

**effects of retention period on field emergence, seed vigour and genetic purity of
soybeans (glycine max. l).**

By

MAZVIRO CRYNOS

SUPERVISOR: MR T. MADANZI

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Faculty of Natural Resources and Agriculture

MIDLANDS STATE UNIVERSITY

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DECLARATION

I hereby declare that this dissertation has not been not been submitted for a degree and that it is entirely my own work and all help has been duly acknowledged.

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MAZVIRO CRYNOS

MADANZI TENDAI

(STUDENT)

(SUPERVISOR)

ABSTRACT

Access to high quality certified soybeans seeds by most small scale commercial farmers is a major constraint and this result in most farmers to retain their seed obtained from the previous harvests. The aim of this study was to assess the effects of retention period on field emergence, vigor and genetic purity of soybean seeds under the smallholder farmers in semi arid regions of Zimbabwe. A survey was first conducted to assess the agronomic and storage practices done by smallholder farmers on soybeans. Questionnaires were used to gather data and it was during this time when seeds were collected from farmers for field experimentation. The experimental treatments were as follows: certified soybean seeds, retained seeds with one year, retained soybeans seeds with two years and retained soybean seeds with three or more years. The experiment was laid in a Randomised Complete Block Design with four treatments replicated three times. The blocking factor was slope. Laboratory test were then conducted to determine seed vigor and genetic purity. Accelerated Aging Test was used to determine seed vigor. The number of seedling emerged under vigor test were counted and then classified into strong, weak and abnormal seedlings. Genetic purity was determined by looking on the physical components of the sample. From the results gathered from a survey it was seen that most famers retain seeds obtained from their previous harvest and most of them produced an average yield of 0.6 tonnes per hectare. From the results obtained it was seen that retention period of soybeans significantly ($p < 0.001$) affect seed emergence, vigor and genetic purity. It was also observed that germination percentage, germination uniformity, seed vigor and genetic purity decreases as retention period increases while mean germination time and days to 50 % emergence increases as retention period increases. A positive relationship was observed between seed viability and seed vigor on correlation analysis done. Farmers should not retain seeds stored for more than one year and also where retained seeds are used, higher seed rates should be used to compensate the low viability of retained seeds.

Key words: Seed, Viability, Vigor, Emergence

DEDICATION

This project is dedicated to my mom, daddy, my wife and son

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ABBREVIATIONS

AOSA -Association of Official Seed Analysis

FAO –Food and Agriculture Organisation

CV –Coefficient of Variation

LSD – Least Significant Difference

MGT- Mean Germination Test

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CHAPTER 1

1.0 INTRODUCTION

The causes of low yield in soybeans by small scale commercial farmers in semi arid regions of Zimbabwe are diverse and yet interrelated. Poor crop establishment has been identified as a major constraint to attaining good yields in smallholder soybean production in Zimbabwe (Mariga and Mabika, 1996). Factors like moisture stress, soil conditions, temperature and oxygen have been found to result in poor soybean germination (Hartmann *et al*, 1990).

Other constraints to soybean production in the smallholder farming sector include use of unimproved varieties, unavailability of certified seeds, use of retained seeds, lack of inoculants and general lack of knowledge on recommended agronomic practices for soybeans (Mpepereki, 1996). Poor plant population, inadequate plant protection, improper fertilizer application and poor adoption of post-harvest technology have been identified as additional constraints to low productivity of soybean by smallholder and marginal farmers of Zimbabwe (Mpepereki *et al*, 1996). Among these constraints, use of retained seeds has been noted as major constraint currently faced by smallholder farmers (Mupuwei *et al*, 2014). Currently a 25kg of certified soybean seed is being sold at 42 US dollars of which a farmer requires 80-100kgs of soybean seed to plant one hectare. As a result farmers end up retaining seed produced from their previous harvest and in most cases they plant the seed without inoculating them with specific *Bradyrhizobium* species (Mabika and Mariga, 1996).

Despite being capital intensive, most smallholder farmers in semi arid regions of Zimbabwe such as Gokwe and Kwekwe are diverting from growing traditional crops such as maize and cotton into soybean production which is fetching lucrative prices on the market at around \$600 to \$800 per tonne (Mupuwei *et al*, 2014). However production of soybeans has been

restricted to high potential areas that receive 700mm rainfall per year such as Harare, Chinhoyi and Chegutu.

For most many years, soybean research has been mostly confined to large scale commercial farmers in high rainfall areas in Zimbabwe (Esteluzen, 2011). Most commercial farmers had easy access to inputs, financial capital, irrigation services and well developed marketing channels (Madanzi et al, 2012). The yield produced by these large scale commercial farmers is comparatively higher than those produced by small scale commercial farmers situated in semi arid regions of Zimbabwe. Average yields of 3 to 4 tons per hectare have been recorded under large scale commercial farming while 0.6 tons per hectare have been observed under smallholder famers in semi arid regions of Zimbabwe (Mabika and Mariga, 1996).

1.2 Main Objectives

To evaluate the effects of retention period on field emergence, vigor and genetic purity of soybean seeds in semi arid areas of Zimbabwe.

1.2.1 Specific Objectives

- To assess the agronomic and storage practices done by small holder farmers on soybeans.
- To determine the effects of retention period on seed emergence, seed vigour and genetic purity of soybean.

1.2 Hypothesis

This study serves to address the following hypotheses:

- Retention period of soybean seeds has a significant effect on seed emergence, seed vigour and genetic purity.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Origin and distribution of soybean

The first domestication of soybean (*Glycine max*) has been traced to the eastern half of North China in the eleventh century B.C. (Whigham and Minor, 1978). Soybean has been one of the major plant food crops of China along with rice, wheat, barley and millet (Abdul-Baki and Anderson, 1973). According to the early authors, soybeans production was localized in China until after the Chinese –Japanese war of 1894-95, when Japanese began to import soybean for use as fertilizer. Shipments of soybeans were made to Europe about 1908 and the soybeans attracted world-wide attention. There were only 1.8 million acres in the United States in 1924 when the first official estimate became available. At that time most of the crop was grown for hay. It was not until the 1920`s that soybean acreage expanded to any great quantity in the US Corn Belt. After the Second World War soybean diffused into many countries (Whigham and Minor, 1978).

2.2 Botany and Morphology of soybean

Soybean is a legume of the family of the *papilionaceae*, to which other well known plants belong such as field beans, cow peas and peas. Soybean is an annual plant that grows up to a height of 1.5 depending on the variety. Erect stems covered with thick brownish hairs. Leaves alternate, trifoliate with ovate leaflets and short peduncles (Hartmann et al, 1990).The fruits are pods of up to 7cm long with one to four seeds inside. These seeds show different colours depending on the variety. Soybeans have two growth habits, determinate and indeterminate. An indeterminate variety continues to grow and put on new leaves and nodes at the top of the plant while at the same time the plant sets flowers and pods at the bottom of the plant. As the

growing season progresses, there may be full size pods at the bottom of the plant while at the top of the plant new leaves will be still emerging (Hartmann et al, 1990). Determinate soybean varieties have a different growth habits. They complete their growth cycle first before they start to flower and set on pods. Smallholder farmers in semi arid regions of Zimbabwe where dry spells during the growing season are more pronounced, they are recommended to select indeterminate varieties as they have the ability to recuperate after periods of dry spells (Madanzi et al, 2012).

2.3 Uses of soybeans

Soybeans were grown for centuries in Asia mainly for their seeds. These seeds were used in preparing a large variety of fresh, fermented and dried food products that were considered indispensable to oriental diets while in United States they were grown for forage and to some extent, green manure (Whigham and Minor, 1978). Most of soybean is processed into oil and meal. Oil extracted from soybean is further processed into various products such as margarine, cooking oil and salad dressings. Soybean oil is also used in industrial paint, varnishes, printing inks and other various products. Development efforts in recent years have resulted in several soybean oil based lubricant and fuel products that replace non-renewable petroleum products. Lecithin, a product extracted from soybean oil, is a natural emulsifier and lubricant used in many food and industrial applications. As an emulsifier, it can make fats and water compatible with each other. The high protein meal remaining after extraction of oil can be processed into soybean flour for human consumption or incorporated into animal feeds. The soybean protein helps to balance the nutrient deficiencies in many grain crops such as maize and wheat which are known to low important amino acids, lysine and tryptophan (Esteliuni, 2011).

2.4 Constraints faced by smallholder farmers in soybean production

Smallholder farmers in soybean production face a number of challenges which causes them not to derive full benefits from this enterprise. Among other factors, is non availability of soybean pure lines varieties. Certified soybean seed has not been readily available within smallholder input outlets if compared to other cash crops (Mpepereki, 1996). Smallholder farmers also uses unimproved retained seeds and didn't have access to *Bradyrhizobium* inoculants this contributed much low yields. Distance to market negatively and significantly affects the intensity of soybean market participation by smallholder farmers. As distance from the market increase, variable transport costs also increases and this discourages resource constrained smallholder farmers from selling high volumes. Other constraint faced by smallholder farmers include lack of knowledge on recommended agronomic practices for soybeans, poor fertilizer application and poor adoption of post harvest technology.

2.5 Seed quality and storage

Seed quality, as a method of measuring viability is very essential in successful seed propagation as a drying seed is characterized by gradual decline in vigor and necrosis or injuries may appear on localized area of the integument (Hartmann *et al*, 1990). Good quality is about high germination, reasonably pure, free from diseases and insect attack. Use of high quality seeds is most important one as quality seeds ensure better germination as well as better yield. If the seed is of inferior quality, crop failure is unavoidable (Ahmand, 2001). Although seed quality is governed by genetic makeup, commonly the quality of seed may deteriorate in subsequent stages like harvesting, threshing, processing and storage period. Retention of seed always forms an important consideration in agricultural practices. Poor seed handling conditions give rise to deterioration of seed quality and resultantly loss of viability.

The storage of grains in the natural environments of tropical areas presents larger problems due to the temperate conditions and relative humidity, when compared to areas having a cold climate (Burris, 1980). The parameters of temperature and relative humidity during storage are decisive in the process of loss of seed viability and alterations in the grain colour and composition (Whigham and Minor, 1978). This poses a lot of challenges to smallholder farmers who retain their seeds as they may fail to manipulate the storage conditions to meet the desired ones such that they can maintain seed viability.

3.6 Vigor testing

Seed vigor is defined as those properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of conditions (AOSA, 1983). A seed vigor test is a series of analyses on a seed lot that provide an indication of its emergence potential in the field. Vigor testing does not only measure the percentage of viable seed in a sample, it also reflects the ability of those seeds to produce normal seedlings under less than optimum or adverse growing conditions similar to those which may occur in the field. Seeds may be classified as viable in a germination test which provides optimum temperature, moisture and light conditions to the growing seedlings; however, they may not be capable of continuing growth and completing their life cycle under a wide range of field conditions. Generally, seeds start to lose vigor before they lose their ability to germinate; therefore vigor testing is an important practice in seed production programs (AOSA, 1983).

Testing for vigor becomes more important for carryover seeds, especially if seeds were stored under unknown conditions or under unfavourable storage conditions. Seed vigor testing is also used as indicator of the storage potential of a seed lot and in ranking various seed lots with different qualities.

It has been established that the conditions of seed development, maturation, storage and aging influence seed vigor. Seeds developed under moisture stress, nutrient deficiency, extreme temperatures, etc. often result in light, shrivelled seed or collectively called poor-vigor seed (AOSA, 1983). Pre -harvest environment of high humidity and warm temperatures can also cause loss in seed viability and vigor. Seed mechanical damage, whether induced by harvesting or conditioning equipment, as well as improper storage conditions are among the factors that adversely affect seed vigor. In addition, genetic factors such as hard-seediness, resistance to diseases, and seed chemical composition influence the expression of seed vigor.

There are various methods that can be used to determine seed vigor and some of them include Accelerated Aging Test, Cold Test, Electric Conductivity Test and Seedling Vigor Classification Test.

2.7 Seed inoculation

Nitrogen (N) fixation is a symbiotic process of converting atmospheric nitrogen into a usable form for the plant and it is critical for producing high soybean yields. For nitrogen fixation to occur, the nitrogen-fixing bacteria known as *Bradyrhizobium japonicum* need to be readily available in the soil or must be applied to the seed (Mabika and Mariga, 1996). In most rural areas the inoculants is not readily accessible and it requires costly storage facilities which cannot be afforded by most smallholder farmers. Inoculants is sensitive to light and temperature during storage, hence recommendation to store in refrigerators. Such facilities are not commonly found in the communal areas making storage difficult.

2.8 Seed germination

According to Hartmann et al, 1990, “Germination is the activation of the metabolic machinery of the embryo leading to the emergence of a new seedling”. Soybean undergoes

epigeal form of germination where the cotyledons come out of the soil. Mobilization of reserves during germination has been concerned with breakdown of storage carbohydrates and proteins in the seed (Matheson and Small, 1980). Moisture, light, temperature and seed viability are some of the factors that have been noted in affecting soybean germination. The seed can take five to ten days to emerge after planting. The hypocotyls begin to elongate and forms a hook that pushes through the soil surface, pushing the cotyledons upward. The cotyledons are temporally source of food for the new seedling. Shortly after emergence, they open and turn green due to exposure of sunlight, and start manufacturing food through photosynthesis.

In semi arid and arid environments, successful crop establishment depends not only on the rapid and uniform germination of seed, but also on the ability of seed to germinate under low water availability (Kazen *et al*, 2012). Rapid and synchronized seed germination and seed emergence are crucial in achieving an optimal crop stand and high productivity. By a good seedling establishment, plant life cycle would be guaranteed a strong plant, with a good plant density and uniformity. Low quality of seeds can potentially decrease the rate and percentage of seedling emergence, leading to poor stand establishment in the field and consequently yield loss (Abdul-Baki and Anderson, 1973)

CHAPTER 3

3.0 MATERIALS AND METHODS

The field experiment was conducted in Gumunyu Ward 19 of Gokwe North District Midlands Province (Fig 3.1). Gokwe North District is situated 350km north west of Harare. The area lies under the Natural Farming Region III. Annual average rainfall ranges from 650mm-850mm. The study was done in a farmer`s field managed by the researcher. The land is slightly gentle with sandy loam soils of 0.5 m deep.

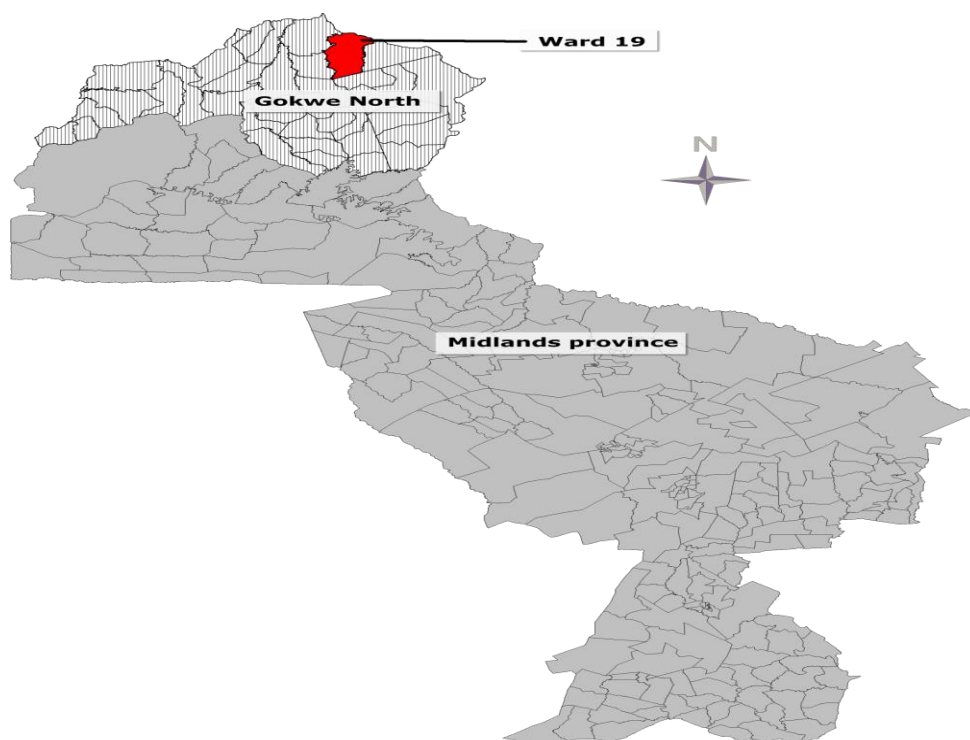


Fig 3.1 Map of Ward 19 of Gokwe North, Midlands Province

3.1. Survey and Experimental design

A survey was first conducted to gather data and collect seed from the farmers. The field experiment was carried out in a Randomized Complete Block Design (RCBD) with four treatments replicated three times. The blocking factor was slope and the seed variety was SC

Safari. This was done to determine standard seed germination. Laboratory tests were also done to determine seed vigor and genetic purity. The experimental treatments were:

Treatment 1= certified seeds (control)

Treatment 2= retained seeds with one year

Treatment 3= retained seeds with two years

Treatment 4= retained seeds with three and more years

The controls were plots planted with certified soybean seeds. A total of 12 plots measuring 3m x 4m each and separated by 1m was selected for this study. The border rows were 2m wide borders hence the total area under the study was 345 m². Five rows 4 m long were planted each with planting distance of 600mm between rows and 50mm within rows were used in this study.

3.2 Storage and Agronomic practices

The current storage and agronomic practices on soybeans done by smallholder farmers in Gumunyu Ward 19 were determined through a formal survey with farmers on a one to one basis with the researcher. A questionnaire was administered to gather information on storage and agronomic practices being done on soybean production (Appendix 4). The data was collected from 50 randomly selected farmers. The sample size was chosen to ensure that adequate information was gathered.

3.3 Field experiment

A total number of 400 soybean seeds were sown per each plot in five rows of 3m long with spacing of 60cm between rows and 5cm between planting stations at a depth of 5cm. Seedling emergence was measured thrice by physically counting the total number of emerged

seedlings. Firstly, once emergence is established, then secondly 9 days after the first count and lastly 7 days after the second count in each plot.

Days to 50% emergence was also determined by physically counting the total number of seedlings that has emerged soon after emergence was established. The number of seedlings emerged were then expressed as a percentage of the total seeds planted in each plot

The total number of seedlings that have emerged in each plot was then counted after 14 days of sowing and then expressed as a percentage using the below formula:

$$\frac{\text{number of seedlings emerged}}{\text{total number of seedings planted}} \times 100 = \text{emergence percentage}$$

3.3.1 Mean Germination Time

Using daily counts, the mean germination time (MGT) was calculated for each sample using the formula cited by Ellis and Roberts (1980) given below:

$$\text{MGT} = \frac{\sum n \cdot D}{\sum n}$$

Where n = number of seeds newly germinated at time D

D = days from beginning of germination test

$\sum n$ = final germination

3.3.3 Germination Uniformity

The germination uniformity was expressed as standard deviation around the mean. This was reported as time to 75 percent germination (T_{75}) minus the time to 25 percent germination (T_{25})

3.4 Seed vigor

Accelerated Aging Test was used to determine soybean seed vigor. A total number of 200 seeds for each sample was placed in small plastic containers and placed on trays in an oven at a temperature of 45°C and near 100% relative humidity for 48 hours. The seed samples were then removed and dried.

3.4.1 Number of seeds emerged under vigor test

The seeds were then planted in trays, the number of emerged seedlings from each sample was physically counted and the total number was recorded.

3.4.2 Classification of seedlings

The emerged seedlings were then classified according to strong, weak and abnormal seedlings. The following four significant morphological sites of seedlings were evaluated for seed quality:

1. Root system.
2. Hypocotyl (the embryonic axis between cotyledons and root).
3. Cotyledons (storage tissue of reserve food for seedling development).
4. Epicotyl (the embryonic axis above the cotyledons).

Seedlings were classified as ‘strong’ if the above four areas were well developed and free from defects, which was an indication of satisfactory performance over a wide range of field conditions. On the other hand, normal seedlings with some deficiencies such as missing part of the root, one cotyledon missing, hypocotyls with breaks, lesions, necrosis, twisting, or curling were classified as ‘weak’

3.4.3 The relationship between seed viability and seed vigor

Correlation analysis was then done using the data obtained from standard seed germination and the data obtained from vigor test. This was done to see if a relationship exists between seed viability and seed vigor.

3.5 Genetic purity

3.5.1 Physical purity

The physical purity test was done on working sample of 30 grams drawn from each treatment.

Weighing of the working sample was as follows:

The number of the decimal places to which the working sample and the components of the working sample were weighed is given below:

Weight of the working sample (g)	the number of decimal place moved
<1	4
1-9.999	3
10-99.99	2
100- 999.9	1
1000 or more	0

The working sample after weighing was then separated into components which pure seed, other crop seeds, weeds and inert material. All the four components were weighed to the required number of decimal places and the percentages of the components was then determined as follows:

$$\frac{\textit{weight of individual component}}{\textit{total weight of all componets}} \times 100$$

3.5.2. Different lines in a given sample

The number of lines in a given sample was physically observed. The defining characteristics of different lines were used to identify the number of lines in a given sample.

CHAPTER 4

4.0 RESULTS

4.1 Agronomic and Storage practices done by smallholder farmers on soybeans

4.1.1 Gender Respondents results

The figure 4.1 below shows the results obtained on the number of males and females interviewed during the survey. It was observed that females dominated the agriculture sector in ward 19.

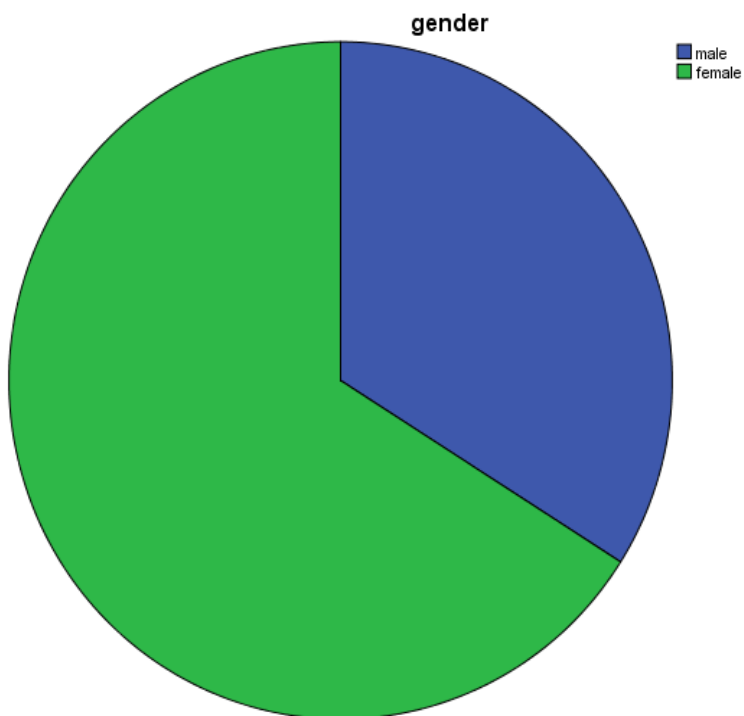


Figure 4.1: Gender respondents

4.1.2 Source of seed for famers

From the results obtained from farmers concerning the source of seed of soybean for planting, it was seen that farmers rely on retained seeds that are either from one`s own

harvest or from neighbours (Fig 2).

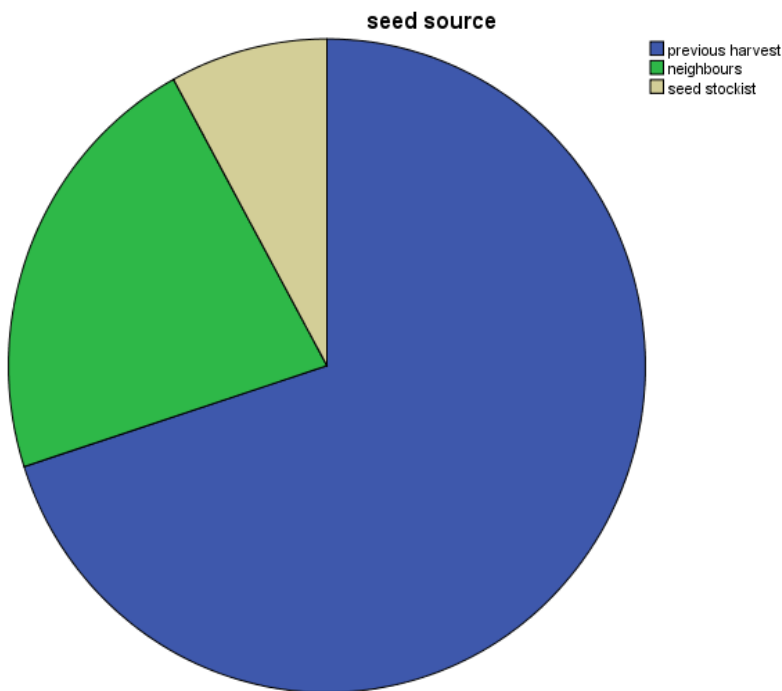


Figure 4.2: Seed source for farmers

4.1.3 Retention period for soybean seeds

Data gathered from farmers on retention period for soybeans is presented in figure 4.3 below. It was seen that farmers usually retain seeds after a period of two and more years.

Table 4.3: Seed retention period

RETENTION PERIOD	NUMBER OF FARMERS	REASON
Retained seeds with 1 year	10	Farmers abandoned growing cotton which was their major cash crop to growing soybeans and most of them have to plant seed from their previous harvest.
Retained seeds with 2 years	21	Farmers have not fully accepted soybeans as their major cash crop which made them not to grow soybeans on yearly basis.

		Drought challenges, this made farmers to have a reserve in case of crop failure.
Retained seeds with 3 and more years	19	Farmers faced problems in marketing their produce and most of them would store the produce for quite a long time. Very low yields produced, this becomes more expensive to transport the produce to the markets and most of them would opt for family consumption and as source of seed.

4.1.4 Average yield/Ha

The average yield produced by most farmers in ward 19 was very low and most of the farmers produced an average yield of 0.6 tonnes per hectare and only few farmers managed to produced average yield above this point. The results obtained are presented on the figure 4.4 below.

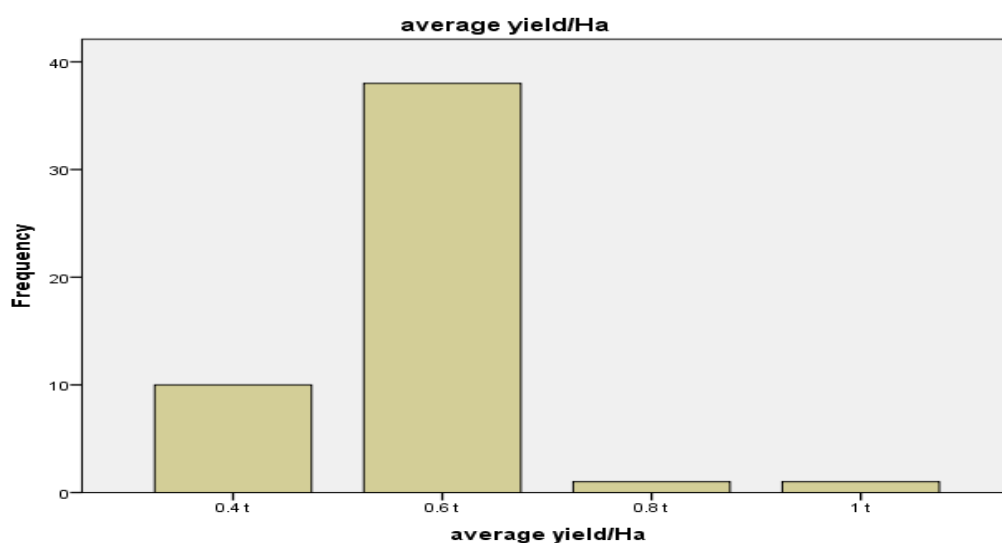


Fig 4.4 Average yield/Ha under by smallholder famers

4.2 Field Experiment

4.1.1 Days to 50% emergence

The results of the days to 50% emergence of the various seed with different retention period are presented in Table 4.1. The days to 50% emergence increased significantly as increase in the retention period of soybean seeds. The results showed that there was no significant difference between certified soybean seeds and retained seeds with one year although certified seeds took 5.667 days to reach 50% emergence while retained seeds with one year 6.667 days. However the days to 50% emergence increased significantly as retention period increased with retained seeds with three or more years recording the highest (10.667 days).

Table 4.1 Days to 50% emergence

Treatment	Days
Certified	5.667 ^a
Retained seeds with 1 year	6.667 ^a
Retained seeds with 2 years	8.667 ^b
Retained seeds with 3 + years	10.667 ^c
LSD	1.290
CV	8.2
P value	P < 0.001

4.2.2 Emergence percentage

All the seedling emergence percentage differences among soybean seeds with different retention period were significantly different ($p < 0.001$). Retention period significantly affect seedling emergence (table 4.2). Certified seeds recorded the highest emergence percentage (88.00), followed by retained seeds with one year (77.00), and then retained seeds with two years (67.00) and lastly retained seeds with three or more years (62.67).

Table 4.2: Emergence percentage

Treatment	Emergence %
Certified seeds	88.00 ^d
Retained seeds with 1 years	77.00 ^c
Retained seeds with 2 years	67.00 ^b
Retained seeds with 3+ years	62.67 ^a
LSD	2.079
CV	1.4
P value	$P < 0.001$

4.2.3 Mean Germination Time

All the mean germination time among soybean seeds with different retention period were significantly different. Retention period significantly affect the mean germination time. Certified seeds recorded the lowest mean germination time (6.33), followed by retained seeds with one year (8.67), and then retained seeds with two years (10.33) and lastly retained seeds with three or more years (11.67).

Table 4.3: Mean Germination Time

TREATMENT	MGT (days)
Certified seeds	6.33 ^a
Retained seeds with 1 year	8.67 ^b
Retained seeds with 2 years	10.33 ^c
Retained seeds with 3+ years	11.67 ^d
LSD	0.881
CV	2.5
P value	p < 0.001

4.2.4 Germination Uniformity

The results obtained under germination uniformity are presented in table 4.4. The results showed that retention period does not significantly affect germination uniformity. However, there was a significant difference ($p < 0.001$) between certified seeds and retained seeds. The germination uniformity decreased as retention period increases but the results were not statistically different.

Table 4.4: Germination Uniformity

TREATMENT	MGT (days)
Certified seeds	4.667 ^a
Retained seeds with 1 year	7.667 ^b
Retained seeds with 2 years	7.667 ^b
Retained seeds with 3+ years	8.000 ^b
LSD	0.999
CV	7.1
P value	p < 0.001

4.3 Seed vigor

4.3.1 Number of seedlings emerged under vigor test

The number of seedlings emerged under vigor test results are presented in table 4.5. The results showed that retention period significantly affect seed vigor as seedling emergence decreased with increase in the retention period. Certified seeds have highest seed emergence (166.0) under vigor test and its difference with normal seedling emergence test was very small (5%). Retained seeds with three or more years recorded the lowest seedling emergence under vigor test (75.7) and it also recorded the greatest difference between normal seedling emergence test and emergence under vigor test (24.82%). From the results obtained under vigor test, it was observed that only certified seeds and retained seeds with one year managed to score a seedling emergence which was above 50% while retained seeds with two years and retained seeds with three or more years failed to reach 50% seedling emergence.

Table 4.5: Number of seeds emerged under vigor test

TREATMENT	NUMBER OF SEEDS EMERGED
Certified seeds	175.7 ^d
Retained seeds with 1 year	166.0 ^c
Retained seeds with 2 years	92.0 ^b
Retained seeds with 3+ years	75.7 ^a
LSD	3.632
CV	1.2
P value	p < 0.001

4.3.2 Seedling vigor classification tests

Table 4.6 below shows the results obtained under seedling vigor classification test. The results on strong seedlings indicated that there was a significant difference among the treatments. Certified seeds recorded the highest percentage of strong seedlings (83.33), while retained seeds with three or more years recorded the lowest percentage (16.67) of strong seedlings. Retained seeds with three or more years recorded the highest number of weak and abnormal seedlings while certified seeds recorded the least number of weak and abnormal seedlings. Although a difference exists between the numbers of weak seedlings on certified seeds, retained seeds with one year and retained seeds with two years, the results were not significantly different.

Table 4.6 Seedling vigor classification

treatment	strong	weak	Abnormal
Certified seed	83.33	13.33	3.33
Retained seeds with 1 year	53.33	30.00	16.67
Retained seeds with 2 years	33.33	36.67	30.00
Retained seeds with 3+ years	16.67	60.00	23.33

4.3.3. The relationship between seed viability and seed vigor

The relationship between seed viability and seed vigor of soybeans is presented in the figure 4.2 below. The results obtained from correlation analysis indicated that there was a positive relation between seed vigor and seed viability.

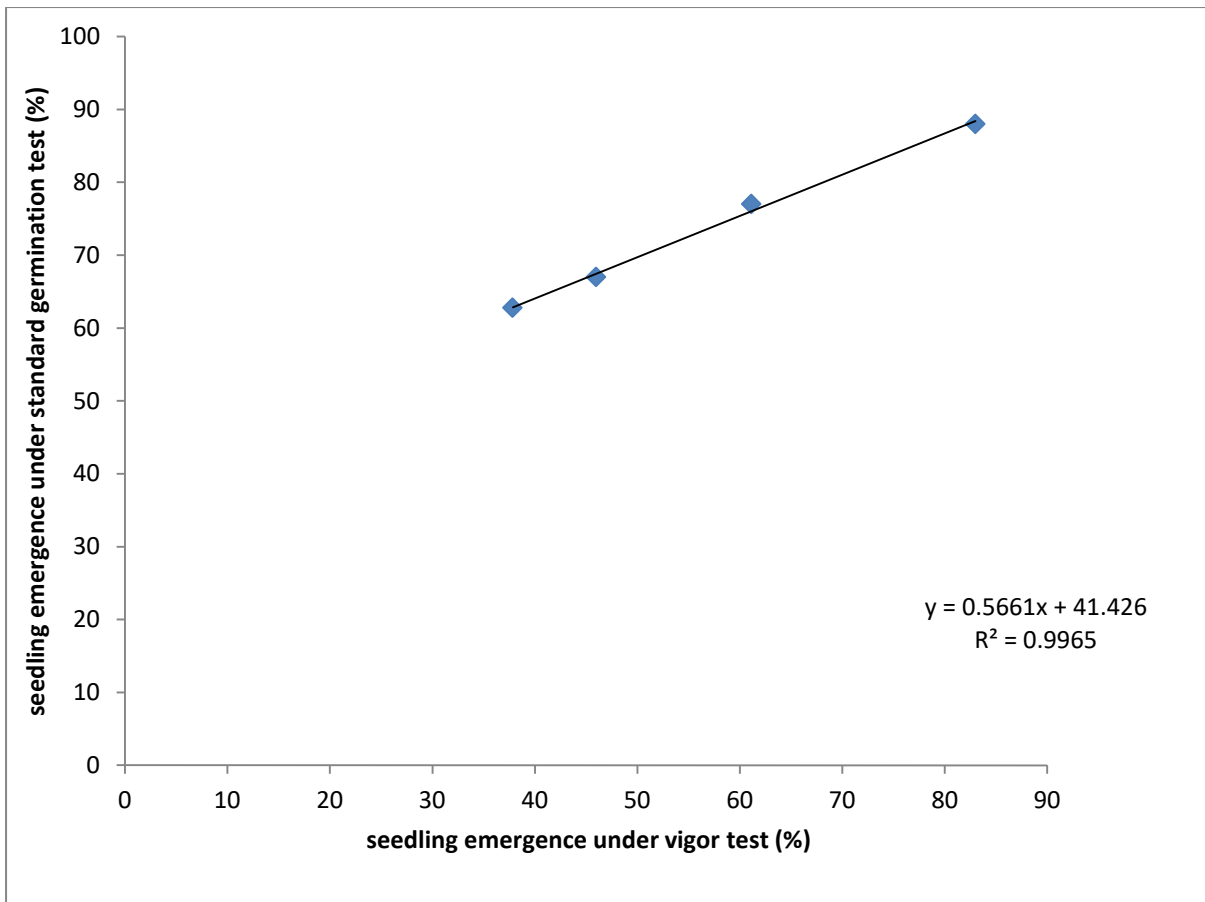


Figure 4.5

4.4 Genetic and physical purity

4.4.1. Physical purity

The genetic purity of soybean seeds with different retention periods are presented in Table 4.7. The percentages of pure seedlings from the four different samples with different retention periods were statistically different. Physical purity decreased with increase in the retention period. Certified seeds recorded the highest number of pure seeds (93.20), followed by retained seeds with one year (82.20), then retained seeds with two years (65.57) and lastly retained seeds with three or more recorded the least (57.80). From the results obtained on other crop seeds, certified seeds were free from admixtures as it didn't contained other crop seeds. The quantity of other crop seeds increased proportionally with increase in retention

period with retained seeds with three or more years recording the highest number (1.6667%). The results on weed contamination reviewed that certified seeds and retained seeds with one year were statistically similar while retained seeds with two years and retained seeds with three or more years were also statistically similar but also statistically different to certified seeds and retained seeds with one year.

Table 7: Physical purity

Treatment	Pure seed	Other crop seeds	weeds	Inert material
Certified seed	92.20 ^d	0.0000 ^a	0.4433 ^a	0.3300 ^a
Retained seeds with 1 years	82.20 ^c	0.5567 ^b	0.6667 ^a	0.5567 ^{ab}
Retained seeds with 2 years	65.57 ^b	1.4433 ^c	1.1100 ^b	0.8900 ^b
Retained seeds with 3+ years	57.80 ^a	1.6667 ^d	1.1100 ^b	1.4467 ^c
LSD	3.319	0.4632	0.4342	0.4612
CV	2.2	25.3	26.1	28.6
P value	P< 0.001	P< 0.001	P,0.022	P< 0.005

4.4.2. Different lines in a given sample.

The number of soybean lines in different samples of soybean seeds with different retention periods is presented in Table 4.8. The numbers of lines from the four different samples with

different retention periods were statistically different. The number of lines in increased with increase in the retention period. Certified seeds recorded the lowest number of pure lines (1.000), this sample only consist of a single line. The number of lines increased significantly as increase in retention period with retained seeds with three years recording the highest number of different lines in the sample (4.667).

Table 4.8 number of lines in a given sample

Treatment	Number of lines
Certified seeds	1
Retained seeds with 1 year	2
Retained seeds with 2 years	3
Retained seeds with 3 + years	4

CHAPTER 5

5.0 DISCUSSIONS

5.1 Agronomic and Storage practices done by small holder farmers on soybeans

The results obtained from the survey conducted it have seen that woman are more dominant in the agricultural sector than man. This might be so as more man go to urban areas in search of jobs. Any project aimed at improving agriculture in small holder farmers should bear in mind the gender issues. The projects must be compatible with woman to enhance its viability and adoption.

The results also reviewed that most famers retain soybean seeds from their own previous harvest and some get the seed from their neighbours. Very few farmers are able to purchases certified seeds due high prices associated with certified seeds. This agrees with results obtained by Mupuwei *et al*, (2014) who also noted the issue of retaining seeds as one of the major constraint faced by smallholder farmers on soybean production. Most farmers retain their seeds after a period of two years and this might so as soybean have not been fully accepted as a the main cash crop and also problems encountered in marketing the produce. The average yield of soybeans produced by most farmers in ward 19 is 0.6 tonnes per hectare and very few farmers were able to produce a yield above 0.6 tonnes per hectare. This is in connection with the work done by Mabika and Mariga, 1996 who pointed out that the average yield produced by small holder farmers is 0.6 tonnes per hectare while that of large commercial farmers is 3 tonnes per hectare. Use of retained seeds is one of the factors that is contributing to low yield as farmers will not be able to purchase seeds.

5.1 Field Experiment

5.1.1 Days to 50% emergence

There was significant difference ($p < 0.001$) among the treatments on the days to 50 percent emergence. The days to 50 percent emergence increased significantly with increase in

retention period. This is in connection with Bharat and Hemant (2012) who reported that the germination time of *Swertia chirayita* increased with increase in storage time. This might be due to continued respiration by seeds while still in the storage and this result in consumption of cotyledonary reserves. If cotyledonary reserves are consumed, the energy required to support germination will be limited, hence plants take long time to emerge.

5.1.2. Germination Percentage

There was a significant difference ($p < 0.001$) among the treatments in the germination percentage of seedlings. The variation in percentage germination decreases significantly as retention period increased which might be due to the deleterious effects of moisture which resulted from storage materials and perhaps environmental conditions. This agrees with Tame (2011) who reported that germination percentage of onion seed decreases with increase in storage time.

5.1.3. Mean Germination Time

The results obtained on Mean Germination Time revealed that there was statistical difference among the treatments. The Mean Germination Time increased significantly with increase in retention period and this is in connection with Bharat and Hemant (2012) who reported that the Mean Germination Time of *Swertia chirayita* seeds increased as increase in storage period. This might be due to limited food reserve in the seed as a result of continued respiration while still in the storage, thus energy required to support germination will be very limited.

5.1.4. Germination Uniformity

There was significant difference ($P < 0.001$) among the treatments on germination uniformity. Certified seed have high germination uniformity and the germination uniformity decreased with increase in retention period but the results among retained seeds were not significantly

different. This agrees with AOSA, (2000) who reported that primed seeds germinate faster and more uniformly. Reduction in germination uniformity may be due to different levels of seed reserves particularly carbohydrates and this will result in poor germination uniformity.

5.2. Seed vigor

5.2.1. Number of seedling emerged under vigor test

There was a significant difference ($p < 0.001$) among the treatments in the number of seeds emerged under vigor test. Seed vigor decreased as retention period increased and this may be due to damages that may occur during harvesting and post harvesting handling. Harvest and post harvest deterioration comprises threshing, processing machinery, transportation and drying. Injuries that may occur during this period may result in physical damage or fracturing of essential seed parts and this also promotes easy entry of fungal (Shelar *et al*, 2008). Most storage fungi belong to *penicillium* and *Aspergillus* genera. They induce seed deterioration by producing toxic substances that destroy the cells of the seeds hence loss seed vigor. The damage due to these fungi increases as retention period increases such that the seeds stored for very long time will have poor vigor.

5.2.2. Seedling vigor classification tests

The results obtained on seedling vigor classification test revealed that there was a difference among the treatments. The seedlings were classified into three main categories which are strong, weak and abnormal and all the treatments were different. Certified seeds have highest number of strong seeds and lowest number of abnormal seedlings. This might be probably due to the conditions under which the seed is produced. Conditions under formal seed sector ensure good agronomic practices and storage condition that maintain high seed vigor. The number of strong seeds decreased significantly with increase in retention period while the number of weak and abnormal seedlings increased with increase in retention period. This may be due to high moisture content within the seeds at initial stage as small holder farmers

do not have enough facilities to determine moisture content before storage. Seeds stored under high moisture content demonstrate increased respiration, heating and fungal invasion resulting in reduced seed vigor and viability. Cotyledonary reserves will be consumed by not only by the seed itself but also by fungi allied with seed (Nasreen *et al*, 2000). This will give rise to more weak and abnormal seeds.

5.2.3. The relationship between seed viability and seed vigor

The results obtained from correlation analysis indicated that there was a positive relationship ($R^2= 0.9965$) between seed vigor and seed viability. The percentage of seeds that emerged under vigor test was very low as compared to seeds that emerged under the standard seed germination test. This agrees with the finding by AOSA (2000) who showed that seed first lose their vigor first before they lose their viability.

5.3. Genetic purity

5.3.1. Physical purity

The results obtained on physical purity of the four different soybean samples with different retention period were statistically different. The composition of the sample was grouped into four different constituents which are pure seed, other crop seeds, weeds and inert material. Certified seeds recorded the highest percentage of pure seeds and low percentage of weeds and inert material, and they do not contain other crop seeds. This might be probably due to the conditions under which the seed is produced. Under formal seed sector, close monitoring of the field is done on regular basis and this enables to manage weeds and volunteer crops within the field. The percentage of pure seed decreased as retention period increases while the percentage of other crop seed, weeds and inert material increased significantly as retention period increased. This may be due to the agronomic practices practiced under the informal seed sector. The crop may be grown in rotation or as an intercrop which may give rise to admixtures.

5.3.2. Different lines in a given sample

There was a difference on the number lines found in different soybean samples with different retention period. Certified seeds consist of only one line of soybean and this might be due to agronomic practices and post harvest handling methods. Rouging of off-type plant is regularly done (FAO, 2001). The number of lines increased as retention increase in retention period this might be due to seed source by farmers and probably post harvest handling. Small holder farmers usually sources seed from other local famers and at times the seed may be sourced from various farmers and then mixed together and as a result, the seed will comprises of more different lines which also increase as retention period increases.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The results obtained from a survey conducted reviewed that most farmers retain soybean seeds obtained from their previous harvest or from neighbours. Very few farmers are able to purchase certified soybeans seeds due to high prices associated with seeds. The retention period is generally long and this may result in loss of viability and consequently a poor crop stand. The yield under small holder farmers is generally despite the efforts being done to increase soybean productivity in small holder farmers. The results presented showed that certified seeds emerged rapidly, uniformly and have higher emergence percentage as compared to the retained seeds. The rate of emergence, germination uniformity and emergence percentage decreases as retention period increases. It has been discovered that seed vigor decreases as retention period increases. From the results obtained, it was discovered that certified seeds have higher seed vigor than retained seeds. The number of weak and abnormal seedlings under vigor test increases as retention period increases. Results also showed that seeds first lose vigor before they lose their viability and there is a positive relationship between seed viability and seed vigor. Certified seeds have been found to have high physical purity and very low admixtures. Physical purity was discovered to decrease as retention period increases while admixtures increases as retention period increases.

6.2 RECOMMENDATION

The following recommendations can be made based on the results obtained.

1. Farmers must not retain soybean seeds stored for more than one year as they result in poor emergence and vigor.
2. Where retained seeds are used, farmers must use higher seed rates as retained seeds have low germination capacity as compared to certified seeds.

3. Farmers are encouraged to minimise mechanical injuries for the seed that is intended to be retained for crop production.

4. Farmers are also encouraged to ensure correct moisture content before they store their seed for the next season.

6.3 Further Research Needs

The future research should look into determining the effect of retention period on yield and diseases (particularly fungal) response of soybeans.

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APPENDICES

Appendix 1: ANOVA TABLE FOR DAYS TO 50% EMERGENCE

Source of variation	d.f	s.s	m.s	v.r	fpr
Block	2	0.1667	0.833	0.20	
Treatment	3	44.2500	14.7500	35.40	<.001
Residual	6	2.5000	0.4167		
Total	11	46.9167			

Appendix 2: ANOVA TABLE FOR NUMBER OF SEEDLINGS EMERGED UNDER VIGOR TEST

Source of variation	d.f	s.s	m.s	v.r	Fpr
Block	2	15.500	7.750	2.34	
Treatment	3	13905.667	4635.222	1402.25	<.001
Residual	6	19.833	3.306		
Total	11	13941.000			

Appendix 3: ANOVA TABLE FOR THE NUMBER OF LINES IN A GIVEN SAMPLE

Source of variation	d.f	s.s	m.s	v.r	fpr
Block	2	1.1667	0.5833	4.20	
Treatment	3	22.9167	7.6389	55.00	<.001
Residual	6	0.833	0.1389		
Total	11	24.9167			

Appendix 4: HOUSEHOLD SURVEY QUESTIONNAIRE

EFFECTS OF RETENTION PERIOD ON FIELD EMERGENCE, SEED VIGOUR AND GENETIC PURITY OF SOYBEANS (Glycine max.)

ENUMERATOR.....

DATE OF INTERVIEW.....

WARD NAME AND NUMBER.....

VILLAGE NAME.....

Please circle the responses

SECTION A: RESPONDENT'S INFORMATION

<p>1. Position in household</p> <p>A) Daughter</p> <p>B) Son</p> <p>C) Nephew</p> <p>D) Aunt</p> <p>E) Uncle</p> <p>F) Mother</p> <p>G) Father</p> <p>H) Other</p>	<p>2. Age in years</p> <p>A) 11-20</p> <p>B) 21-30</p> <p>C) 31-40</p> <p>D) 41-50</p> <p>E) 50 +</p>
<p>3. Sex of the</p> <p>A) Male</p> <p>B) Female</p>	<p>4. Marital status</p> <p>A) Single</p> <p>B) Married</p>

	C) Others
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SECTION B : PRODUCTION AND STORAGE METHODS

<p>6. Where do you get the seed</p> <p>A) From our previous harvest</p> <p>B) From neighbours</p> <p>C) Purchase from seed stockiest</p> <p>D) Others</p>	<p>7. If from previous harvest, how long do you store the seed</p> <p>A) 1 year</p> <p>B) 2 years</p> <p>C) 3 years +</p>
<p>8. Which method do you use to control weeds</p> <p>A) Hand hoeing</p> <p>B) Mechanical- use of cultivators</p> <p>C) Cultivators + hand hoeing</p> <p>D) Chemical</p> <p>E) Biological</p> <p>F) Integrated weed management</p>	<p>9. If hand, how many times do you weed the crop</p> <p>A) 1</p> <p>B) 2</p> <p>C) 3</p> <p>D) others</p>
<p>10. If chemicals, which chemicals do you use</p> <p>A) Selective herbicides</p> <p>B) Non selective herbicides</p> <p>C) Combination</p>	<p>11. How do you control pest and diseases</p> <p>A) Cultural methods</p> <p>B) Chemical method</p> <p>C) Integrated pest management</p>

	D) Others
<p>12. When do you start harvesting the crop</p> <p>A) When the pods are already dry</p> <p>B) When the plant is dry</p> <p>C) When both the plant and the pods are dry</p> <p>D) When pods start to shatter</p> <p>14. Do you treat the seed before storage</p> <p>A) Yes</p> <p>B) No</p>	<p>13. Where do you put the seed before shelling</p> <p>A) Under the shade</p> <p>B) Direct to sunlight</p> <p>C) Others</p> <p>15. How do you select the seed for planting</p> <p>A) By marking vigorously growing plants</p> <p>B) Select bigger seeds</p> <p>C) Others</p>
<p>16. Where do you store the seed</p> <p>A) In the kitchen (smoking)</p> <p>B) In the granary</p> <p>C) Under the shade</p> <p>D) Others</p>	

