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EVALUATION OF SEED QUALITY OF JUTE MALLOW (*CORCHORUS OLITORIUS*)

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ABSTRACT

Production of high quality seeds helps to increase crop yields. Currently, there are no high quality seeds of Jute mallow (*Corchorus olitorius*) from breeders to farmers, resulting in farmers using re-cycled planting seed whose quality is not assured. This has resulted in low yields due to many reasons, one of them being poor quality seeds. Yields of crop has remained low 2-4 tons/ha/annum compared to expected yield of 5-8 tons/ha/annum. Farmers use up to 7kg/ha seed instead of 5kg/ha, indicating 40% extra seeds used. Though Kenya Agriculture and Livestock Research Organization (KALRO) are focusing her efforts on generation of appropriate strains of the vegetable, little is being done to examine seed used by farmers for its quality. Objective was to examine seed quality of Jute mallow used by farmers at planting. A field survey was conducted using structured questionnaires in five Counties of Keiyo, Uasin Gishu, Nandi, Trans Nzoia, and West Pokot and Simlaw Seed Company. A sample size of 500 farmers were visited and interviewed by use of stratified random sampling method and seed simultaneously collected. Seed quality tests and data analysis on analytical purity, germination and seed vigor was done using ISTA (2004) procedures. Results showed high seed analytical purity of 99% from both Simlaw seeds and Uasin Gishu, indicating superior quality seed (above 98%). Lowest purity was from West Pokot (95%). Germination results showed Simlaw Seed (89%) was highest, while Nandi (37%) was lowest. Germination from three counties of Keiyo (57%), West Pokot (49%) and Nandi (37%) does not meet seed quality standard (above 60%). Electrical conductivity (E.C) results showed highest seed vigor was from Simlaw (2.3 $\mu Scm^{-1}g^{-1}$) and lowest from Nandi (8.2 $\mu Scm^{-1}g^{-1}$). It was concluded that planting seed used by farmers were of poor physiological quality and recommended they be trained on quality seed production.

Key words: Indigenous, Vegetable, Quality Seed.

INTRODUCTION

Jute mallow (*Corchorus olitorius*) is one among the African Leafy Vegetables (ALVs) consumed much worldwide (Abukutsa-Onyango, 2002). Governments worldwide have been advocating for its production and consumption in its strategy for food self-sufficiency, though seed quality has been a hurdle in improving yields (MOA, 2019). Seed production is a biological industry and good agriculture depends upon good quality seed and one cannot develop or advance without affecting the other (Schippers, 2003). Agriculturally, seeds with assured quality can be expected to increase yields (Amarjit, 1995).

Informal on-farm seed production systems are prevalent globally and are responsible for providing more than 90% of seed used in most countries, as well as being recognized as major system for seed supply (Adebooye *et al*., 2005). The challenge or gap in seed industry is that majority of small-scale farmers use on-farm produced and saved seed (Muliokela, 1999), but unfortunately available seed is usually of poor quality (Louwaars, 1994). It is surprising, though, how many farmers actually sell the best produce and keep the worst for seed, the exact opposite of what should be done. Such practice has lead to a rapid decline in seed quality and productivity, and therefore low profits (KALRO, 2019). The reason as to why most of the seed obtained from the informal sector is of low quality is that many farmers value the most 'adequate physical purity of seed' and reasonable germination percentages while other seed quality parameters are considered less important (Wright *et al.*, (1994) and K'Opondo *et al*., (2005).

The cost of seed is a small proportion of total growing costs, yet the final crop is as dependent on seed quality in terms of yield and product uniformity as on the cultural environment (Amarjit, 1995). The first step in crop improvement is a full assessment of the local material. More often than not, local seed materials are not of excellent quality and have led to non-acceptance by farmers and consumers (George, 1999). During production, Jute mallow is mainly grown in kitchen gardens for home consumption and little for urban market (Abukutsa- Onyango, 2002). However, the problem is that they have been neglected in terms of research on agronomic aspects e.g. seed production and improvement (Ndinya, 2005). In most cases, they have been allowed to regenerate at onset of rains without a serious effort to plant new seed or even apply other cultural practices on them (Okongo, 2005). The local demand for the vegetables is still largely unmet and farmers have continued to use their own seed or purchase the scarce seed of unknown quality from the local market (K'Opondo *et al*., 2005) necessitating research on quality of seed used by farmers.

Seed quality test is science of evaluating seed potential for agricultural purposes. It is important in evaluation of the planting quality of field crop and vegetable seeds, and also in determining the quality of crop, flower, and tree seeds (Mc Donald, 1980, 1994). Seed quality is usually a composite of several factors, all of which contribute to the desirability or planting value of the seed. Each aspect of seed quality may be the result of different testing procedure (Ellis and Roberts 1980). The most direct method of testing the quality of seed is germination test, as it gives reliable counts of germination, judged by percentage emergence of healthy radicle in about 2-5 days. Other quick methods of testing seed quality include Tetrazolium tests for viability, electrical conductivity test, free fatty acid content test (Simmonds, 1976). A variety of tests of vegetable seed vigor have been suggested like Tetrazolium, Electrical conductivity and cool germination test which is similar to standard germination test except that temperature of 18^{o}C used and percentage of normal seedlings at 4 cm long is determined (Delouche, 1981). These simple tests show true germination capacity and vigor of stock and whether sowing rates need to be increased, so that correct plant populations are achieved.

There is little sense in sowing seed of low germination several times, in the hope that some miracle will overcome a basic seed fault. In practice, such marvels are rare and farming plans based on such hopes usually prove costly and frustrating. All seed should therefore be tested before planting, especially home-produced and stored over sometime, like over a year, which may have been kept in less than ideal condition. Seed rates and treatments can then be adjusted on the tangible facts of a properly executed and interpreted seed test. In countries where farmers produce their own seed and areas where seed testing services are absent, a farmer can test his/her own seed by placing seeds on a wet medium, such as cotton wool, newspaper or wet sand. In one or two weeks, depending on species he/she can obtain a reasonable estimate of percentage of normal plants growing also called seedling emergence which translates to field situation (Delouche, 1981).

Seedling emergence is the result of a large number of preceding processes, which occur against the often-hostile background of seedbed environment. Under these circumstances the chances of successful seedling emergence are greatly influenced by seed quality. If the quality of seed is low then emergence will be low. Laboratory germination tests reveal differences in seed lot viability, which will inevitably result in differences in levels of seedling emergence (Benjamin, 1990). In general, poor quality seeds will have low viability, reduced germination and emergence rates, poor tolerance to sub-optimal conditions, and low seedling growth (Mc Donald, 1980). Physiological seed treatment on seeds generally act to improve seed performance directly by reducing the time to germination and seedling emergence, or indirectly by improving the seeds potential to cope with stresses such as limited water availability (George, 1985).

Seed vigor is sum of all those properties of seed that determine level of activity and performance of a non-dormant seed or seed lot during germination and seedling emergence (ISTA, 2004). A vigorous seed lot is one likely to succeed under a wide variety of field conditions, while non-vigorous ones are unlikely to produce a satisfactory stand under certain field conditions. A vigor test is however not a test for field response *per se* since field response of a particular seed lot may more closely correlate with vigor test or ordinary laboratory test, depending on nature of field conditions under which they are planted. A vigor test, therefore, is an examination under specific environmental conditions so as to provide means of detecting differences that are not discernible in an ordinary laboratory germination test (Perry, 1978). Direct vigor tests simulate pertinent unfavorable field conditions on a laboratory scale, and include: Brick Gravel, Paper Piercing and Accelerated Ageing tests. Indirect vigor tests measure certain physiological attributes of seeds and include: seedling growth rate (germination speed), Tetrazolium (TZ) test, Leaching/ Electrical Conductivity (E.C) test, Enzyme and Respiration test. In Electrical conductivity (E.C) test, measurement of electrical conductivity of leachates provides an assessment of extent of electrolyte leakage from plant tissues. Conductivity measurement is done on soak water in which bulk sample of seeds e.g. Pea, (*Pisum sativum)* seeds has been steeped gives an estimate of seed vigor. Seed lots that have high electrolyte leakage, that is, having high leachate conductivity, are considered as having low vigor, while those with low leakage (low conductivity) are considered high vigor. The conductivity test offers a vigor test for seeds (particularly for pea seeds), which relates to the field emergence potential of seed (ISTA, 2004).

Quality of seeds has profound influence on economic production of agricultural crops of all species, vegetables included, though there is limited good quality seed available of Jute mallow from breeders to farmers (Ndinya, 2005). This is because production of high quality seeds has not been practiced in many of the African leafy vegetables (Abukutsa-Onyango, 2002). Farmers have been getting re-cycled planting seed of *Corchorus olitorius* every season from the local markets and farms whose potential is not assured (Okongo, 2005). Yields of crop has remained low 2-4 tons/ha/annum compared to expected yield of 5-8 tons per ha per annum (KALRO, 2019), and the major constraints has been use of poor quality seeds which forces farmers to use as much as 7kg/ha instead of 5kg/ha of seed required for a density of 250 000 plants/ha, which amounts to 40% extra seed (MOA, 2019). Seeds with assured quality can be expected to increase yields (Bhattacharjee *et al.,* 2000). Improved or quality seed for crop production of vegetable like Jute mallow can play an important role in improving food security, health and general rural livelihoods (Fondio and Grubben, 2004). Expansion of production of these vegetables continues to be hampered by lack of a reliable source of quality planting materials like seed and technical information (Ngoze and Okoko, 2005). This necessitated study to examine the seed quality of Jute mallow seed accessions used by farmers as planting material.

MATERIALS AND METHODS

Seed Material Sourcing for Research

Sourcing of seed was done from Keiyo, Uasin Gishu, Nandi, Trans Nzoia and West Pokot counties and Simlaw Seed where farmers were interviewed on agronomy of Jute mallow using a structured questionnaire and seed samples simultaneously collected. A sample size of 500 farmers was visited by use of stratified random sampling method. The seed samples collected were well-labeled and taken to University of Eldoret seed laboratory for seed quality tests of purity, germination and vigor as per ISTA, (2004) procedures and survey data analyzed using descriptive statistics and GENSTAT package.

Seed Testing as per ISTA, 2004

Analytical Purity Test

The objective of making a seed purity analysis was to determine mechanical quality of sample and percentage by weight of each component, and by inference composition of seed lot. In the test a seed sample which contained about 2500-3000 seeds was subjected to analytical purity and separated into three fractions of: pure seed, seed of other species, and inert matter. Quality seed is considered superior, if pure percentage of seed is above 98% and other species seeds are almost negligible or nil (below 0.1%) and inert matter percentage be as low as possible. From the sample submitted to laboratory, a working sample (weighed portion) was taken, by successive halving method, and moved to a dark smooth surface for ease of discerning. The analyst examined every seed of crop/others and inert matter, separating them into the said three fractions where each fraction was weighed and reported as a percentage of total weight.

Germination Test

In germination test, 400 seed of Jute mallow was counted from pure seed fraction of purity test submitted-sample. The seeds receive no pre-treatment. The counting of seeds was done without discrimination as to size or appearance by hand and aid of counting board or vacuum counter. The seeds, arranged in four replicates of 100 seeds on Petri-dish, were placed in growth chamber and under favorable moisture conditions in accordance with methods prescribed by ISTA (2004). The replicates were examined and counts made of seedlings and seeds in the various categories required for reporting in ISTA (2004) protocol. Proper spacing of seeds was done to minimize contact of seedlings with each other during germination. The distance between seeds was not being less than 1 to 5 times the width or diameter of seed being tested. Normal seedling category showed capacity for continued development into normal plants and possessed all essential structures and included, well developed root system, intact hypocotyls and epicotyls. Abnormal seedlings included those damaged, deformed and decayed. Also checked was presence of hard, fresh ingeminated or dead seeds and reported.

Electrical Conductivity (Seed vigor) Test

Distilled water of 250 ml was measured and put in 24 well labeled flasks and covered with aluminum foil to control any contamination. Other 2 flasks of distilled water of 250 ml was each set aside as control and covered with aluminum foil. The flasks were put on bench for 24 hrs at room temperature (20-23^{o}C). Jute mallow seeds (50) were added to each flask and left to soak for 24 hours. The soaked seeds was then swirled gently for 10-15 seconds and conductivity (□ S $cm^{-1}g^{-1}$) of soak water was measured upon meter showing constant reading. Between measurements, dip cell was rinsed twice in distilled water and dried using clean dry paper towels. The conductivity per gram of seed weight for each replicate was calculated after accounting for the background conductivity of the original water and the average of the four replicates provided the seed lot result.

RESULTS

Analytical Purity Results of Jute Mallow Seeds

The highest seed purity percentage (99%) was from Simlaw Seed Company with 1% inert matter, while lowest (95%) was from West Pokot (95%) with impurities of 3% (other seeds) and 2% inert mater (table 1). Analysis showed only Simlaw seeds and Uasin Gishu county seeds were of superior quality since their analytical purity percentages are above 98%. The quality of seed is considered superior if analytical purity percentage is above 98% (ISTA, 2004).

Table 1: Jute mallow seeds analytical Purity in percentage in nearest whole number.

County	% Pure Seed	% Other Seed	% Inert Matter
Keiyo	97	2	1
Uasin Gishu	99	1	0
Nandi	96	2	2
Trans Nzoia	98	0	1
West Pokot	95	3	2
Simlaw seed company	99	0	1

Seeds with highest impurities were from West Pokot (5%), Nandi (4%) and Keiyo (3%) and lowest were from Uasin Gishu, Trans Nzoia and Simlaw seeds each with 1% impurities.

Germination of Jute Mallow Seeds

The highest germination was from Simlaw Seed Company (89%), followed by Uasin Gishu (78%) and lowest was from Nandi County (37%), loosely next by West Pokot (49%) shown by table 2. The highest dead seed was Nandi County (56%) as well as West Pokot (45%) and lowest was from Simlaw Seed Company (9%) as well as Uasin Gishu (18%). The highest abnormal seedlings were from Nandi (7%), West Pokot (6) and Keiyo (5%) and least abnormal seedlings were from Simlaw seed (2%) and Trans Nzoia (3%).

Table 2: Germination and Emergence percentage of Jute mallow

County	Standard Germination test			% Emergence of radicle
	% Dead Seeds	% Abnormal seedlings	% Normal Seedlings	
Keiyo	38	5	57	62
Uasin Gishu	18	4	78	82
Nandi	56	7	37	44
Trans Nzoia	29	3	68	71
West Pokot	45	6	49	55
Simlaw seed company	9	2	89	91

Compared to ISTA (2004) minimum Jute mallow seed germination requirement of 60%, germination from three counties of Keiyo (57%), West Pokot (49%) and Nandi (37%) does not meet this minimum standard. The germination variation is eminent from comparisons in plate no. 1

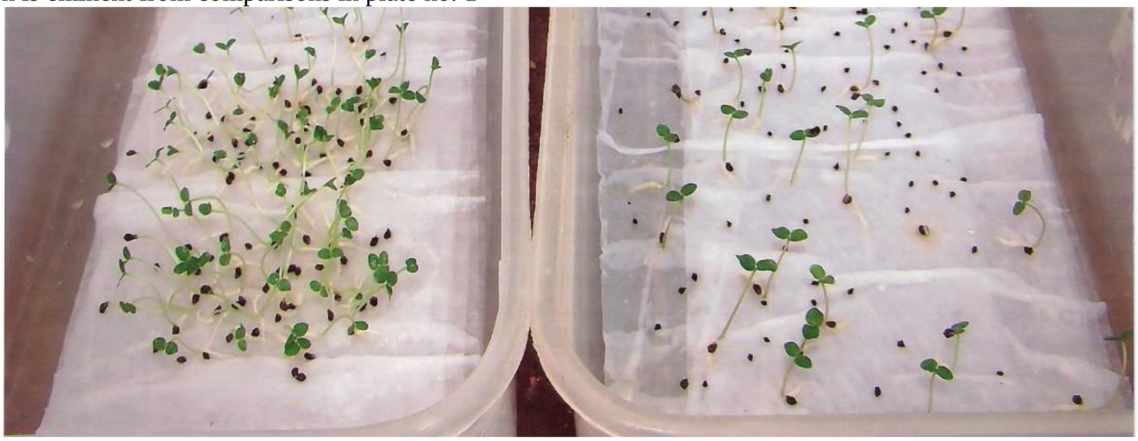

Plate 1: Germination comparison of seeds from Simlaw Seed Company (A) being higher than West Pokot (B)

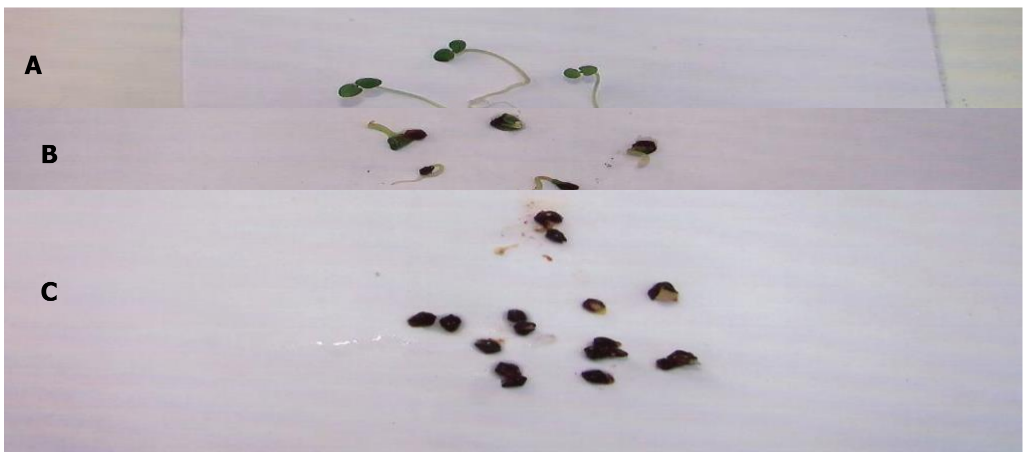

Plate 2: Jute mallow seedlings; **(A)** Normal, (**B)** Abnormal having either shoot or root (**C)** Dead seeds - soft and rotten

Radicle Emergence (Emerged seedlings): This is all seeds that showed life (normal and abnormal seedlings) in the test (plate 2). Emerged seedling result showed Simlaw seed had highest seedling emergence of 91%, as opposed to counties' best being Uasin Gishu (82%) followed by Trans Nzoia (71%), (table 2). This shows Simlaw seed were best in terms of germination and emergence than the entire county's seeds. It was also observed that though seedling emergence of Trans Nzoia (71%) and Uasin Gishu (82%) was high, germination percentage were reduced to Trans Nzoia (68%) and Uasin Gishu (78%) by abnormal seedlings by 3% (Trans Nzoia) and 4% (Uasin Gishu). This trend was also observed in seed from other counties (Table 2).

Table 3: Cumulative seedling emergence in numbers on filter paper at growth chamber

County	Day 1	Day 3	Day 5
Keiyo	38	57	62
Uasin Gishu	66	73	82
Nandi	28	36	44
Trans Nzoia	41	60	71
West Pokot	31	44	55
Simlaw seed	72	81	91

Emergence results showed most of seeds germinated in all seed sources with Simlaw seed (72) being highest followed by Uasin Gishu (66) and lowest emergence from West Pokot (31) (table 3). This variation in seed emergence as seen also in plate 1 simulates the field if these seeds were planted actually on the soils in farm. On average over half of seed in the research germinated on the 1st day (Table 3).

Electrical Conductivity of Jute Mallow

The conductivity per gram of seed weight for each replicate was calculated after accounting for the background conductivity of the original water and the average of the four replicates provided the seed lot result (ISTA, 2004). From Electrical conductivity (E.C) analysis (table 4), there was significant variation in their readings and most were high but below 10 E.C, indicating that the seeds were of low vigor and poor physiological quality. The highest E.C/vigor was from Simlaw seed (2.33 $\mu Scm^{-1}g^{-1}$) as well as Uasin Gishu (3.12 $\mu Scm^{-1}g^{-1}$) and lowest E.C from Nandi County (8.27 $\mu Scm^{-1}g^{-1}$) as well as West Pokot County (6.71 $\mu Scm^{-1}g^{-1}$).

Table 4: Electrical conductivity reading in $\mu Scm^{-1}g^{-1}$ of seeds leachet from various sources

County	Mean E.C
Nandi	8.27±0.8
West Pokot	6.71±0.9
Keiyo	5.34±0.6
Uasin Gishu	3.12±0.4
Trans Nzoia	4.06±0.2
Simlaw seed company	2.33±0.3

The higher the readings of conductivity per gram of seed indicates low seed vigor /poor quality seed and readings above 10 $\mu Scm^{-1}g^{-1}$ such seed should not be used as planting material.

DISCUSSIONS

Analytical Purity of Jute Mallow Seeds

Analytical purity showed Simlaw Seed had highest purity percentage (99%) compared with seed from most of the counties except Uasin Gishu (99%) having equally high. West Pokot (95%) and Nandi (96%) had lowest purity. According to ISTA, (2004), quality seed is considered superior if purity percentage is above 98% meaning that apart from Simlaw seed, only two counties (Uasin Gishu (99%) and Trans Nzoia (98%) seed were of superior quality. Though so, Louwaars, (1994) observed that analytical purity *per se* is not gauge of good quality seed but a sum total of several seed attributes, needing more tests to ascertain seed quality, which the study also agree and outlaid.

Germination of Jute Mallow Seeds

Germination results show Simlaw seed Company (89%) was highest closely followed by Uasin Gishu (78%) and lowest germination was from Nandi (37%). This means that Simlaw Seed Company Jute mallow seed would do better in field than all of the seeds from Counties analyzed concurring with out-put of works by Ngoze and Okoko, (2005) and Bhattacharjee *et al.*, (2000). Equally good germinations were shown by Uasin Gishu (78%) and Trans Nzoia (68%). Compared to ISTA, (2004), which requires Jute mallow seeds germination to have minimum germination percentage of 60%, three counties of Keiyo (57%), West Pokot (49%) and Nandi (37%) did not meet required minimum standard for its accessions to be used as quality seed supporting similar studies by K'Opondo *et al.*, (2005). Simlaw seed had high seed vigor (91%), followed by Uasin Gishu (82%) and Trans Nzoia (71%) in terms of emergence as compared with low Jute mallow seed emergence analyzed from other counties including Keiyo (62%), West Pokot (55%) and Nandi (44%). This same trend could be expected to be performed in the field if these seeds were planted on the soils in farm concurring with research by Abukutsa-Onyango, (2002) and reports by KALRO, (2019), MOA, (2019). This low seedling emergence could contribute to low yields and supports what was observed by Mc Donald, (1980) and Benjamin, (1990) and was as result of abnormal seedlings or dead seeds. Such was evident in this research where the highest dead seed was Nandi County (56%) as well as West Pokot (45%) and lowest was from Simlaw Seed Company (9%) as well as Uasin Gishu (18%). Also contributing to low yields were high abnormal seedlings from Nandi (7%), West Pokot (6) and Keiyo (5%) and least abnormal seedling were from Simlaw seed (2%) and Trans Nzoia (3%). This concurred with results of other research including Amarjit, (1995), George, (1999) and Ndinya, (2005) on crop improvement and full assessment of local seeding material for quality aspect.

Electrical Conductivity (seed vigor) of Jute Mallow Seeds

Simlaw seed had the lower leachate conductivity of 2.33 $\mu Scm^{-1}g^{-1}$ as well as Uasin Gishu (3.12 $\mu Scm^{-1}g^{-1}$) meaning that the seeds were of high vigor and could be used for planting concurring with studies by Amarjit, (1995) and Schippers, (2003) indicating agricultural, seeds with assured quality can be expected to increase yields. Seeds from counties generally had high leachate conductivity with highest being Nandi (8.27 $\mu Scm^{-1}g^{-1}$) followed by West Pokot with Electrical conductivity of 6.71 $\mu Scm^{-1}g^{-1}$ as well as Keiyo (5.34 $\mu Scm^{-1}g^{-1}$) all the seeds were considered of poor quality. This means that though seeds from counties were of low physiological vigor, further tests on seeds needed to ascertain other reasons of why there was low quality concurring with research results of Louwaars, (1994) and Amarjit, (1995). Also supporting these results were studies by Wright *et al.*, (1994) and Okongo, (2005) recommending several seed tests needed to be done to find out why some seeds show poor performance in field yet laboratory results show high seed vigor.

CONCLUSIONS

It is concluded that Jute mallow seed grown by farmers though of high analytical purity is of poor physiological seed quality and low seed vigor as seen from the high percentage of dead seeds at germination and high leachet conductivity. The dead seeds could be result of immature harvested seed, diseased seeds, poor processing methods and storage conditions right from field to markets. It is recommended that breeders or seed companies avail new varieties or improved selections for farmers use as well farmers be trained on quality seed production and proper post harvest handling to improve seed quality.

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