59 g, 30.51 g, 30.46 g, and 30.41 g, with the least drying losses of 0.42%, 0.62%, 0.88%, 1.04%, and 1.20% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. This moisture content facilitated equilibrium with the surrounding air (Table 1 and Fig 1).

3.6 Pigeon pea

The relationship between seed moisture content and redgram seed weight over 10 months of storage is depicted in Table 4. Redgram seeds, ranging from 8% to 20% moisture content, achieve equilibrium moisture content (EMC) from the 2nd month of storage. The seeds stabilize at an average EMC of 13.02%, 13.11%, 13.08%, 13.17%, and 13.25% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively.

In the study's various seed moisture treatments (8% to 20%), the maximum reduction in seed weight occurred in seeds stored at 20%, decreasing from an initial weight of 16.18 g to 14.38 g, 14.31 g, 14.30 g, 14.28 g, and 14.23 g during the 2nd, 4th, 6th, 8th, and 10th months, respectively. This reduction was accompanied by higher drying losses of 11.12%, 11.56%, 11.62%, 11.74%, and 12.05%, respectively. Conversely, seeds stored at 8% moisture content gained weight by 2.99%, 3.30%, 3.46%, 1.42%, and 0.39% during the corresponding months. Seeds stored at 13% moisture content showed minimal variation in seed weight from 14.08 g to 13.99 g, 13.95 g, 13.94 g, 13.91 g, and 13.67 g, with the least drying losses of 0.64%, 0.92%, 0.99%, 1.21%, and 2.91% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. At this moisture content, seeds attained equilibrium with the surrounding air (Table 1 and Fig. 1).

3.7 Greengram

The relationship between seed moisture content and greengram seed weight during 10 months of storage is depicted in Table 5. Greengram seeds, with moisture content ranging from 8% to 20%, attain equilibrium moisture content (EMC) from the 2nd month of storage. The seeds stabilize at an average EMC of 13.09%, 13.18%, 13.09%, 13.05%, and 13.04% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively.

In various seed moisture treatments (8% to 20%), the maximum reduction in seed weight occurred in seeds stored at 20%, decreasing from an initial weight of 48.12 g to 43.75 g, 43.39 g, 43.24 g, 43.17 g, and 42.95 g during the 2nd, 4th, 6th, 8th, and 10th months, respectively. This reduction was accompanied by higher drying losses of 9.08%, 9.83%, 10.14%, 10.29%, and 10.74%, respectively. Conversely, seeds stored at 8% moisture content gained weight by 2.32%, 3.85%, 3.75%, 3.63%, and 1.78% during the corresponding months. Seeds stored at 13% moisture content showed minimal variation in seed weight from 43.25 g to 43.05 g, 42.99 g, 42.93 g, 42.75 g, and 42.68 g, with the least drying losses of 0.46%, 0.60%, 0.74%, 1.16%, and 1.32% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. At this moisture content, seeds attained equilibrium with the surrounding air (Table 1 and Fig. 1).

3.8 Soybean

The impact of seed moisture content on soybean seed weight over a 10-month storage period is depicted in Table 6. Soybean seeds, with moisture content ranging from 8% to 20%, achieve equilibrium moisture content (EMC) from the 2nd month of storage. The seeds stabilize at an average EMC of 11.51%, 11.40%, 11.13%, 11.08%, and 11.22% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively.

Within the various seed moisture treatments (8% to 20%), the maximum reduction in seed weight occurred in seeds stored at 20%, decreasing from an initial weight of 14.09 g to 12.97 g, 12.57 g, 12.51 g, 12.40 g, and 12.29 g during the 2nd, 4th, 6th, 8th, and 10th months, respectively. This reduction was accompanied by higher drying losses of 7.95%, 10.79%, 11.21%, 11.99%, and 12.78%, respectively. Conversely, seeds stored at 8% moisture content gained weight by 2.67%, 3.03%, 1.56%, 0.46%, and -0.09% during the corresponding months. Seeds stored at 11% moisture content showed minimal variation in seed weight from 12.19 g to 12.18 g, 12.17 g, 12.15 g, 12.13 g, and 12.05 g, with the least drying losses of 0.08%, 0.16%, 0.33%, 0.49%, and 1.15% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. At this moisture content, seeds attained equilibrium with the surrounding air (Table 1 and Fig. 1).

3.9 Groundnut

The impact of seed moisture content on groundnut seed weight over a 10-month storage period is shown in Table 7. Groundnut seeds, with moisture content ranging from 8% to 20%, achieve equilibrium moisture content (EMC) from the 2nd month of storage. The seeds stabilize at an average EMC of 9.58%, 9.43%, 9.24%, 9.13%, and 9.26% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively.

Among various seed moisture treatments (8% to 20%), the maximum reduction in seed weight occurred in seeds stored at 20%, decreasing from an initial weight of 49.71 g to 45.17 g, 44.73 g, 44.61 g, 44.38 g, and 44.25 g during the 2nd, 4th, 6th, 8th, and 10th months, respectively. This reduction was accompanied by higher drying losses of 9.13%, 10.02%, 10.26%, 10.72%, and 10.98%, respectively. Conversely, seeds stored at 8% moisture content gained weight by 0.14%, 0.27%, 0.32%, -0.52%, and -0.77% during the corresponding months. Seeds stored at 10% moisture content showed minimal variation in seed weight from 44.75 g to 44.67 g, 44.63 g, 44.47 g, 43.99 g, and 43.92 g, with the least drying losses of 0.18%, 0.27%, 0.63%, 1.70%, and 1.85% during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively. At this moisture content, seeds attained equilibrium with the surrounding air (Table 1 and Fig. 1).

Across all crop types, seeds stored at higher moisture contents (20%) exhibited the highest weight loss and drying loss percentages throughout the storage period. In contrast, seeds stored at lower moisture levels (8–10%) often demonstrated weight gains, likely due to their proximity to equilibrium moisture conditions. Minimal weight fluctuations were observed in seeds stored at moisture contents near their equilibrium moisture content (EMC), indicating stability in mass under those conditions. These findings align with Mwithiga & Sifuna (2006), who reported that increases in seed moisture content lead to an increase in seed mass and volume due to hygroscopic expansion of cellular structures. This expansion not only affects individual seed weight but also alters bulk density and packing behaviour during storage. Egli (1990) highlighted that seed water relations play a critical role in regulating the duration of seed growth in soybean, directly influencing final seed size. This supports our analysis linking seed moisture content with seed weight across diverse crop varieties. Kelly et al. (2011) demonstrated that storage reserves are not solely decisive for germination, while Zhang et al. (1994) showed that volatile compounds from dry seeds accelerate deterioration. Together, these findings emphasize that seed weight and moisture content serve as critical structural traits governing seed quality and longevity across diverse crop varieties.

Furthermore, Sravanthi et al. (2022) emphasized the significance of understanding moisture-weight dynamics across crop types, supporting the observed variability in seed weight changes in relation to storage moisture content in the present study.

3.10 Quantification of Economic Loss Due to Seed Drying at Various Levels of Moisture

Seed weight shrinkage due to desorption of moisture throughout storage marks seed drying loss. It is a physical loss of grain caused by drying, even though drying loss is not considered as post-harvest loss (Grolleaud, 2002 and Monika, 2018) but still it yields considerable economic loss during seed storage. Hence, an attempt was made to quantify the economic losses at various moisture levels during seed storage in different crops. Quantification of economic loss due to drying loss was estimated using the existing minimum support price (Anon., 2020) for paddy (1868 Rs/q), maize (1850 Rs/q), redgram (6000 Rs/q), greengram (7196 Rs/q), soybean (3880 Rs/q) and groundnut (5275 Rs/q) and the results are discussed as below.

For paddy, the higher economic losses were recorded at moisture content of 20%, amounting to 189.78, 219.67, 242.74, 270.32, and 295.70 Rs/q during the 2nd, 4th, 6th, 8th, and 10th months of storage, respectively, due to drying losses of 10.16%, 11.76%, 12.99%, 14.47%, and 15.83% (Table 8) . In maize, similar trends were observed with economic losses of 116.20, 149.32, 161.81, 178.10, and 202 Rs/q at the same moisture level during the respective months due to drying losses of 6.28%, 8.07%, 8.75%, 9.63%, and 10.92% (Table 9). Redgram exhibited higher economic losses of 667.49, 693.45, 697.16, 704.57, and 723.11 Rs/q at the moisture content of 20% due to drying losses of 11.12%, 11.56%, 11.62%, 11.74%, and 12.05% (Table 10). In greengram, economic losses reached up to 653.50, 707.34, 729.77, 740.24, and 773.14 Rs/q at the same moisture content with drying losses of 9.08%, 9.83%, 10.14%, 10.29%, and 10.74% (Table 11). For soybeans, the economic losses were recorded at higher levels as well, with values of 308.42, 418.57, 435.09, 465.38, and 495.67 Rs/q due to maximum drying losses of 7.95%, 10.79%, 11.21%, 11.99%, and 12.78% (Table 12). Lastly, groundnut experienced economic losses of 481.76, 528.46, 541.19, 565.60, and 579.39 Rs/q at a moisture content of 20% due to drying losses of 9.13%, 10.02%, 10.26%, 10.72%, and 10.98% (Table 13).

In turn Table 2 to 13 indicates the higher drying and economic losses in cereals (paddy and maize) followed by pulses (redgram and greengram) and least were observed in oilseeds (groundnut) over 10 months of storage. This is as a consequence of desorption of large amount free water from the seed system into the surrounding air, when the moisture content of the seed is higher than the surrounding. The moist air must be evacuated and refreshed by dry air. This process continues till the seeds have reached the required equilibrium moisture (Alsadon, 2001; Vega et al., 2005; Gaston et al., 2009) and this is recognized by a shrinkage factor (Hicks and Cloud, 2001). Seed moisture loss might be lead to economic loss if it is not taken into account by grading for price control (Gaston et al., 2009; Gardisser and Langston, 2019).

The economic losses associated with seed drying at various moisture levels might be attributed to several interrelated factors. First, the relationship between seed moisture content and drying loss is critical, as moisture content increases, the potential for drying loss also rises, leading to significant economic impacts (Grolleaud, 2002; Monika, 2018). Additionally, prolonged storage duration exacerbates these losses, as seeds experience increased moisture desorption over time. Crop-specific characteristics also play a role, for instance,

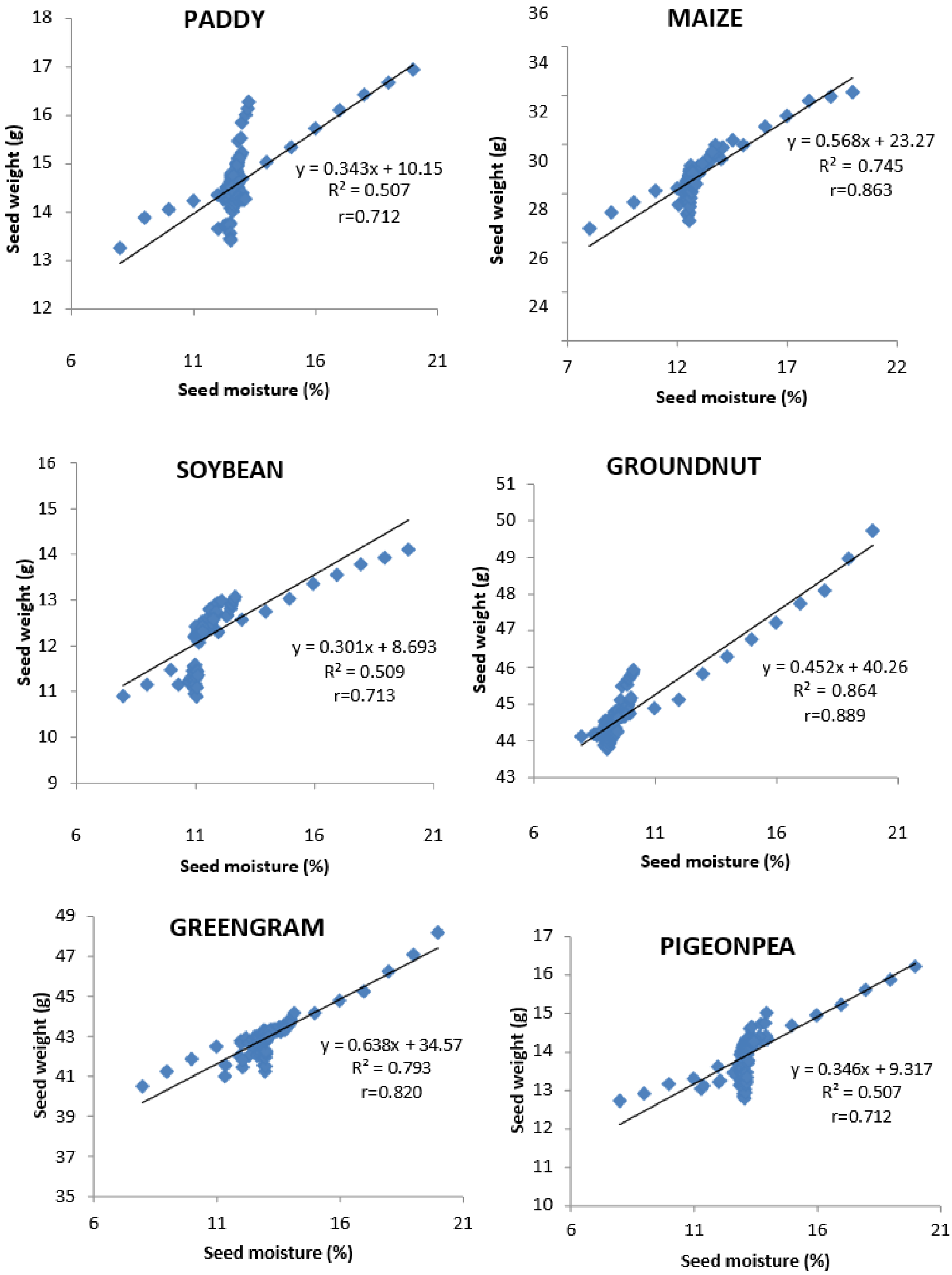

Fig. 1. Simple linear regression and correlation matrix between seed weight and its moisture content under storage condition in various crops

redgram exhibited the highest economic losses at Rs/q 723.11 at 20% moisture content due to its unique physiological traits (Monika, 2018). Furthermore, the prevailing minimum support prices influence the quantification of these losses, with variations across different crops affecting overall economic impact. Understanding these dynamics is essential for developing strategies to mitigate economic losses during seed storage (Grolleaud, 2002).

Table 1. List of equilibrium moisture content (EMC) of various crop seeds (at temp ±25 ^{0}C and RH between ±60 and ±65 %)

Sl.No.	Crops	EMC (%)	
		RH ±60 %	RH ±65 %
1	Paddy	12.5	13.5
2	Maize	12.6	13.2
3	Redgram	13.0	14.0
4	Greengram	13.0	14.0
5	Soybean	10.0	11.0
6	Groundnut	8.8	9.6

Table 2. Influence of seed moisture content on seed weight of paddy during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
1	8.00	13.23	12.27	13.69	3.48	12.41	13.71	3.63	12.49	13.73	3.78	12.51	13.54	2.34	12.53	13.39	1.21
2	9.00	13.86	12.31	14.25	2.81	12.43	14.29	3.10	12.51	14.30	3.17	12.53	14.06	1.44	12.62	13.99	0.94
3	10.00	14.03	12.35	14.35	2.28	12.45	14.37	2.42	12.53	14.26	1.64	12.54	14.17	1.00	12.69	14.11	0.57
4	11.00	14.21	12.39	14.49	1.97	12.51	14.45	1.69	12.55	14.25	0.28	12.59	14.22	0.07	12.71	14.19	-0.14
5	12.00	14.33	12.41	14.51	1.26	12.55	14.49	1.12	12.57	14.35	0.14	12.49	14.24	-0.63	12.73	14.17	-1.12
6	13.00	14.67	12.76	14.65	-0.14	12.59	14.61	-0.41	12.57	14.53	-0.95	12.58	14.49	-1.23	12.76	14.24	-2.93
7	14.00	15.01	12.68	14.83	-1.20	12.59	14.63	-2.53	12.63	14.58	-2.86	12.58	14.31	-4.66	12.77	14.26	-5.00
8	15.00	15.32	12.75	14.98	-2.22	12.63	14.67	-4.24	12.67	14.59	-4.77	12.68	14.38	-6.14	12.79	14.26	-6.92
9	16.00	15.71	12.79	15.01	-4.46	12.69	14.71	-6.37	12.61	14.62	-6.94	12.73	14.38	-8.47	12.87	14.28	-9.10
10	17.00	16.09	12.83	15.09	-6.22	12.71	14.74	-8.38	12.63	14.66	-8.89	12.77	14.41	-10.44	12.95	14.25	-11.44
11	18.00	16.41	12.91	15.13	-7.80	12.73	14.78	-9.93	12.63	14.69	-10.48	12.79	14.43	-12.07	13.01	14.23	-13.28
12	19.00	16.66	12.96	15.17	-8.94	12.76	14.86	-10.80	12.63	14.71	-11.70	12.81	14.46	-13.21	13.09	14.23	-14.59
13	20.00	16.93	12.98	15.21	-10.16	12.77	14.94	-11.76	12.65	14.73	-12.99	12.85	14.48	-14.47	13.13	14.25	-15.83
Mean	14.00	15.11	12.65	14.72	-2.26	12.60	14.56	-3.27	12.59	14.46	-3.89	12.65	14.27	-5.11	12.82	14.14	-5.97
SEm±	0.138	0.257	0.24	0.26	0.104	0.227	0.249	0.101	0.242	0.266	0.103	0.229	0.252	0.099	0.232	0.254	0.105
CD (P=0.01)	0.521	1.012	0.95	1.04	0.411	0.894	0.982	0.406	0.954	1.047	0.397	0.904	0.992	0.393	0.913	1.002	0.415
CV (%)	2.01	2.98	3.08	3.06	7.06	2.91	2.89	6.89	3.11	3.08	6.82	2.94	2.92	6.75	2.97	2.95	7.13

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 3. Influence of seed moisture content on seed weight of maize during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
1	8.00	28.54	12.35	29.68	3.99	12.39	29.73	4.17	12.42	29.83	4.52	12.44	29.14	2.10	12.53	28.86	1.12
2	9.00	29.18	12.38	29.94	2.60	12.43	30.09	3.12	12.44	30.11	3.19	12.47	29.73	1.88	12.56	29.42	0.82
3	10.00	29.61	12.42	30.31	2.36	12.45	30.35	2.50	12.47	30.13	1.76	12.50	30.09	1.62	12.61	29.78	0.57
4	11.00	30.07	12.47	30.37	1.00	12.49	30.39	1.06	12.51	30.16	0.30	12.53	30.10	0.10	12.62	29.99	-0.27
5	12.00	30.18	12.43	30.43	0.83	12.49	30.41	0.76	12.51	30.25	0.23	12.56	30.13	-0.17	12.66	30.03	-0.50
6	13.00	30.78	12.55	30.65	-0.42	12.53	30.59	-0.62	12.51	30.51	-0.88	12.57	30.46	-1.04	12.69	30.41	-1.20
7	14.00	31.35	12.75	30.69	-2.11	12.62	30.63	-2.30	12.53	30.57	-2.49	12.59	30.37	-3.13	12.70	30.21	-3.64
8	15.00	31.93	12.79	30.77	-3.63	12.71	30.71	-3.82	12.53	30.65	-4.01	12.61	30.38	-4.85	12.71	30.23	-5.32
9	16.00	32.68	12.93	31.05	-4.99	12.79	30.85	-5.60	12.54	30.69	-6.09	12.63	30.43	-6.88	12.72	30.27	-7.37
10	17.00	33.11	13.41	31.22	-5.71	12.91	30.98	-6.43	12.55	30.73	-7.19	12.66	30.53	-7.79	12.77	30.29	-8.52
11	18.00	33.71	13.57	31.46	-6.67	13.03	31.03	-7.95	12.57	30.87	-8.42	12.68	30.59	-9.26	12.77	30.31	-10.09
12	19.00	33.89	13.66	31.59	-6.79	13.19	31.17	-8.03	12.58	30.95	-8.68	12.69	30.75	-9.27	12.81	30.33	-10.50
13	20.00	34.07	13.73	31.93	-6.28	13.32	31.32	-8.07	12.61	31.09	-8.75	12.69	30.79	-9.63	12.84	30.35	-10.92
Mean	14.00	31.47	12.88	30.78	-1.99	12.72	30.63	-2.40	12.52	30.50	-2.81	12.59	30.27	-3.56	12.69	30.04	-4.29
SEm±	0.138	0.533	0.23	0.546	0.083	0.236	0.517	0.085	0.223	0.552	0.081	0.238	0.522	0.086	0.225	0.528	0.081
CD (P=0.01)	0.521	2.09	0.906	2.142	0.327	0.929	2.027	0.335	0.879	2.163	0.317	0.938	2.048	0.338	0.888	2.069	0.320
CV (%)	2.01	2.97	3.00	3.04	4.93	3.08	2.88	5.06	2.91	3.07	4.78	3.11	2.91	5.15	2.94	2.93	4.83

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 4. Influence of seed moisture content on seed weight of redgram during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
1	8.00	12.71	11.42	13.09	2.99	12.90	13.13	3.30	13.00	13.15	3.46	13.03	12.89	1.42	13.07	12.76	0.39
2	9.00	12.89	12.08	13.22	2.56	12.95	13.25	2.79	13.02	13.19	2.33	13.07	13.01	0.93	13.11	12.92	0.23
3	10.00	13.14	12.63	13.43	2.21	12.96	13.41	2.05	13.04	13.32	1.37	13.09	13.21	0.53	13.11	13.13	-0.08
4	11.00	13.28	12.88	13.48	1.51	12.98	13.54	1.96	13.04	13.41	0.98	13.12	13.23	-0.38	13.16	13.17	-0.83
5	12.00	13.58	12.92	13.71	0.96	12.99	13.81	1.69	13.06	13.67	0.66	13.13	13.45	-0.96	13.18	13.31	-1.99
6	13.00	14.08	12.98	13.99	-0.64	13.01	13.95	-0.92	13.08	13.94	-0.99	13.13	13.91	-1.21	13.21	13.67	-2.91
7	14.00	14.29	13.07	14.15	-0.98	13.04	14.13	-1.12	13.08	14.11	-1.26	13.17	13.99	-2.10	13.23	13.75	-3.78
8	15.00	14.65	13.11	14.19	-3.14	13.06	14.17	-3.28	13.08	14.14	-3.48	13.19	14.08	-3.89	13.25	14.02	-4.30
9	16.00	14.91	13.27	14.21	-4.69	13.10	14.18	-4.90	13.10	14.16	-5.03	13.20	14.15	-5.10	13.27	14.08	-5.57
10	17.00	15.19	13.34	14.25	-6.19	13.25	14.23	-6.32	13.12	14.21	-6.45	13.23	14.19	-6.58	13.36	14.091	-7.24
11	18.00	15.57	13.72	14.27	-8.35	13.33	14.24	-8.54	13.12	14.22	-8.67	13.27	14.22	-8.67	13.39	14.18	-8.93

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
12	19.00	15.83	13.89	14.29	-9.73	13.43	14.27	-9.85	13.14	14.25	-9.98	13.31	14.24	-10.04	13.41	14.21	-10.23
13	20.00	16.18	13.94	14.38	-11.12	13.49	14.31	-11.56	13.15	14.30	-11.62	13.26	14.28	-11.74	13.46	14.23	-12.05
Mean	14.00	14.33	13.02	13.90	-2.66	13.11	13.89	-2.67	13.08	13.85	-2.98	13.17	13.76	-3.68	13.25	13.66	-4.41
SEm±	0.138	0.245	0.137	0.251	0.023	0.135	0.238	0.024	0.133	0.254	0.022	0.134	0.240	0.024	0.130	0.243	0.023
CD (P=0.01)	0.521	0.96	0.52	0.984	0.079	0.508	0.931	0.081	0.498	0.994	0.077	0.507	0.941	0.082	0.491	0.950	0.077
CV (%)	2.02	2.99	2.01	3.06	9.35	2.00	2.90	9.59	1.83	3.09	9.07	1.97	2.93	9.68	1.92	2.96	9.17

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 5. Influence of seed moisture content on seed weight of greengram during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
1	8.00	40.49	12.07	41.43	2.32	12.65	42.05	3.85	12.81	42.01	3.75	12.96	41.96	3.63	12.99	41.21	1.78
2	9.00	41.21	12.32	42.01	1.94	12.71	42.69	3.59	12.89	42.64	3.47	12.98	42.18	2.35	13.01	41.47	0.63
3	10.00	41.83	12.47	42.55	1.72	12.83	42.96	2.70	12.91	42.98	2.75	12.99	42.67	2.01	13.01	41.91	0.19
4	11.00	42.45	12.56	42.69	0.57	12.89	43.08	1.48	12.93	43.26	1.91	12.99	42.83	0.90	13.03	42.11	-0.80
5	12.00	42.73	12.59	42.91	0.42	12.91	43.01	0.66	12.96	43.21	1.12	13.01	42.87	0.33	13.03	42.21	-1.22
6	13.00	43.25	13.03	43.05	-0.46	12.97	42.99	-0.60	12.95	42.93	-0.74	13.03	42.75	-1.16	13.01	42.68	-1.32
7	14.00	43.72	13.19	43.28	-1.01	13.15	43.11	-1.40	13.09	42.95	-1.76	13.05	42.85	-1.99	13.02	42.71	-2.31
8	15.00	44.12	13.26	43.29	-1.88	13.19	43.19	-2.11	13.15	42.99	-2.56	13.05	42.97	-2.61	13.03	42.75	-3.11
9	16.00	44.73	13.35	43.32	-3.15	13.26	43.21	-3.40	13.21	43.07	-3.71	13.07	43.02	-3.82	13.04	42.79	-4.34
10	17.00	45.18	13.56	43.43	-3.87	13.51	43.26	-4.25	13.23	43.13	-4.54	13.09	43.06	-4.69	13.06	42.83	-5.20
11	18.00	46.20	13.81	43.47	-5.91	13.68	43.35	-6.17	13.29	43.17	-6.56	13.12	43.10	-6.71	13.09	42.88	-7.19
12	19.00	47.01	13.94	43.73	-6.98	13.76	43.37	-7.74	13.33	43.21	-8.08	13.15	43.14	-8.23	13.11	42.93	-8.68
13	20.00	48.12	13.97	43.75	-9.08	13.81	43.39	-9.83	13.37	43.24	-10.14	13.19	43.17	-10.29	13.11	42.95	-10.74
Mean	14.00	43.93	13.09	42.99	-1.95	13.18	43.05	-1.79	13.09	42.98	-1.93	13.05	42.81	-2.33	13.04	42.42	-3.25
SEm±	0.138	0.742	0.108	0.761	0.051	0.106	0.720	0.052	0.105	0.768	0.049	0.112	0.727	0.053	0.104	0.735	0.050
CD (P=0.01)	0.521	2.917	0.437	2.990	0.198	0.432	2.829	0.203	0.428	3.019	0.192	0.452	2.859	0.205	0.423	2.888	0.194
CV (%)	2.01	2.97	1.16	3.05	10.75	1.15	2.89	11.01	1.14	3.08	10.42	1.209	2.91	11.16	1.131	2.94	10.53

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 6. Influence of seed moisture content on seed weight of soybean during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
1	8	10.88	10.77	11.17	2.67	10.93	11.21	3.03	10.97	11.05	1.56	11.01	10.93	0.46	11.09	10.87	-0.09
2	9	11.13	10.86	11.27	1.26	10.98	11.35	1.98	10.99	11.21	0.72	11.03	11.15	0.18	11.11	11.07	-0.54
3	10	11.45	10.97	11.53	0.70	11.03	11.56	0.96	11.03	11.5	0.44	11.06	11.43	-0.17	11.15	11.34	-0.96
4	11	12.19	11.01	12.18	-0.08	11.05	12.17	-0.16	11.03	12.15	-0.33	11.08	12.13	-0.49	11.19	12.05	-1.15
5	12	12.28	11.32	12.29	0.08	11.19	12.24	-0.33	11.07	12.21	-0.57	11.08	12.17	-0.90	11.17	12.11	-1.38
6	13	12.55	11.54	12.51	-0.32	11.37	12.25	-2.39	11.08	12.24	-2.47	11.12	12.21	-2.71	11.18	12.19	-2.87
7	14	12.73	11.61	12.61	-0.94	11.49	12.29	-3.46	11.11	12.24	-3.85	11.04	12.22	-4.01	11.21	12.19	-4.24
8	15	13.01	11.63	12.78	-1.77	11.51	12.35	-5.07	11.13	12.27	-5.69	11.09	12.25	-5.84	11.23	12.21	-6.15
9	16	13.34	11.77	12.83	-3.82	11.64	12.34	-7.50	11.19	12.29	-7.87	11.12	12.26	-8.10	11.23	12.23	-8.32
10	17	13.53	11.89	12.89	-4.73	11.69	12.41	-8.28	11.21	12.37	-8.57	11.12	12.29	-9.16	11.27	12.24	-9.53
11	18	13.76	11.97	12.92	-6.10	11.71	12.48	-9.30	11.24	12.41	-9.81	11.15	12.33	-10.39	11.29	12.26	-10.90
12	19	13.91	12.13	12.95	-6.90	11.74	12.51	-10.06	11.25	12.43	-10.64	11.09	12.38	-11.00	11.35	12.29	-11.65
13	20	14.09	12.15	12.97	-7.95	11.81	12.57	-10.79	11.33	12.51	-11.21	11.05	12.40	-11.99	11.35	12.29	-12.78
Mean	14.00	12.68	11.51	12.38	-2.15	11.40	12.13	-3.95	11.13	12.07	-4.48	11.08	12.01	-4.93	11.22	11.95	-5.43
SEm±	0.138	0.217	0.231	0.222	0.046	0.237	0.210	0.047	0.224	0.225	0.045	0.239	0.213	0.048	0.226	0.215	0.045
CD (P=0.01)	0.521	0.853	0.904	0.874	0.182	0.927	0.827	0.187	0.877	0.883	0.177	0.936	0.836	0.188	0.886	0.844	0.178
CV (%)	2.02	2.99	3.02	3.06	4.17	3.10	2.90	4.27	2.93	3.09	4.04	3.13	2.93	4.31	2.96	2.96	4.08

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 7. Influence of seed moisture content on seed weight of groundnut during storage

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
2	9.00	44.55	8.98	44.54	0.02	8.98	44.55	0.04	8.98	44.43	-0.27	9.02	43.97	-1.30	9.11	43.83	-1.62
3	10.00	44.75	9.31	44.67	-0.18	9.21	44.63	-0.27	9.07	44.47	-0.63	9.05	43.99	-1.70	9.16	43.92	-1.85
4	11.00	44.89	9.36	44.79	-0.22	9.29	44.51	-0.85	9.13	44.43	-1.02	9.05	44.05	-1.87	9.18	43.99	-2.00
5	12.00	45.12	9.41	44.81	-0.69	9.35	44.56	-1.24	9.18	44.45	-1.48	9.08	44.09	-2.28	9.21	44.03	-2.42
6	13.00	45.83	9.53	44.83	-2.18	9.43	44.59	-2.71	9.21	44.47	-2.97	9.11	44.13	-3.71	9.23	44.08	-3.82
7	14.00	46.29	9.71	44.85	-3.11	9.49	44.61	-3.63	9.29	44.49	-3.89	9.12	44.17	-4.58	9.27	44.11	-4.71
8	15.00	46.76	9.82	44.88	-4.02	9.51	44.63	-4.56	9.33	44.51	-4.81	9.16	44.21	-5.45	9.29	44.13	-5.62
9	16.00	47.21	9.87	44.92	-4.85	9.57	44.64	-5.44	9.33	44.52	-5.70	9.19	44.26	-6.25	9.33	44.16	-6.46
10	17.00	47.73	9.93	44.98	-5.76	9.63	44.67	-6.41	9.39	44.55	-6.66	9.22	44.28	-7.23	9.33	44.18	-7.44
11	18.00	48.08	9.99	45.09	-6.22	9.75	44.68	-7.07	9.45	44.57	-7.30	9.23	44.29	-7.88	9.37	44.22	-8.03

Sl.No.	Initial / 0 month		2 month			4 month			6 month			8 month			10 month		
	MC (%)	SW (g)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)	MC (%)	SW (g)	LSW (%)
12	19.00	48.96	9.99	45.13	-7.82	9.81	44.71	-8.68	9.48	44.59	-8.93	9.25	44.33	-9.46	9.41	44.23	-9.66
13	20.00	49.71	10.03	45.17	-9.13	9.85	44.73	-10.02	9.51	44.61	-10.26	9.29	44.38	-10.72	9.48	44.25	-10.98
Mean	14.00	46.46	9.58	44.83	-3.39	9.43	44.59	-3.89	9.24	44.49	-4.12	9.13	44.16	-4.84	9.26	44.07	-5.03
SEm±	0.138	0.786	0.063	0.806	0.023	0.062	0.762	0.023	0.062	0.814	0.025	0.065	0.770	1.174	0.061	0.778	0.021
CD (P=0.01)	0.521	3.09	0.243	3.167	0.086	0.240	2.997	0.085	0.238	3.198	0.084	0.251	3.028	0.078	0.235	3.059	0.083
CV (%)	2.02	4.98	0.83	5.10	1.14	0.82	4.83	1.12	0.82	5.15	1.11	0.86	4.87	0.02	0.81	4.93	1.11

MC: Moisture Content, SW: Seed Weight, LSW: Loss in seed weight

Table 8. Economic loss in paddy owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
13	-0.14	-2.55	-0.41	-7.64	-0.95	-17.83	-1.23	-22.92	-2.93	-54.75
14	-1.20	-22.40	-2.53	-47.29	-2.86	-53.51	-4.66	-87.12	-5.00	-93.34
15	-2.22	-41.46	-4.24	-79.26	-4.77	-89.01	-6.14	-114.62	-6.92	-129.25
16	-4.46	-83.23	-6.37	-118.91	-6.94	-129.61	-8.47	-158.14	-9.10	-170.03
17	-6.22	-116.10	-8.38	-156.60	-8.89	-166.02	-10.44	-195.04	-11.44	-213.62
18	-7.80	-145.71	-9.93	-185.47	-10.48	-195.79	-12.07	-225.39	-13.28	-248.16
19	-8.94	-167.07	-10.80	-201.84	-11.70	-218.64	-13.21	-246.67	-14.59	-272.46
20	-10.16	-189.78	-11.76	-219.67	-12.99	-242.74	-14.47	-270.32	-15.83	-295.70

Table 9. Economic loss in maize owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
13	-0.42	-7.81	-0.62	-11.42	-0.88	-16.23	-1.04	-19.23	-1.20	-22.24
14	-2.11	-38.95	-2.30	-42.49	-2.49	-46.03	-3.13	-57.83	-3.64	-67.27
15	-3.63	-67.21	-3.82	-70.69	-4.01	-74.16	-4.85	-89.81	-5.32	-98.50
16	-4.99	-92.27	-5.60	-103.60	-6.09	-112.65	-6.88	-127.37	-7.37	-136.43
17	-5.71	-105.60	-6.43	-119.01	-7.19	-132.98	-7.79	-144.16	-8.52	-157.57
18	-6.67	-123.48	-7.95	-147.08	-8.42	-155.86	-9.26	-171.23	-10.09	-186.59
19	-6.79	-125.55	-8.03	-148.48	-8.68	-160.49	-9.27	-171.41	-10.50	-194.33
20	-6.28	-116.20	-8.07	-149.32	-8.75	-161.81	-9.63	-178.10	-10.92	-202.00

Table 10. Economic loss in redgram owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
13	-0.64	-38.35	-0.92	-55.40	-0.99	-59.66	-1.21	-72.44	-2.91	-174.72
14	-0.98	-58.78	-1.12	-67.18	-1.26	-75.58	-2.10	-125.96	-3.78	-226.73
15	-3.14	-188.40	-3.28	-196.59	-3.48	-208.87	-3.89	-233.45	-4.30	-258.02
16	-4.69	-281.69	-4.90	-293.76	-5.03	-301.81	-5.10	-305.84	-5.57	-334.00
17	-6.19	-371.30	-6.32	-379.20	-6.45	-387.10	-6.58	-395.00	-7.24	-434.10
18	-8.35	-500.96	-8.54	-512.52	-8.67	-520.23	-8.67	-520.23	-8.93	-535.65
19	-9.73	-583.70	-9.85	-591.28	-9.98	-598.86	-10.04	-602.65	-10.23	-614.02
20	-11.12	-667.49	-11.56	-693.45	-11.62	-697.16	-11.74	-704.57	-12.05	-723.11

Table 11. Economic loss in greengram owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
13	-0.46	-33.28	-0.60	-43.26	-0.74	-53.24	-1.16	-83.19	-1.32	-94.84
14	-1.01	-72.42	-1.40	-100.40	-1.76	-126.74	-1.99	-143.20	-2.31	-166.24
15	-1.88	-135.37	-2.11	-151.68	-2.56	-184.30	-2.61	-187.57	-3.11	-223.45
16	-3.15	-226.84	-3.40	-244.53	-3.71	-267.05	-3.82	-275.10	-4.34	-312.10
17	-3.87	-278.73	-4.25	-305.81	-4.54	-326.51	-4.69	-337.66	-5.20	-374.29
18	-5.91	-425.22	-6.17	-443.91	-6.56	-471.95	-6.71	-482.85	-7.19	-517.12
19	-6.98	-502.08	-7.74	-557.19	-8.08	-581.68	-8.23	-592.40	-8.68	-624.54
20	-9.08	-653.50	-9.83	-707.34	-10.14	-729.77	-10.29	-740.24	-10.74	-773.14

Table 12. Economic loss in soybean owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
11	-0.08	-3.18	-0.16	-6.37	-0.33	-12.73	-0.49	-19.10	-1.15	-44.56
12	0.08	3.16	-0.33	-12.64	-0.57	-22.12	-0.90	-34.76	-1.38	-53.71
13	-0.32	-12.37	-2.39	-92.75	-2.47	-95.84	-2.71	-105.12	-2.87	-111.30
14	-0.94	-36.58	-3.46	-134.11	-3.85	-149.35	-4.01	-155.44	-4.24	-164.59
15	-1.77	-68.59	-5.07	-196.83	-5.69	-220.69	-5.84	-226.66	-6.15	-238.59
16	-3.82	-148.34	-7.50	-290.85	-7.87	-305.40	-8.10	-314.12	-8.32	-322.85
17	-4.73	-183.53	-8.28	-321.18	-8.57	-332.65	-9.16	-355.59	-9.53	-369.93
18	-6.10	-236.86	-9.30	-360.93	-9.81	-380.67	-10.39	-403.23	-10.90	-422.97
19	-6.90	-267.78	-10.06	-390.51	-10.64	-412.83	-11.00	-426.77	-11.65	-451.88
20	-7.95	-308.42	-10.79	-418.57	-11.21	-435.09	-11.99	-465.38	-12.78	-495.67

Table 13. Economic loss in groundnut owing to its seed drying loss during storage above its equilibrium moisture content

MC (%)	2 month		4 month		6 month		8 month		10 month	
	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)	Drying loss (Kg/q)	Economic loss (Rs/q)
8	0.14	7.18	0.27	14.36	0.43	22.74	-0.41	-21.55	-0.66	-34.71
9	0.02	1.18	0.04	2.37	-0.22	-11.85	-1.26	-66.34	-1.57	-82.92
10	-0.18	-9.43	-0.27	-14.15	-0.63	-33.01	-1.70	-89.59	-1.85	-97.84
11	-0.22	-11.75	-0.85	-44.65	-1.02	-54.05	-1.87	-98.71	-2.00	-105.76
12	-0.69	-36.24	-1.24	-65.47	-1.48	-78.33	-2.28	-120.42	-2.42	-127.43
13	-2.18	-115.10	-2.71	-142.72	-2.97	-156.54	-3.71	-195.67	-3.82	-201.42
14	-3.11	-164.10	-3.63	-191.45	-3.89	-205.12	-4.58	-241.59	-4.71	-248.42
15	-4.02	-212.08	-4.56	-240.29	-4.81	-253.82	-5.45	-287.67	-5.62	-296.69
16	-4.85	-255.87	-5.44	-287.16	-5.70	-300.57	-6.25	-329.62	-6.46	-340.79
17	-5.76	-303.92	-6.41	-338.18	-6.66	-351.45	-7.23	-381.29	-7.44	-392.34
18	-6.22	-328.04	-7.07	-373.02	-7.30	-385.09	-7.88	-415.81	-8.03	-423.49
19	-7.82	-412.65	-8.68	-457.90	-8.93	-470.83	-9.46	-498.84	-9.66	-509.61
20	-9.13	-481.76	-10.02	-528.46	-10.26	-541.19	-10.72	-565.60	-10.98	-579.39

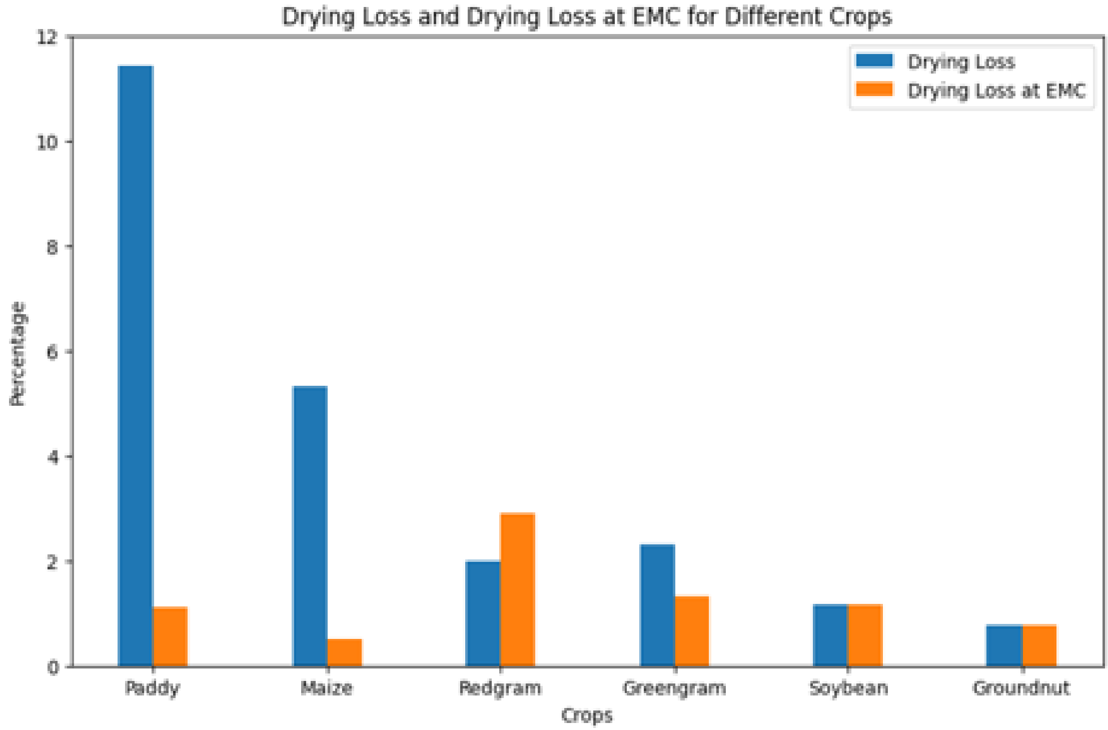

Fig. 2. Comparison of drying loss and drying loss at equilibrium moisture content across various crops

4. CONCLUSION

The findings of this study underscore the significant impact of seed moisture content on seed weight and overall quality during storage. The established correlations between moisture levels and weight loss highlight the necessity for effective moisture management strategies to minimize drying losses and associated economic impacts. The variations in EMC among different crop types suggest that tailored storage conditions are essential for maintaining seed viability and quality. Given the substantial economic losses quantified in this research, stakeholders in agriculture should prioritise optimal moisture control practices to enhance seed longevity and reduce financial risks associated with seed storage. Future research could focus on developing specific guidelines for moisture management tailored to individual crop varieties, thereby improving storage outcomes and ensuring better quality seeds for agricultural production.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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