



Seed Blending: A Modern Approach to Efficient Seed Utilization and Crop Diversification

*Swagatika Behera, Arpita Priyadarsini, N Rusali and Soubhagya Behera
Department of Seed Science and Technology, College of Agriculture, OUAT,
Bhubaneswar, Odisha-751003, India

*Corresponding Author's email: beheraswagatika333@gmail.com

Seed is the basic part of crop production, and its quality has a direct influence on crop establishment, plant population, productivity and yield. The use of high-quality seed is therefore necessary for getting a healthy and uniform crop stand. However, seed lots produced at different times or under different conditions may vary in germination, purity, seed size, moisture content and other physical or physiological characteristics. Seed blending provides a practical approach for utilizing compatible seed lots efficiently while maintaining the desired quality of the final seed mixture. Seed blending is the deliberate mixing of two or more suitable seed lots or seed components in predetermined proportions to obtain a uniform mixture with a specific purpose. In seed-processing operations, it can be used to combine compatible seed lots, correct certain differences in seed quality and make better use of available seed resources. At the field-production level, blending may also involve cultivar mixtures, where genetically different cultivars are grown together to raise crop diversity and potentially improve stability, disease management and productivity. Seed blending, however, is not simply the indiscriminate mixing of available seed. It is a planned operation that requires appropriate seed selection, accurate measurement, thorough mixing, documentation and quality testing. The final blend must satisfy the applicable seed-quality requirements.

Key words-Seed blending, Seed lot, uniformity, seed quality, Pearson method

Principles of Seed Blending

1. Homogeneity of the blend

The first principle of successful seed blending is homogeneity. The different seed components should be distributed as uniformly as possible throughout the mixture so that a representative portion of the blend contains approximately the required proportion of each component. Proper mixing is therefore essential. Inadequate mixing leads to heterogeneous seed lot in which one portion contains more and other portion less. This reduces the seed quality, planting uniformity and the intended performance of the blend. Seed characteristics such as size, shape, density and surface properties should also be considered because large physical differences among components leads to increase the chance of segregation during transportation, conveying and storage.

2. Ensure seed-quality standards

Seed blending should be done only with seed lots that have the required quality standards for their future application. Blending should not be done with poor quality seed and damaged seed. The component lots should be analysed for important characteristics such as physical purity, germination, moisture content, seed health and varietal identity and purity. All the blended lot should be tested whether they meet the quality standard.

3. Documentation

Proper documentation is important for seed blending. Records should identify:

- the seed lots

- variety or cultivar name
- lot number
- original quality characteristics
- each component quantity
- blending ratio
- date of blending
- equipment or method used
- Final blend quality

This record helps in maintaining quality control during storage, transportation and distribution. Proper labelling is required when several seed lots or varieties are mixed in the same facility.

Necessity of Seed blending

Seed blending carried out for several practical and agronomic purposes.

➤ **Achieve desired germination**

Two seed lots with different germination percentages are mixed to obtain a desired germination level. Mathematical approaches such as the Karl Pearson Square Method can be used to calculate the appropriate proportion of two seed lots. However, this should be done when the component lots are suitable for blending and the final mixture meet the applicable quality requirements.

➤ **Efficient use of seed**

The seed lot in small quantities sometimes remain unused as they are not enough for separate utilisation. Where seed lots are compatible, blending can provide a way to utilize these resources efficiently.

➤ **Meeting commercial requirements**

In some situations, blending can help prepare an adequate quantity of seed to meet production requirement or market demand. This can reduce maintenance of several small lots separately and facilitates subsequent handling, packaging and distribution.

Pure Live Seed and Seed-Rate Considerations

An important concept related to seed blending and seed-rate calculation is Pure Live Seed (PLS). PLS represents the proportion of a seed lot that consists of pure seed capable of germinating under the conditions of the germination test.

The basic calculation is:

$$\text{PLS (\%)} = [\text{Purity (\%)} \times \text{Germination (\%)}] \div 100$$

For example, if a seed lot has 95% purity and 80% germination:

$$\text{PLS} = (95 \times 80) \div 100 = 76\%$$

This means that approximately 76% of the bulk seed represents pure live seed according to the test values. The PLS concept is useful because purity and germination together provide a more meaningful basis for determining how much viable seed is actually being planted.

Importance of PLS in seed-rate calculation

Seed rate should be considered in relation to the desired plant population, seed size or thousand-seed weight, germination and, where appropriate, purity or PLS. When a seed lot has lower PLS, a greater quantity of bulk seed may be required to achieve the desired amount of viable seed.

For example, if the recommended planting rate is 10 kg of pure live seed per hectare and the seed lot has 80% PLS, the approximate bulk seed requirement would be:

$$\text{Bulk seed required} = 10 \div 0.80 = 12.5 \text{ kg ha}^{-1}$$

Thus, consideration of PLS can avoid under-seeding caused by using a seed lot with lower purity or germination. Extension guidance similarly recommends adjusting seed rates according to PLS when seed quality differs among lots.

This makes PLS particularly useful when comparing seed lots and planning accurate seed requirements.

Karl Pearson Square Method

The Karl Pearson Square Method provides a simple mathematical procedure for calculating the proportion of two seed lots with different germination percentages when a particular germination percentage is desired in the final blend.

For example:

- High-germination seed lot = 90%
- Low-germination seed lot = 60%
- Desired germination = 80%

The differences are:

$$90 - 80 = 10$$

$$80 - 60 = 20$$

Therefore:

High-germination seed: Low-germination seed = 20:10 = 2:1

Thus, two parts of the 90% germination seed lot can theoretically be combined with one part of the 60% germination seed lot to obtain an 80% germination mixture, assuming the components are otherwise suitable and the simple two-component calculation applies.

ICAR has specifically identified a Seed Blending Calculator based on the Karl Pearson square method for blending marginal seed lots with higher-germination seed lots.

The method is useful because it converts a desired final germination level into a practical mixing ratio, germination should never be considered in isolation. Purity, seed health, moisture, varietal identity and other quality requirements must also be checked before blending.

Applications of Seed Blending

Seed blending has various applications starting from seed processing and quality management to crop diversification and sustainable production.

1. Use of compatible seed lots

Suitable seed lots available in smaller quantities can be mixed when their quality and characteristics are compatible. This can improve the utilization of available seed resources.

2. Achieve proper germination percentage

When suitable seed lots have different germination percentages, blending can be used to obtain a average germination level. The Karl Pearson Square Method provides a convenient way to calculate the required ratio for two components.

3. Preparation of a uniform seed lot

Proper blending provides a relatively homogeneous mixture when the components are precisely measured and thoroughly mixed. This is applicable when uniform distribution of components is present.

4. Accessibility of seed

Where sufficient quantities of a suitable seed lot are not available individually, compatible lots can sometimes be combined to obtain the required quantity, so that we get the resulting mixture as per the quality requirement.

5. Satisfying Market need

Seed blending helps seed-processing enterprises prepare adequate quantities of an acceptable seed product for a particular production or market requirement. Maintaining records and quality testing are necessary in this cases.

6. Simplifying handling and storage

Mixing of compatible seed lots can reduce the number of separate lots that need to be handled, shipped and stored. However, the storage requirements of all components must be same.

7. Crop diversification

Cultivar mixtures introduce genetic diversity within a crop population. Different cultivars may possess complementary characteristics, creating an opportunity to improve resilience compared with dependance on a single cultivar.

8. Increasing stability of crop performance

One of the major benefits of cultivar mixtures is greater stability across variable environments. Different cultivars may respond differently to drought, temperature, disease and other stresses. As a result, poor performance of one component under a particular condition may be partly adjusted by another component.

Research has shown that cultivar mixtures can increase yield stability compared with monocultures under some conditions (Reiss & Drinkwater, 2018; Huang et al., 2024).

9. Increasing adaptation to environmental conditions

Blends having cultivars with complementary environmental adaptations may provide more balanced performance across different field conditions. For example, cultivars differing in drought tolerance, maturity or temperature response may provide greater flexibility under uncertain weather.

10. Pest and disease management

Cultivar mixtures improves pest and disease management by enhancing genetic diversity within the crop. Different resistance characteristics can reduce the uniformity of the host population available to a pathogen.

Mundt (2002) reported considerable potential for cultivar mixtures in disease management, particularly for many diseases of small-grain cereals. The performance depends on the crop, pathogen, resistance characteristics and environmental conditions.

Limitations and Precautions

Seed blending is not applicable for every seed lot. Several factors must be evaluated before blending, those are:-

- physical purity
- germination percentage
- seed moisture
- seed size and density
- seed health
- varietal identity
- maturity characteristics
- Utilisation
- storage requirements
- applicable quality standards.

One major practical problem is segregation. Differences in seed size, shape and density can cause components to differentiate after blending during transportation or storage. Therefore, thorough mixing, careful handling and representative sampling are needed. Especially seed blending must never be used to disguise poor-quality seed. The quality of each component and the final mixture must be accurately documented and verified.

Conclusion

Seed blending is a simple but systemically planned practice that can increase the utilization, management and application of appropriate seed resources. Its outcome depends on four fundamental principles: homogeneity, ensure seed-quality standards, proper documentation and a clearly defined purpose. The use of the Karl Pearson Square Method makes it possible to calculate blending proportions when seed lots differ in germination percentage, while the concept of Pure Live Seed gives how much amount of viable seed actually available for planting and for adjusting seed rates where needed. Other than seed processing, well-designed cultivar mixtures can provide broader agronomic use, including greater stability, increase adaptation to different environments, pest and disease management, complementary resource use and, under suitable conditions, increased yield and quality. So seed blending should not be considered as the mixing of seed lots. It is a systematically planned seed-management and crop-diversification strategy in which the appropriate seed components are selected, accurately proportioned, thoroughly mixed, properly documented and evaluated for their utilisation.

When these principles are applied, seed blending can provide efficient utilisation of seed and more resilient and sustainable crop production.

References

1. Huang, T., Döring, T. F., Zhao, X., Weiner, J., Dang, P., Zhang, M., Zhang, M., Siddique, K. H. M., Schmid, B., & Qin, X. (2024). Cultivar mixtures increase crop yields and temporal yield stability globally: *Agronomy for Sustainable Development*, 44, Article 28. https://doi.org/10.1007/s13593-024-00964-6
2. Kiær, L. P., Skovgaard, I. M., & Østergård, H. (2009). Grain yield increase in cereal variety mixtures: *Field Crops Research*, 114(3), 361–373. https://doi.org/10.1016/j.fcr.2009.09.006
3. Mikaberidze, A., McDonald, B. A., & Bonhoeffer, S. (2015). Developing smarter host mixtures to control plant disease. *Plant Pathology*, 64(4), 996–1004. https://doi.org/10.1111/ppa.12321
4. Mundt, C. C. (2002). Use of multiline cultivars and cultivar mixtures for disease management. *Annual Review of Phytopathology*, 40, 381–410. https://doi.org/10.1146/annurev.phyto.40.011402.113723
5. Reiss, E. R., & Drinkwater, L. E. (2018). Cultivar mixtures: the effect of intraspecific diversity on crop yield. *Ecological Applications*, 28(1), 62–77. https://doi.org/10.1002/eap.1629
6. Wolfe, M. S. (1997). Use of wheat cultivar blends to improve grain yield and quality and reduce disease and lodging. *Field Crops Research*, 52(3), 261–269. https://doi.org/10.1016/S0378-4290(97)00007-5
7. Wuest, S. E., Peter, R., & Niklaus, P. A. (2021). Ecological and evolutionary approaches to improving crop variety mixtures. *Nature Ecology & Evolution*, 5, 1068–1077. https://doi.org/10.1038/s41559-021-01497-x
8. https://researchprofiles.ku.dk/en/publications/cultivar-mixtures-increase-crop-yields-and-temporal-yield-stabili/?utm_source=chatgpt.com "Cultivar mixtures increase crop yields and temporal yield stability globally.
9. https://researchprofiles.ku.dk/en/publications/grain-yield-increase-in-cereal-variety-mixtures-a-meta-analysis-o/?utm_source=chatgpt.com "Grain yield increase in cereal variety mixtures: a meta-analysis of field trials - University of Copenhagen Research Portal"
10. https://www.sciencedirect.com/science/article/pii/S0378429097000075?utm_source=chatgpt.com "Use of wheat cultivar blends to improve grain yield and quality and reduce disease and lodging - ScienceDirect"
11. https://www.nature.com/articles/s41559-021-01497-x?utm_source=chatgpt.com "Ecological and evolutionary approaches to improving crop variety mixtures | Nature Ecology & Evolution"