A RESEARCH COMPENDIUM
ON
STATISTICAL EVALUATION OF EXPERIMENTAL VARIABILITY FOR IMPROVING EFFICIENCY OF FIELD EXPERIMENTATION

CROPS COVERED UNDER VARIABILITY STUDIES

Department of Agricultural Statistics
B. A. College of Agriculture
Anand Agricultural University
Anand

Plan Scheme:"Statistical evaluation of experimental variability and strengthening research in Agricultural Statistics" (BH 12041)

(Sanctioned vide office order No. GAU/Res/1(1)/18041-50/91, dated 4-9-91)

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MESSAGE

I am delighted to know that the Department of Agricultural Statistics, B. A. College of Agriculture, Anand Agricultural University, Anand is going to publish a Research Compendium in the ensuing AGRESCO-2017 viz; "Statistical evaluation of experimental variability for improving efficiency of field experiments" after a detailed exercise on experimental data received from the various Research Stations of GAU/AAU. I am confident that this compendium will be helpful for the Crop Scientists as well as the concerned Researchers to know the yardstick of coefficient of variation for various crops and accordingly plan their future research programmes.

I compliment all the Statisticians, who have worked for the project during more than 24 years and also congratulate the entire team of the Department of Agricultural Statistics for bringing out a comprehensive publication in the form of compendium.

(N. C. Patel)

Director & Dean, PG Studies
Anand Agricultural University
Anand

PREFACE

In pursuit of a science of agriculture, there is a big role of agricultural statistics in analysis of field experiments. The application of statistical principles and methods is necessary for effective practice in resolving different problems that arise in many fields of agricultural science like: Agriculture, Horticulture, Forestry, Dairy, Food science, Veterinary, Fisheries, Agricultural Engineering and other related fields.

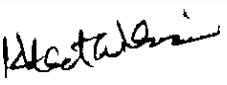
Statistics are often used to describe and interpret the results. Most researchers are familiar with the use of the least significant difference (LSD) needed to separate two or more means. Another statistical measurement familiar to many scientists and taught in most basic statistics course is the coefficient of variation or the CV. This familiar measurement was created in the late eighteen century as a measure of population variability. However, ever since it was promoted as a measure of experimental validity by Snedecor and Cochran in 1937, its original purpose has been largely ignored. Many scientists use the CV to accept or reject the validity of trials. The CV is based on the assumption that the mean and error variance change together at a constant rate such that the natural log of the error variance is twice the natural log of the mean.

Moreover, the experimental data provide information on controlled (treatment effect) and uncontrolled variation. The uncontrolled variation is expressed as experimental error, which could be quantified as an estimate called ‘coefficient of variation (CV)’. Besides, land fertility variation among experimental units (land plots), the factors contributing toward uncontrolled variation are climatic and experimental. Therefore, CV of field experiments varies with the situation. Lower magnitude of CV is the reflection of reliability (precision) of the experimental results. The acceptable range of CV advocated by various workers is based on the experience with very limited number of experiments. There is a need to develop a yardstick (critical value) for CV based on theory and also on a large number of experiments conducted under different situations.

In long term experiments, it has also been observed that the CV % are found considerably higher (above 25 %) in case of field experiments on Pulses, Maize, Vegetables crops, upland paddy, Tobacco, plant protection, plant physiology etc. The findings based on such experiments are less reliable. This keeps scientists in dilemma as they have to repeat the same experiment (s) for number of years (seasons) to arrive at definite conclusion/ recommendation. In other words, such conditions unnecessarily increase pressure on valuable resources beside time factor. Therefore, it is necessary to devise statistical approaches to minimize experimental variability and also develop yard stick for reliability of the experimental data.

Since no work has been done exclusively on this aspect for Gujarat situation, Department of Agricultural Statistics, B. A. College of Agriculture, Anand Agricultural University, Anand has been working since January 1, 1992 through a Plan Scheme viz. "Statistical evaluation of experimental variability for improving efficiency of field experiments". (B.H.–12041). Wherein, Variability studies on Crop Experiments on Medicinal and Aromatic plants like Isabgul, Ashwagandha, Safedmusali etc at Anand; Cotton, Gram, Wheat, Safflower etc at Arnej as well as few crops at Dhandhuka Centre have been taken up and has released a few Recommendations for Scientific Communities by analysing a huge amount of field trials data of long-term experiments running through a long period of time at major research stations of Gujarat State.

This Research Compendium provides information and results on how an exercise of Statistical Evaluation of Experimental Variability was carried out at Anand Agricultural University, Anand on various crops of Gujarat State for Improving Efficiency of Field Experimentation. I hope that the developed yard sticks will be helpful to the scientific community to conduct future programmes, as well as accepting the results of various experiments on the basis of coefficient of variation (CV).



(K. B. Kathiria)

Principal & Dean
B.A.College of Agriculture
Anand

Message

It gives me an immense pleasure to pen a few words as prologue to our Research Compendium viz; “Statistical evaluation of experimental variability for improving efficiency of field experiments”. I congratulate Dr. P. R. Vaishnav, Professor & Head, Department of Agricultural Statistics & his team of B. A. College of Agriculture, Anand Agricultural University, Anand for bringing out such a useful publication for students and researchers.

I feel happy to note that this Research Compendium is a collection of summaries of work carried out for more than 24 years and relentless efforts made by various statisticians with thorough and in-depth statistical analysis.

Considering the role of coefficient of variation (CV) in the results of crop experiments, I am confident that information given in the compendium will resolve many problems for the Crop Scientists in future by using developed yardsticks for meaningful interpretation of the research data.

I convey my good wishes...

(K P Patel)

Professor & Head
Department of Agricultural Statistics
B.A.College of Agriculture
AAU, Anand

ACKNOWLEDGEMENTS

This research compendium owes its existence to the help, support and inspiration received from several people. Firstly, I would like to express my sincere appreciation and gratitude to Dr. N. M. Patel who has prepared and submitted a Plan project to work on this aspect and started work in 1992. I am thankful for the initiative taken by Dr. N. M. Patel.

In the erstwhile Gujarat Agricultural University, 25 years ago, during the annual presentation of research outcomes of various crop experiments in joint AGRESCO, a major concern was raised on how to resolve the problem of recurrently accounting very larger variability and how to adjudge the validity of the experiment.

As such no exclusive work done previously on this aspect, minimum 15 years experimental research data from crop scientists of the various research stations were called one by one for the purpose and got analyzed. The then Senior Statistician Professor and Head Dr. M. R. Vaishnav had assigned basic primary work to Prof. L. P. Purohit. Thus the entire Department got involved and initiated work on this aspect with collective efforts to develop crop-wise variability yardstick. I would also like to express my deep gratitude to Dr. M. R. Vaishnav for stimulating work, for providing proper platform & for bringing funding for the project for the Department. This work would not have been possible at all without basic statistical help of Senior Statistician Dr. N. P. Patel. I express my sincere thanks to Dr. N. P. Patel & Prof. L. P. Purohit.

I am equally thankful to Dr. S. K. Dixit and Dr. J.S. Patel for their valuable help and guidance during their tenure as the Professor & Head of this Department and as an amazing source of support even after the retirements.

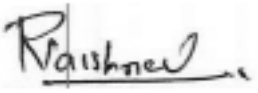
I am especially grateful to Dr. G.N. Motka and Dr. D. J. Parmar who contributed immensely for the project.

Here, I would also like to acknowledge the work done by Dr. V. B. Darji. As a Head of the Department, I have had the pleasure to receive the help of Dr. A. D. Kalola and Dr. A. N. Khokhar.

Dr. X. U. Shukla, Shri. U.J. Upadhyay and Shri. D. K. Patel who have rendered help through the Computer lab deserve special thanks.

While showcasing variability project work, my particular thanks goes to the Research Scientists and their research staff of erstwhile GAU and AAU. Although they were very busy with their daily tasks, they have always been available to me for providing all the needed information & data timely.

Finally, I would like to thank the university authorities for their grand support and for timely release of project funds.



(P. R. Vaishnav)

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STATISTICAL EVALUATION OF EXPERIMENTAL VARIABILITY FOR IMPROVING EFFICIENCY OF FIELD EXPERIMENTATION

1. Preamble

The precision of the treatment estimate depends on the magnitude of the variation i.e. experimental error which is usually expressed in terms of coefficient of variability (CV %). The CV in the field experiments depends on the fertility variation, size and shape of plots, arrangement of plots in the block, number of replications, size of experiment, nature of experimental material etc. It has been observed that the CV % are considerably higher (above 25 %) in case of field experiments on Pulses, Maize, Vegetables crops, upland paddy, Tobacco, plant protection, plant physiology etc, The findings based on such experiments are less reliable. This puzzles to the scientists because they have to repeat the same experiment (s) for number of years (seasons) to arrive at definite conclusion/ recommendation. In other words, such conditions unnecessarily increase pressure on valuable resources beside time factor. Therefore, it is necessary to devise statistical approaches to minimize experimental variability and also develop yard stick for reliability of the experimental data. For this purpose a plan scheme "Statistical evaluation of experimental variability for improving efficiency of field experimentation" was sanctioned by the University, vide office order No. GAU/Res/1(1)/18041-50/91 dated 4-9-91 at the department of Agricultural Statistics, B. A. College of Agriculture, AAU, Anand and operating since January 1, 1992 with a view

i. to study the distribution of variability (experimental error as judged by CV%) in the field experiments conducted at the GAU Research Centers on Pulses, Maize, upland paddy, Vegetable crops, Tobacco and other crops,

ii. to study the factors responsible for high variability in the experimental results,

iii. to develop yardstick for reliability of the experimental results of above crops,

iv. to develop statistical methods/approaches to minimize error,

v. to catalogue research results/findings for users.

The data

i. The basic information (research data) of the field experiments conducted on Pulses, Maize, paddy, Vegetable crops, Tobacco, Castor, forage crops, mustard, cotton, wheat, Dry farming medicinal and aromatic plants, Bhal and coastal zone (Arnej and Dhandhuka) experiments reported by the concerned research scientist in the annual reports was collected for further screening/analysis. The information collected relates to location, year of study, crop(s), disciplines, number of treatments, number of replications, plot size, design (field layout) of experiment and CV of the yield attribute.

ii. The uniformity trials were conducted on gram at Derol, Maize at Godhra, paddy at Derol, arhar at SK Nagar, cotton at Rajkot (Targhadiya), cluster bean at SK Nagar and chilli at Anand with a view to determine optimum size (Federe, 1955) and shape of field experimentation.

Statistical approaches/methods

i. The average CV% was calculated for each of the factors influencing experimental variability (the error) and tabulated for interpretation.

ii. CV % of the experiment is, in the present study, considered as index of reliability of the result. CV = 0 or nearer to zero is the best situation but in the field experimentation such situation is never achieved/possible. Therefore, the upper fiducial limit of CV % was estimated.

The plot-wise yield data of each experiment were subjected to statistical analysis and CV was estimated. The same was assumed as random variable in further analysis. CV is a function of square root of mean square (*s*) and mean ($\bar{x}$).

$$CV = \frac{S}{\bar{X}} \qquad (1)$$

The distributions of $\bar{x}$and shave simple forms and Student's *t* distribution provides complete solution for testing the hypothesis or estimating fiducial limits relating to either *m* or *s*, singly. But *t* distribution cannot be used for$CV = \frac{S}{\bar{X}}$.Mckay, 1932 used non-central *t*-distribution for providing fiducial limits of CV.

Let *z* be a quantity distributed normally about zero mean with unit standard deviation and let *w* be a quantity distributed independently as χ^2, with degrees of freedom of χ^2. Then, if *t* is defined by the equation:

$$t = \frac{Z+\delta}{\sqrt{W}} \qquad (2)$$

Where $\delta$is some constant, then *t* is distributed in a manner depending only on $\delta$and *f*. This distribution is a non central *t*-distribution. When δ equals zero, the distribution is the familiar Student's *t*.

Let an estimate of *V* be *v* = s/$\bar{x}$the sample coefficient of variation.

Now, one may write

$$\frac{\sqrt{n}}{v} = \frac{\sqrt{n}\bar{X}}{S} = \frac{\sqrt{n}(\bar{X}-\mu)}{\sigma} + \frac{\sqrt{n}\mu}{\sigma} + \frac{S}{\sigma} \qquad (3)$$

It appears from comparison with eq. (2) that $\frac{\sqrt{n}}{v}$ is distributed as non-central *t* with *f* = (*n* – 1) and$\frac{\sigma\sqrt{n}}{v}$. This distribution can be used for test of significance and for providing fiducial limits of *V* (i.e. CV), as is done for μ. Since the objective was to work out the yardstick based on CV, the upper fiducial limit of CV using non-central *t*-distribution was estimated following the procedure given by (Johnson and Welch, 1939).

The procedure is briefly explained below. Let,

(i) $CV = \frac{\sqrt{Errormeansquare}}{Generalmean}$

Now, the upper fiducial limit of CV is,

$$CV_{UL} = \frac{\sqrt{n}}{\delta}(f, to\varepsilon)$$

Where, $t_0 = \frac{\sqrt{n}}{CV}$ and n = number of treatments × number of replications in a given experiment, $f = n - 1$ degrees of freedom.

(ii) Find

$$Y = \left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

Or

$$Y' = \frac{t_0}{\sqrt{2f}}\left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

According whether $\frac{t_0}{\sqrt{2f}}$ is greater than or less than 0.75. ConsiderY', if $\frac{t_0}{\sqrt{2f}}$lies between0.75 and 0.75, otherwise consider Y.

(iii) If $f > 9$, calculate $\frac{12}{\sqrt{f}}$

(iv) Select desired probability level of confidence, i.e. e and obtain $\lambda(f, t_0, \varepsilon)$ from the table in (Johnson and Welch, 1939) interpolating with respect to the quantities obtained in (ii) and (iii).

(v) Calculate

$$\delta(f, t_0, \varepsilon) = t_0 - \lambda\left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

The yardstick of CV (i.e. CV_{UL} for field experiments was worked out using two concepts:

(i) average upper fiducial limit of CV for each of the field experiments was worked out separately and then average of these upper fiducial limits was computed.

(ii) upper fiducial limit of CV based on average size of experiments, i.e. degree of freedom. The upper fiducial limit of 95 % was worked out using the theory of truncated t distribution as described by (Johnson and Welch, 1939).

The value of the upper limit i.e. 95 % limit is taken as cut off point for accepting the results.

"Natural selection is a mechanism for generating an exceedingly high degree of improbability."

- R. A. Fisher

2. EXPERIMENTAL DATA

2.1 PULSE CROPS

The information of 1841 experiments conducted on 7 crops at 16 different research stations of the Gujarat Agricultural University for the period of 1980 to 1990 by the Research Scientist (Pulses), S.K.Nagar was utilized to study the variability in the experimental results of the Pulse crops in Gujarat State.

Table 1: Treatment and Replication- wise distribution of CV% of Pulse experiments

Treatments	Replications					Average
	2	3	4	5	≥6	
< 5	15.59	35.62	20.33	-	-	**21.85**
6 - 10	26.55	23.65	21.80	32.03	17.33	**22.44**
11 - 15	26.53	21.29	18.71	67.42	-	**19.94**
16 - 20	27.71	22.49	20.43	-	-	**21.23**
21 - 25	24.06	22.38	23.80	-	-	**23.06**
26 - 30	21.88	20.39	20.88	-	-	**20.68**
>30	23.03	24.09	17.20	-	-	**22.68**
Average	**24.93**	**22.35**	**20.39**	**42.14**	**17.33**	**21.29**

Table 2: Plot Size and Treatments- wise distribution of CV % of Pulse experiments

Plot Size(m^2)	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
1 – 3	15.59	31.45	26.65	30.79	22.20	20.36	27.60	**26.72**
3 – 6	22.11	23.59	23.19	20.80	25.09	20.54	20.50	**22.14**
6 – 9	19.47	22.00	28.61	20.73	25.75	19.58	23.39	**20.56**
9 – 12	21.51	20.30	18.30	21.57	22.53	21.36	13.87	**20.03**
12 – 15	13.00	22.48	19.67	23.16	22.42	18.09	-	**21.27**
15 – 18	30.85	20.69	17.78	20.96	15.88	23.65	-	**20.70**
18 – 21	-	31.76	16.09	12.47	17.60	21.19	30.59	**22.69**
21-31	23.77	17.03	17.98	15.21	-	23.51	23.99	**18.11**
Average	**21.85**	**22.44**	**19.94**	**21.23**	**23.06**	**20.68**	**22.68**	**21.29**

Table 3: Design and Replications- wise distribution of CV % of Pulse experiments

Design	Replications					Average
	2	3	4	5	6	
RBD	24.29	22.58	20.57	42.14	22.56	**21.51**
FRBD2	38.23	21.28	15.48	-	-	**17.23**
FRBD3	-	21.93	15.12	-	-	**16.29**
SPT11	-	21.03	23.55	-	12.10	**22.63**
SPT12	-	21.42	17.47	-	-	**20.32**
SPT21	-	21.42	20.46	-	-	**21.26**
Others	-	18.76	-	-	-	**18.76**
Average	**24.93**	**22.35**	**20.39**	**42.14**	**17.33**	**21.29**

Table 4: Plot size and Crops- wise distribution of CV % of Pulse experiments

Plot Size (m^2)	Crops							
	Arhar	**Cowpea**	**Gram**	**Guar**	**Moth**	**Mung**	**Urid**	**Average**
< 3	30.83	22.21	25.00	25.35	63.94	23.98	20.31	**26.72**
3 – 6	28.42	22.37	17.87	22.42	43.92	21.84	19.01	**22.14**
6 – 9	25.40	20.71	17.90	18.38	35.08	19.75	16.46	**20.56**
9 -12	21.50	16.86	16.29	19.73	29.80	19.18	14.38	**20.03**
12 - 15	21.55	20.70	11.17	22.18	34.43	21.98	21.47	**21.27**
15 - 18	18.21	41.10	25.27	38.02	26.65	25.68	-	**20.70**
18 - 21	17.72	20.16	14.94	21.22	29.55	35.54	-	**22.69**
21 - 31	18.09	22.05	13.39	25.50	20.75	17.53	3.72	**18.11**
Average	**22.92**	**21.22**	**18.71**	**20.53**	**33.42**	**21.55**	**17.25**	

In relation to any experiment we may speak of this hypothesis as the "null hypothesis," and it should be noted that the null hypothesis is never proved or established, but is possibly disproved, in the course of experimentation. Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis.

- (Edinburgh: Oliver)

Table 5: Crop and Location -wise distribution of CV % of Pulse experiments

Crop	Location															Average
	Anand	Arnej	Baroda	Bhachau	Bharuch	Deesa	Derol	Dahod	Junagadh	Kothara	Navsari	SK Nagar	Talod	Tanchha	Waghai	
Arhar	20.84	21.91	22.77	17.22	20.67	13.20	30.03	15.23	14.15	-	12.17	33.26	21.80	24.22	26.67	**22.92 (566)**
Cowpea	21.16	-	23.13	-	-	17.75	32.56	15.24	11.29	-	08.59	23.07	-	-	-	**21.22 (135)**
Gram	24.24	16.11	-	-	22.89	-	22.29	21.47	12.60	-	14.50	29.92	-	15.75	31.30	**18.71 (366)**
Guar	-	28.62	-	20.33	-	18.19	-	-	-	15.95	-	21.28	-	-	-	**20.53 (161)**
Moth	-	-	-	28.68	30.76	-	-	-	-	31.36	-	35.11	-	-	-	**33.42 (51)**
Mung	18.81	21.18	20.22	21.24	19.75	16.40	26.44	15.32	13.24	21.53	08.69	27.22	20.58	18.50	-	**21.55 (373)**
Urid	18.53	-	20.78	06.70	13.78	12.56	35.13	16.71	13.82	-	10.78	21.48	24.27	-	-	**17.25 (132)**
Average	**21.17 (126)**	**17.50 (86)**	**22.32 (174)**	**21.99 (34)**	**20.03 (67)**	**17.06 (50)**	**27.65 (133)**	**19.32 (131)**	**13.23 (311)**	**20.65 (31)**	**11.76 (92)**	**27.51 (505)**	**23.18 (18)**	**18.85 (20)**	**28.21 (06)**	**21.29 (1784)**

Note: (1) Figure in the parenthesis indicates number of experiments.

(2) 57 other crops are not included in the above table.

Upper fiducial limit and yard stick of CV%

The yardstick of CV % could be used as guideline for acceptance or rejection of the results of field experiment. Lower CV % (nearer to zero) is always desirable. The upper fudicial limit at 95% confidence interval based on non-central t distribution was work out for yield character for each factor and crop under study. The yardstick of CV % of field experiments established on the basis of average upper fiducial limit (95% confidence) of CV % of each experiment.

Table 6: Upper fiducial limit of CV % for different location of Pulse experiments

Location	No. of Expt.	Mean CV %	Upper fiducial limit	Expt. having CV % >26.45	
			(0.95)	No.	Proportion
Anand	126	21.21	25.73	26	0.20
Arnej	86	17.57	21.22	13	0.15
Baroda	174	22.57	28.12	43	0.25
Bhachau	34	21.99	27.04	9	0.26
Bharuch	67	20.03	24.01	13	0.19
Deesa	50	17.06	20.77	7	0.14
Derol	133	27.27	33.19	56	0.43
Dohad	131	19.44	24.74	23	0.18
Junagadh	311	13.23	16.00	22	0.08
Kothara	31	20.56	25.59	6	0.19
Navsari	92	11.64	13.93	9	0.10
SKNagar	505	27.49	35.03	214	0.43
Talod	18	23.18	27.93	3	0.17
Tanchha	20	18.65	22.66	3	0.15
Waghai	6	28.56	35.16	5	0.83
Average	**(1784)**	**21.29**	**26.45**		**0.26**

Table 7: Upper fiducial limit of CV% for different discipline of Pulse experiments

Discipline	No. of Expt.	Mean CV %	Upper fiducial limit	Experiment Having CV % >26.45	
			(0.95)	No.	Proportion
Agronomy	242	17.53	21.67	39	0.16
Entomology	170	29.25	39.93	76	0.46
Pl. Physiology	14	26.41	34.60	6	0.40
Pl.Breeding	1247	20.38	24.70	301	0.24
Pl.Pathology	111	27.19	35.10	48	0.43
Average	**(1784)**	**21.29**	**26.45**		**0.26**

Table 8: Average upper fiducial limit and yardstick of CV % for Pulseexperiments

Average of 1784experiments	Mean CV%	Upper fudicial limit of CV% (0.95)
	21.29	26.45
Overall yard stick of CV% 26.45 (27%)		

The analysis of 1839 experiments on seven Pulse crops at 15 locations showed that the deviation (range) in CV % was maximum due to crops followed by locations, plot size, replications, design and treatments. The average CV % of 1839 experiments is 21.29 %. Therefore, crops and stations/locations showing larger CV than 21.29 % require great care in planning and execution of experiments at field level.

Experiments on Moth crop had maximum variation (33.42 %) next in line were arhar and mung crop. The experiments on Moth crop at four stations had higher CV. (greater than 27 % the upper limit) indicating that this crop requires great care in planning and layout of experiments, recording biometrical attributes, sample size for measurement of attributes and analysis of data by proper statistical tool. For these four locations, it is worth to work out optimum plot size, number of replications and design of experiments on moth crop. This hold true for almost all crops studied at S. K. Nagar and Derol.

The average CV % revealed that the proper experimental (net) plot size for guar crop is 6-9 sq.m. for cowpea, mung and urid 9-12 sq.m. and for gram 12.-15 sq.m. Four replications are sufficient to achieve reasonable efficiency in Pulse crop experiments.

Uniformity trial on semi rabi Arhar at SK Nagar (Appendix I) revealed 7.2 sq.m. as optimum plot size, but experimental results (Table 4 and Table 5) show large variation in yield. Therefore, it is advised to repeat uniformity trial on Arhar at SK Nagar.

Uniformity trial at Derol on semi rabi Arhar (Appendix II) indicated that 10.8 sq.m plot size is optimum. But experimental results (Table 5) show large variation (CV) in yield attribute. Therefore, it is advised to repeat the uniformity trial at Derol on Arhar crop.

Uniformity trial on Cluster bean (Guar) (Appendix III) showed similar results as that of experimental data (Table 4) i.e. 6-9 sq.m plot size as optimum plot size.

The upper limit i.e. yard stick of CV % for accepting the results of the Pulse crop experiments, worked out for yield character is 27%.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV% for accepting the results of Pulse crop experiments is 27 per cent for yield character.

2.2 MAIZE

The experiments on Maize are conducted at the Maize research station, Godhra (Dist. Panchmahal). The information of 231 plant breeding experiments (92 % of total experiments at Godhra) for the years 1983-92 reported by the Research Scientist (Maize), were utilized in the present study.

Table 1: Treatment and Plot size- wise distribution of CV% of Maize experiments

Treatments	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	18-21	21-24	
< 5	-	-	-	-	29.23	-	28.89	**29.11 (06)**
5-9	37.89	25.30	-	34.44	25.52	24.79	24.94	**25.88 (65)**
10-14	41.34	25.99	-	32.16	31.82	40.07	37.70	**33.20 (44)**
15-19	46.81	31.02	18.10	24.20	30.45	-	-	**38.10 (45)**
20-24	38.02	36.35	-	-	36.80	-	-	**36.73 (19)**
25-29	31.18	28.45	-	-	-	-	-	**29.18 (15)**
> 30	33.95	29.49	-	-	-	-	-	**32.98 (37)**
Average	**39.13 (70)**	**29.80 (72)**	**18.10 (01)**	**31.22 (12)**	**27.55 (38)**	**28.61 (12)**	**27.70 (26)**	**31.98(231)**

Table 2: Treatment and Replication- wise distribution of CV% of Maize experiments

Treatments	Replications					Average
	2	3	4	5	6	
< 5	-	-	24.29	20.08	26.72	**29.11**
6 – 10	27.70	20.77	28.43	-	28.20	**28.02**
11 - 15	43.20	21.70	32.61	-	-	**35.95**
16 - 20	44.13	29.70	31.30	-	-	**37.38**
21 – 25	31.32	33.37	33.72	-	-	**32.90**
26 - 30	28.44	24.53	30.35	-	-	**28.63**
>30	34.17	31.90	31.80	-	-	**33.74**
Average	**37.82 (73)**	**26.45 (13)**	**29.76 (136)**	**20.08 (1)**	**26.91 (8)**	**31.98 (231)**

Table 3: Plot size and Replication- wise distribution of CV% of Maize experiments

Plot size (m^2)	Replications					Average
	2	3	4	5	6	
3-6	39.91	26.38	39.57	-	-	**39.13**
6-9	24.62	30.86	30.62	-	-	**29.80**
9-12	-	-	18.10	-	-	**18.10**
12-15	-	21.70	32.08	-	-	**31.22**
15-18	-	14.00	27.55	-	30.96	**27.55**
18-21	-	-	28.61	-	-	**28.61**
21-24	-	24.15	29.50	20.08	22.85	**27.70**
Average	**37.82 (73)**	**26.45 (13)**	**29.76 (136)**	**20.08 (1)**	**26.91 (8)**	**31.98 (231)**

Upper fiducial limit and yardstick for CV %

Yardstick of CV % for Maize crop field experiments was worked out by using average upper fiducial limit of CV %, based on probability distribution.

Table 4: Upper limit of CV % for different treatment of Maize experiments

Treatments	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >40.53	
			(0.95)	No.	Proportion
< 5	6	29.11	40.98	1	0.17
5-9	65	25.88	34.75	5	0.08
10-14	44	33.20	43.00	13	0.30
15-19	45	38.10	49.16	16	0.36
20-24	19	36.73	43.17	8	0.42
25-39	15	29.18	33.87	2	0.13
30-34	6	36.23	43.62	1	0.17
35-39	13	32.86	38.44	4	0.31
40-44	5	32.63	37.34	1	0.20
45-49	11	29.19	33.61	1	0.09
50-54	2	45.75	53.77	1	0.50
Average	**(231)**	**31.98**	**40.53**	**53**	**0.23**

Table 5: Upper fiducial limit of CV% for different replication of Maize experiments

Replications	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >40.53	
			(0.95)	No.	Proportion
2	73	37.82	48.70	32	0.44
3	13	26.45	32.22	1	0.08
4	136	29.76	37.30	20	0.15
5	1	20.08	26.78	-	-
≥6	8	29.91	36.13	1	0.13
Average	**(231)**	**31.98**	**40.53**	**53**	**0.23**

Table 6: Upper fiducial limit of CV% for different plot size of Maize experiments

Plot size (m^2)	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >40.53	
			(0.95)	No.	Proportion
3-6	70	39.13	50.09	32	0.46
6-9	72	29.80	36.58	10	0.14
9-12	1	18.10	21.24	-	-
12-15	12	31.22	38.99	2	0.17
15-18	38	27.55	34.91	4	0.11
18-21	12	28.61	37.59	2	0.17
21-24	26	27.70	37.12	3	0.12
Average	**-**	**31.78**	**40.53**	**53**	**0.23**

Table 7: The average upper fiducial limit and yardstick of CV % for Maize experiments

Average of 231 experiments	Average CV%	Upper fudicial limit of CV% (0.95)
	31.98	40.53
Overall yard stick of CV% is 41.0 - Not recommended.		

The results of 231 experiments and the uniformity trial (Appendix IV) on Maize crop showed in general, very high variability (CV %). The plot size contributed the most followed by replications and treatments. Analysis did not help to recommend plot size, replications required and yard stick of CV % for field experimentation on Maize crop at Godhra farm.

Through uniformity trial Singh (1995) observed two way fertility gradient in the experimental area. He advocated Latin Square Design for field experiments, however it along with lattice design needs confirmation through repeated uniformity trials.

Godhra station needs special attention to bring in uniformity in the experimental area, to help save resources. If this is not feasible then it is advisable to shift the Maize research at other location, in the interest of Maize growers.

2.3 RICE

The information of 1097 experiments conducted on Rice crop at the Main Rice Research Station, Navagam and other research stations of the Gujarat Agricultural University for the period of 1980 to 1992 were utilized to study the variability in the experimental results of Rice crop.

Table 1: Location and Discipline- wise distribution of CV% of Rice experiments

Location	Discipline				Average
	Agronomy	Entomology	Pl. Pathology	Pl. Breeding	
Anand	-	-	13.50	9.68	**11.59**
Bardoli	-	-	-	6.38	**06.38**
Dabhoi	6.06	-	13.32	10.60	**10.59**
Derol	25.76	-	-	24.91	**25.34**
Dahod	15.21	-	-	-	**15.21**
Navsari	10.55	5.21	16.67	12.49	**12.29**
Navagam	11.17	10.02	16.88	12.05	**12.10**
Ubharat	10.26	-	-	18.55	**18.23**
Vyara	12.08	10.10	13.35	11.52	**11.53**
Waghai	20.78	-	10.39	10.29	**18.16**
Other	-	-	-	18.97	**18.97**
Average	**18.97**	**9.32**	**16.80**	**13.40**	**13.19**

Table 2: Treatment and Replication- wise distribution of CV% of Rice experiments

Treatments	Replications					Average
	2	3	4	5	6	
< 5	-	8.65	10.79	17.55	14.41	**12.48**
6 – 10	14.67	10.44	12.39	14.64	20.38	**12.25**
11 - 15	15.96	13.20	11.65	-	-	**12.14**
16 - 20	13.72	18.59	12.21	-	-	**13.48**
21 – 25	15.18	24.28	11.90	-	21.80	**15.37**
26 - 30	14.68	13.44	13.69	-	-	**13.85**
>30	18.57	13.96	13.62	-	12.61	**16.71**
Average	**16.23 (123)**	**14.80 (209)**	**12.09 (731)**	**16.97 (5)**	**15.63 (29)**	**13.19**

Table 3: Plot size and Replication- wise distribution of CV% of Rice experiments

Plot size (m^2)	Replications					
	2	**3**	**4**	**5**	**6**	**Average**
< 3	27.86	17.41	23.54	-	17.20	**22.50**
3 – 6	15.33	18.20	13.76	-	14.22	**15.45**
6 – 9	13.92	14.61	11.17	-	-	**10.98**
9 – 12	18.63	12.45	11.69	16.89	45.03	**12.34**
12 – 15	18.16	19.47	13.37	-	16.44	**15.15**
15 – 18	60.06	11.34	12.83	15.82	11.92	**12.32**
18 – 21	-	11.14	11.68	19.40	16.57	**12.40**
>21	-	-	11.52	-	-	**11.52**
Average	**16.23**	**14.80**	**12.09**	**16.97**	**15.63**	**13.19**

Table 4: Design and Replication wise distribution of CV% of Rice experiments

Design	Replications					Average
	2	**3**	**4**	**5**	**6**	
RBD	16.35	14.79	12.05	16.97	15.63	**13.23**
FRBD2	-	9.56	7.45	-	-	**08.27**
FRBD3	-	-	14.17	-	-	**14.17**
SPT11	20.3	14.75	11.47	-	-	**11.35**
SPT12	-	9.35	11.94	-	-	**11.84**
SPT13	-	-	13.13	-	-	**13.13**
SPT22	-	20.72	17.84	-	-	**19.41**
Other	16.56	9.00	-	-	-	**12.78**
Average	**16.23**	**14.80**	**12.09**	**16.97**	**15.63**	**13.19**

Upper fiducial limit and yard stick of CV%

Table 5: Upper fiducial limit of CV % for different location of Rice experiments

Location	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.17	
			(0.95)	**No.**	**Proportion**
Anand	11	9.68	11.72	1	0.10
Bardoli	15	6.38	8.05	0	0.00
Dabhoi	91	10.59	12.93	12	0.13
Derol	96	24.91	30.85	73	0.76
Dohad	12	15.21	19.41	5	0.42
Navsari	143	12.29	15.13	38	0.26
Nawagam	452	12.10	14.80	93	0.21
Ubharat	26	18.23	22.01	11	0.42
Vyara	173	11.53	13.98	28	0.16
Waghai	58	11.20	13.64	13	0.22
Other	20	18.97	23.80	9	0.45
Average	**(1097)**	**13.19**	**16.17**	**(283)**	**0.26**

Table 6: Upper fiducial limit of CV % for different design of Rice experiments

Design	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.17	
			(0.95)	No.	Proportion
RBD	1002	13.23	16.28	263	0.26
FRBD2	8	8.27	10.19	0	0.00
SPT11	24	11.35	13.44	4	0.17
SPT12	25	11.84	13.73	2	0.06
SPT23	15	13.13	14.79	3	0.20
SPT22	11	19.41	22.56	7	0.64
Other	4	12.78	15.34	1	0.25
Average	**(1097)**	**13.19**	**16.17**	**(283)**	**0.26**

Table 7: Upper fiducial limit of CV% for different discipline of Rice experiments

Discipline	No. of Expt.	Average C V %	Upper fiducial limit	Expt. having CV % >16.17	
			(0.95)	Numbers	Proportion
Agronomy	133	18.97	14.27	26	0.17
Entomology	73	9.32	12.14	6	0.11
Pl. Breeding	830	13.40	16.31	226	0.27
Pl. Pathology	63	16.80	22.24	25	0.40
Average	**(1097)**	**13.19**	**16.17**	**(283)**	**0.26**

Table 8: Average upper fiducial limit and yardstick of CV % for Rice experiment

Average of 1097 experiments	Average CV%	Upper fudicial limit of CV%
		0.95
	13.19	**16.17**
Overall yard stick of CV% 16.17 (17.00)		

The average CV % presented in Tables for rice crop showed maximum variation due to locations followed by design, plot size, discipline, replication and treatment. Experiments at Derol had high CV % (24.92%) resulting poor performance/ information in 76% experiments, suggesting that there is a need to work on plot technique including experimental design at Derol to help minimize variation in the experimental data. At Ubharat also such studies will improve the situation. 64% of the total experiments conducted in SPT 22 crossed upper limit of CV i.e. 16.17 % suggesting that such design may be ignored at the time of planning of the experiments on rice crop. 263 experiments (26 per cent) of 1002 experiments conducted in RBD crossed upper limit of CV % indicating that some other designs, wherever feasible be introduced in place of RBD. Experiments in pathology discipline require attention on plot technique to generate better results through statistical tools. Plot size of 6-9 sq.m.is the sufficient and effective size for experiments on rice crop. Similarly, 4 replications are sufficient. Experiments should not be planned with 2,5 or 6 replications. Uniformity trial on drill paddy at Derol (Appendix V) also yielded similar results. It showed that 7.2 sq.m plot size is optimum which is within the range of 6-9 sq.m area, as evinced from 1002 experiments.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV% for accepting the results of Rice crop experiment is 17 per cent for yield character.

2.4 DRY FARMING EXPERIMENTS

The information of 222 experiments conducted by the Dry farming research stations of Gujarat Agricultural University for the period of 1980 to 1990 by the Research Scientist (Dry farming) were utilized to study the variability in the experimental results of different Dry farming crops.

Table 1: Crop and Location- wise distribution of CV % of Dry land crop experiments

Crop	Location						Avg.
	Dhari	Jamkhambhalia	Nana khandhasar	Radha-npur	Targhadia	Vallbhi-pur	
Arhar	**-**	**-**	**-**	**-**	24.23	-	**24.23 (21)**
Bajra	**-**	7.10	34.74	28.41	15.54	**-**	**17.16 (28)**
Castor	-	-	-	-	14.00	-	**14.00 (01)**
Cotton	15.72	-	33.58	-	24.00	-	**25.20 (09)**
Groundnut	13.89	10.09	-	-	16.29	-	**15.82 113)**
Gram	-	-	-	-	31.58	-	**31.58 (01)**
Greengram	25.23	17.54	19.58	17.07	22.89	15.55	**19.66 (17)**
Sesamum	5.63	-	-	-	23.26	-	**14.44 (02)**
Sorghum	15.39	-	-	-	27.32	63.21	**28.12 (30)**
Average	**17.57**	**11.58**	**25.69**	**22.74**	**19.14**	**27.47**	**19.07 222)**

Table 2: Treatment and Replication- wise distribution of CV% of Dry land crop experiments

Treatments	Replications						Average
	2	3	4	5	6	8	
< 5	-	-	17.73	8.71	17.67	22.48	**16.09 (55)**
6 – 10	-	20.17	14.75	-	-	-	**16.71 (94)**
11 - 15	-	20.92	22.97	-	-	-	**21.82 (25)**
16 - 20	-	29.25	29.60	-	-	-	**29.35 (24)**
21 – 25	29.65	21.31	25.26	-	-	-	**24.66 (11)**
26 - 30	-	16.09	22.46	-	-	-	**17.69 (8)**
> 30	-	22.93	22.32	-	-	-	**22.81 (5)**
Average	**29.65 (3)**	**22.11 (81)**	**17.95 (113)**	**8.71 (11)**	**15.32 (12)**	**22.48 (2)**	**19.07 (222)**

Table 3 : Location and Plot size- wise distribution of CV % of Dry land crop experiments

Location	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	18-21	>21	
Dhari	-	15.39	5.68	25.23	-	15.72	13.69	**17.57 (11)**
Jamkhambhaliya	-	-	-	17.54	-	-	9.19	**11.58 (14)**
Nanakandhasar	-	-	34.74	1948	-	-	33.58	**25.69 (7)**
Radhanpur	-	-	-	18.33	-	-	30.08	**22.74 (8)**
Targhadiya	27.15	22.66	21.49	25.18	18.23	16.24	14.03	**19.14(178)**
Vallabhipur	-	63.21	-	15.55	-	-	-	**27.47 (4)**
Average	**27.15 (09)**	**24.24 (20)**	**21.38 (22)**	**23.24 (61)**	**18.23 (6)**	**16.11 (04)**	**19.14 (100)**	**19.07 (222)**

Upper fiducial limit and yard stick of CV %

The upper fiducial limit of CV % for different factor for Dry farming experiment were work out and presented in the Tables 4 to 6.

Table 4 : Upper fiducial limit of CV% for different location of Dry land experiments

Location	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >24.64	
			(0.95)	No.	Proportion
Dhari	11	17.57	23.98	2	0.18
Jamkhambhalia	14	11.58	15.94	1	0.07
Nanakhandhasar	7	25.69	34.94	4	0.57
Radhanpur	8	22.74	29.98	2	0.25
Targhadia	178	19.14	24.44	37	0.21
Vallbhipur	4	27.47	36.38	2	0.50
Average	**(222)**	**19.07**	**24.64**	**48**	**0.22**

Table 5: Upper fiducial limit of CV% for different plot size of Dry land crop experiments

Plot size m^2	No. of Expt.	Mean CV %	Upper fiducial limit	Expt. Having CV% >24.64	
			(0.95)	No.	Proportion
3-6	9	27.15	33.50	5	0.56
6-9	20	24.24	30.20	6	0.30
9-12	22	21.38	27.09	7	0.32
12-15	61	23.24	30.15	17	0.28
15-18	6	18.23	22.89	1	0.17
18-21	4	16.11	19.28	0	0.00
>21	100	19.14	19.14	12	0.12
Average	**(222)**	**19.07**	**24.64**	**48**	**0.22**

Table 6: Upper fiducial limit of CV% for different discipline of Dry land experiments

Discipline	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >24.64	
			(0.95)	No.	Proportion
Agronomy	99	15.88	20.85	16	0.19
Entomology	8	11.06	14.38	0	0.00
Pl. Physiology	8	21.13	26.90	2	0.22
Pl. Breeding	96	23.17	29.64	29	0.30
Pl. Pathology	11	16.35	20.89	1	0.10
Average	**(222)**	**19.07**	**24.64**	**48**	**0.22**

Table 7: Upper fiducial limit of CV% for different treatments of Dry land experiments

Treatments	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >24.64	
			(0.95)	No.	Proportion
< 5	55	16.09	22.33	10	0.18
6-10	94	16.72	22.05	14	0.15
11-15	25	21.82	27.34	05	0.20
16-20	24	29.35	36.29	12	0.50
21-25	11	24.66	29.30	05	0.45
26-30	08	17.69	20.39	01	0.13
> 30	05	22.81	25.65	01	0.20
Average	**(222)**	**19.07**	**24.64**	**48**	**0.22**

Table 8: Upper fiducial limit of CV% for different replications of Dry land experiments

Replications	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >24.64	
			(0.95)	No.	Proportion
2	03	29.65	36.62	34.90	0.67
3	81	22.11	28.00	26.53	0.37
4	113	19.95	23.58	22.15	0.17
5	11	08.71	11.93	11.12	0.00
6	12	15.32	19.81	18.68	0.00
>6	02	22.48	29.17	27.50	0.50
Average	**(222)**	**19.07**	**24.64**	**23.24**	**0.22**

Table 9: The average upper fiducial limit and yardstick of CV % for Dry land experiments

Average of 222 experiments	Mean CV%	Upper fudicial limit of CV% (0.95)
	19.07	**24.64**
Overall yard stick of CV% 24.64 = 25%		

The experimental results of 222 Dry farming experiments revealed that the replication effect was the major contributor in the experimental variability, followed by crops, locations, treatments and plot size under Dry farming situation. 4 to 5 replications are necessary requirement for better precision of the experimental results.

Gram crop experiments showed maximum CV (31.58 %) followed by experiments on sorghum, cotton and arhar crops. The experiments on gram at Targhadia, sorghum at Vallabhipur and Targhadia, cotton at Nanakandhasar and Targhadia, bajra at Nanakandhasar and Radhanpur and arhar at Targhadia gave higher CV- more than 19.07 %. The crops and locations listed herein need great care in planning of experiments; recording biometrical attributes especially plant stand and applying proper methodology in analysis of the data.

Larger plot size i.e. larger than 15 sq.m gave low variability in the results of Dry farming experiments. However, with a view to save resources it is advised to work out optimum plot size for arhar, cotton, gram, sesamum and sorghum crops for Targhadia farm. Nanakandhasar (bajra, cotton), Vallabhipur (sorghum) and Radhanpur (bajra) also require such experiments. Such repeated exercise will be required to arrive at definite conclusion.

Plant breeding trials showed large variation for which change in use of experimental design (s) is essential/necessary. Plant Physiology experiments are also needing improvement in plot technique to improve efficiency of the experiments.

Uniformity trial on SRT 1 Cotton at Targhadia (Appendix VI) revealed 10.8 sq.m plot size as an optimum plot size for filed experiments on cotton. However, considering the results of experiments (Table 3) it is worth to repeat uniformity trial on cotton at Targhadia to arrive at definite plot size.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV % for accepting the results of Dry land crop experiments is 25 % for yield character.

2.5 TOBACCO

In all 544 field experiments conducted on bidi, chewing and rustica Tobacco at the Bidi Tobacco Research Station, Anand, Gujarat Agricultural University during the years 1980 to 1992 were scrutinized for variability analysis.

Table 1: Plot size and Treatment- wise distribution of CV% of Tobacco experiments

Plot Size(m^2)	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
< 3	-	-	11.60	-	-	-	-	**11.60**
3 – 6	14.47	14.28	22.07	-	-	-	-	**15.87**
6 – 9	8.51	12.04	17.35	14.61	10.26	5.75	19.30	**12.73**
9 – 12	18.00	16.0	15.60	13.13	13.55	12.77	14.20	**13.97**
12 – 15	15.72	13.04	13.42	15.20	15.93	14.29	25.08	**14.96**
15 – 18	16.92	-	15.02	-	-	-	-	**16.48**
18 – 21	-	12.24	14.72	-	-	-	-	**13.94**
21-31	11.92	16.11	13.20	7.80	-	-	-	**13.98**
>31	6.05	7.50	-	10.78	8.70	-	-	**9.51**
Average	**12.71**	**13.90**	**15.22**	**13.93**	**13.48**	**12.81**	**21.75**	**14.02**

Table 2: Plot size and Replication- wise distribution of CV% of Tobacco experiments

Plot Size (m^2)	Replications					Average
	2	3	4	5	6	
< 3	-	11.60	-	-	-	**11.60**
3 – 6	-	17.43	16.80	6.40	13.10	**15.87**
6 – 9	19.50	13.25	13.57	-	6.85	**12.73**
9 – 12	-	13.54	17.24	-	14.50	**13.97**
12 – 15	12.98	15.38	15.22	-	11.31	**14.96**
15 – 18	-	6.20	18.32	-	11.93	**16.48**
18 – 21	-	12.74	16.00	-	11.05	**13.94**
21-31	-	12.90	15.60	7.90	13.01	**13.98**
>31	-	10.50	7.50	-	6.05	**9.51**
Average	**13.54**	**14.04**	**15.49**	**7.60**	**11.13**	**14.02**

Table 3: Plot size and Design- wise distribution of CV% of Tobacco experiments

Design	Plot size (m^2)									
	1-3	3-6	6-9	9-12	12-15	15-18	18-24	21-31	>31	Average
RBD	11.60	15.87	12.31	13.89	14.86	16.67	17.00	12.91	9.51	**13.97**
FRBD2	-	-	15.26	-	9.60	-	11.99	15.33	-	**13.83**
FRBD3	-	-	13.80	-	10.50	23.90	16.37	-	-	**14.69**
SPT11	-	-	-	15.51	16.38	16.20	-	10.76	-	**14.17**
SPT12	-	-	14.40	10.55	12.03	-	-	-	-	**11.93**
SPT21	-	-	13.70	-	17.37	-	-	17.80	-	**16.27**
Other	-	-	-	-	15.05	-	-	11.10	-	**14.40**
Average	**11.60**	**15.87**	**12.73**	**13.97**	**14.96**	**16.48**	**13.94**	**13.98**	**9.51**	**14.02**

Table 4: Design and Treatment- wise distribution of CV % of Tobacco experiments

Design	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
RBD	12.70	14.12	16.02	14.00	13.04	12.83	19.57	**13.97**
FRBD2	-	13.50	14.41	-	-	-	-	**13.83**
FRBD3	-	10.50	17.44	-	-	3.80	-	**14.69**
SPT11	-	-	11.70	10.76	17.33	17.30	25.34	**14.17**
SPT12	-	-	-	11.93	-	-	-	**11.93**
SPT21	-	13.70	-	19.33	-	11.55	-	**16.27**
Other	-	-	11.10	-	-	-	16.05	**14.40**
Average	**12.71(78)**	**13.90(101)**	**15.22(106)**	**13.93(148)**	**13.48(68)**	**12.81(33)**	**21.75(10)**	**14.02**

Table 5: Treatment and Replication- wise distribution of CV % of Tobacco experiments

Treatments	Replications					Average
	2	3	4	5	≥ 6	
Up to 5	-	12.90	16.61	7.60	10.81	**12.71**
6-10	-	11.65	14.58	-	11.86	**13.90**
11-15	12.40	15.43	16.98	-	12.14	**15.22**
16-20	11.50	13.66	16.36	-	-	**13.93**
21-25	-	13.48	-	-	-	**13.48**
26-30	-	12.90	9.80	-	-	**12.81**
>30	17.20	24.47	19.10	-	-	**21.75**
Average	**13.54 (12)**	**14.04 (326)**	**15.49 (141)**	**7.60 (5)**	**11.13 (60)**	**14.02**

Upper fiducial limit and yardstick of CV %

Table 6: Upper fiducial limit of CV % for different location of Tobacco experiments

Type	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
Bidi	407	13.58	16.69	90	0.22
Chewing	23	16.25	19.94	8	0.35
Rustica	114	15.24	18.99	38	0.33
Average	**(544)**	**14.02**	**17.31**	**(136)**	**0.25**

Table 7: Upper fiducial limit of CV% for different design of Tobacco experiments

Design	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
RBD	432	13.97	17.36	108	0.25
FRBD2	36	13.83	17.17	7	0.19
FRBD3	10	14.69	17.96	4	0.40
SPT11	45	14.17	16.79	11	0.24
SPT2	6	11.93	13.98	0	0.00
SPT21	12	16.27	19.13	6	0.50
Other	3	14.40	16.96	0	0.00
Average	**(544)**	**14.02**	**17.31**	**136**	**0.25**

Table 8: Upper fiducial limit of CV% for different discipline of Tobacco experiments

Discipline	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
Agronomy	144	13.50	16.96	33	0.23
Chemistry	22	16.35	20.84	10	0.45
Entomology	18	15.32	19.50	6	0.33
Pl. Physiology	54	11.42	14.99	12	0.22
Pl.Breeding	285	14.16	16.96	65	0.23
Pl.Pathology	21	18.18	24.72	10	0.42
Average	**(544)**	**14.02**	**17.31**	**(136)**	**0.25**

Table 9: Upper limit of CV% for different treatment of Tobacco experiments

Treatment	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
≤ 5	78	12.71	17.36	14	0.18
6-10	101	13.90	17.80	29	0.28
11-15	106	15.22	18.80	33	0.31
16-20	148	13.93	16.62	31	0.21
21-25	68	13.48	15.83	17	0.25
26-30	33	12.81	14.80	6	0.20
> 30	10	21.75	24.68	6	0.60
Average	**(544)**	**14.02**	**17.31**	**(136)**	**0.25**

Table 10: Upper fiducial limit of CV% for different replication of Tobacco experiments

Replication	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
2	12	13.54	16.96	3	0.25
3	326	14.04	16.88	74	0.23
4	141	15.49	19.90	54	0.38
5	5	7.60	10.09	0	0.00
6	51	11.13	14.18	5	0.10
> 6	9	10.92	14.44	0	0.00
Average	**(544)**	**14.02**	**17.31**	**(136)**	**0.25**

Table 11: Upper fiducial limit of CV% for different plot size of Tobacco experiments

Plot size (m^2)	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >17.31	
			(0.95)	No.	Proportion
< 3	1	11.60	14.53	0	0.00
3-6	21	15.87	21.09	7	0.33
6-9	100	12.73	15.89	26	0.26
9-12	152	13.97	16.86	34	0.22
12-15	168	14.96	18.16	45	0.27
15-18	17	16.48	22.45	8	0.47
18-21	16	13.94	17.21	4	0.25
21-31	48	13.98	17.88	12	0.25
>31	21	9.51	11.46	0	0.00
Average	**(544)**	**14.02**	**17.31**	**(136)**	**0.25**

Table 12: Average upper fiducial limit and yardstick of CV % for Tobacco experiment

Average of 544 experiments	Average CV%	Upper fudicial limit of CV%
		0.95
	14.02	17.37
Overall yard stick of CV% 17.37 (18 %)		

The average CV % of the Tobacco experiments (544), in general, showed acceptable range of variation. However, following suggestions are made for improving efficiency of the field experimentation on Tobacco.

- RBD and SPT 11 should be replaced by other designs when treatments are ≥ 30.
- Plot size of 6-9 sq.m. area is the proper size for conducting experiments.
- Three replications are sufficient (except for 30 or more treatments)
  (Note: Inter relationship between four replications and plot size, in general, could not be resolved)
- Experiments in Chemistry, Entomology and Pl. Pathology disciplines require refinement in plot technique.

The average upper fiducial limit (17.37 % = 18 %) CV could be considered as yardstick of CV % for Tobacco crop experiment for yield character results.

2.6 VEGETABLE CROPS

The Vegetable crop experiments (540) conducted at different Vegetable research stations and department of horticulture during 1984 to 1995 were scrutinized for variability study.

Table 1: Treatment and replication- wise distribution of CV % of Vegetable experiments

Treatments	Replications					Average
	2	3	4	5	>=6	
≤ 5	-	14.83	16.60	13.23	15.91	**15.47**
6 - 10	17.08	19.50	14.76	33.56	20.74	**17.73**
11 - 15	20.91	19.51	19.26	-	12.56	**19.47**
16 - 20	19.92	15.56	15.64	-	-	**16.08**
21 - 25	18.77	14.03	17.52	-	-	**15.88**
26 - 30	15.37	14.88	13.02	-	-	**14.73**
> 30	17.14	23.92	27.29	-	-	**22.91**
Average	**18.46 (35)**	**18.65 (295)**	**16.17 (152)**	**16.13 (21)**	**16.99 (37)**	**17.73 (540)**

"Statistics is the grammar of science."

- Karl Pearson

Table 2: Plot size and Location -wise distribution of CV% of Vegetable experiments

Plot Size(m^2)	Location						Average
	Anand	Junagadh	Navsari	SK Nagar	Waghai	Other	
0 – 3	14.63	10.69	-	-	-	-	**14.39**
3 – 6	20.77	13.92	6.67	17.28	-	25.00	**17.31**
6 – 9	17.20	21.55	8.07	12.49	15.68	6.39	**17.36**
9 – 12	23.12	16.21	15.23	12.89	-	-	**19.16**
12 – 15	17.29	18.39	14.59	15.35	17.39	16.25	**17.06**
15 – 18	17.21	19.78	10.92	10.97	-	-	**17.60**
18 – 21	29.13	18.18	3.60	-	-	-	**20.39**
>21	18.68	24.80	10.24	18.11	-	-	**17.48**
Average	**19.49 (232)**	**17.86 (196)**	**12.15 (51)**	**14.97 (46)**	**16.24 (12)**	**15.88 (03)**	**17.73 (540)**

Table 3: Design and Replication- wise distribution of CV % of Vegetable experiments

Design	Replications					Average
	2	3	4	5	>=6	
RBD	20.30	19.70	15.22	16.13	16.99	**18.16**
FRBD2	-	15.82	12.87	-	-	**14.61**
FRBD3	26.23	15.98	22.34	-	-	**18.66**
SPT11	4.45	9.53	19.33	-	-	**12.86**
SPT12	8.33	9.62	17.51	-	-	**13.35**
SPT21	12.14	13.16	-	-	-	**12.55**
Others	16.33	9.44	28.53	-	-	**19.64**
Average	**18.46 (35)**	**18.65 (295)**	**16.17 (152)**	**16.13 (21)**	**16.99 (37)**	**17.73 (540)**

Table 4: Design and Treatment -wise distribution of CV % of Vegetable experiments

Design	Treatments							Average
	≤ 5	6-10	11-15	16-20	21-25	26-30	> 30	
RBD	15.47	17.80	19.55	17.62	17.40	17.62	25.70	**18.16**
FRBD2	-	20.10	18.51	12.61	-	3.70	-	**14.61**
FRBD3	-	-	-	22.38	14.96	22.34	-	**18.66**
SPT11	-	7.55	7.84	10.96	17.16	-	26.39	**12.86**
SPT12	-	-	-	-	14.76	9.12	-	**13.35**
SPT21	-	-	-	14.09	6.39	-	-	**12.55**
Others	-	23.97	33.10	-	9.59	-	12.81	**19.64**
Average	**15.47 (72)**	**17.73 (199)**	**19.47 (131)**	**16.08 (52)**	**15.88 (47)**	**17.73 (12)**	**22.91 (27)**	**17.73 (540)**

Table 5: Plot size and Design- wise distribution of CV % of Vegetable experiments

Plot Size(m^2)	Design							Average
	RBD	FRBD2	FRBD3	SPT11	SPT12	SPT21	Others	
0 – 3	13.81	-	-	-	-	-	23.80	**14.39**
3 – 6	17.50	14.59	20.62	10.14	9.36	19.93	28.54	**17.31**
6 – 9	19.18	2.81	22.34	9.87	9.63	6.39	8.71	**17.36**
9 – 12	19.89	17.39	15.89	4.45	22.57	-	9.29	**19.16**
12 – 15	16.76	-	-	32.36	-	-	-	**17.06**
15 – 18	18.02	-	19.83	10.91	-	-	12.17	**17.60**
18 – 2 1	21.75	-	-	-	9.12	-	-	**20.39**
>21	17.29	18.10	-	20.61	31.02	12.14	-	**17.48**
Average	**18.16**	**14.61**	**18.66**	**12.86**	**13.35**	**12.55**	**19.64**	**17.73**

Table 6: Crop and Plot size- wise distribution of CV% of Vegetable experiments

Crop	Plot Size (m^2)							
	< 3	**3-6**	**6-9**	**9-12**	**12-15**	**15-18**	**18-21**	**>21**
B.gourd	5.98	15.84	-	-	16.55	17.82	-	21.18
Brinjal	15.50	13.69	12.86	15.94	13.76	18.59	15.81	20.10
Cauliflower	-	16.68	10.37	12.89	21.11	-	-	10.56
Cabbage	-	12.55	10.87	9.39	-	-	-	4.54
Chilly	-	29.25	23.28	20.72	32.88	-	49.38	-
Garlic	-	16.73	-	-	-	-	-	-
Okra	14.34	15.57	19.03	19.00	13.82	16.64	-	18.52
Onion	-	11.67	7.09	15.82	9.34	-	-	-
Potato	-	-	9.19	-	-	-	-	-
Tomato	-	23.05	21.72	23.32	20.64	14.82	22.58	22.36
Others	-	20.63	14.75	12.74	20.98	14.47	-	12.51
Average	**14.39 (17)**	**17.31 (118)**	**17.36 (76)**	**19.16 (100)**	**17.06 (103)**	**17.60 (63)**	**20.39 (28)**	**17.48 (35)**

Upper fudicial limit and yardstick for CV %

Table 7: Upper fiducial limit of CV % for different location of Vegetable experiments

Location	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
Anand	232	19.49	24.77	76	0.33
Junagadh	196	17.86	22.83	45	0.23
Navsari	51	12.15	15.76	4	0.07
S K Nagar	46	14.97	18.01	7	0.15
Waghai	12	16.24	22.43	5	0.42
Other	3	15.88	20.16	1	0.33
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

"By a small sample, we may judge of the whole piece."

- Miguel de Cervantes

Table 8: Upper fiducial limit of CV % for different Vegetable experiments

Crop	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
B. Gourd	16	18.43	23.58	5	0.31
Brinjal	152	15.90	20.48	22	0.14
Cauliflower	18	13.41	17.18	4	0.22
Cabbage	11	9.47	11.77	0	0.00
Chilly	46	27.13	34.84	27	0.59
Garlic	20	16.73	20.93	4	0.22
Okra	93	16.81	20.79	16	0.17
Onion	35	11.93	15.07	3	0.09
Potato	9	9.19	12.46	1	0.11
Tomato	111	21.70	27.74	53	0.48
Other	29	15.84	20.06	3	0.10
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

Table 9: Upper fiducial limit of CV % for different design of Vegetable experiments

Design	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
RBD	457	18.16	23.31	120	0.26
FRBD2	17	14.61	17.93	4	0.23
FRBD3	10	18.66	22.37	4	0.40
SPT11	22	12.86	15.25	1	0.05
SPT12	12	13.35	15.41	2	0.17
SPT21	15	12.55	14.55	0	0.00
Other	17	19.64	24.13	7	0.41
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

Table 10: Upper fiducial limit of CV % for different treatments of Vegetable experiments

Treatments	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
<6	72	15.47	21.22	14	0.19
6-10	199	17.73	23.44	47	0.24
11-15	131	19.47	24.43	41	0.31
16-20	52	16.05	19.39	13	0.25
21-25	47	15.88	18.73	8	0.17
26-30	12	14.73	17.14	1	0.08
>30	27	22.91	25.81	14	0.52
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

Table 11: Upper fiducial limit of CV % for different replication of Vegetable experiments

Replication	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
2	35	18.46	22.86	11	0.31
3	295	18.65	23.60	85	0.29
4	152	16.17	20.71	29	0.19
5	21	16.13	21.86	5	0.24
6	37	16.99	22.06	8	0.22
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

Table 12: Upper fiducial limit of CV % for different plot size of Vegetable experiments

Plot size	No. of experiment	CV %	U L	Expt. having CV % > 22.56	
			(0.95)	No. of exp.	Proportion
< 3	17	14.39	17.17	2	0.12
3-6	118	17.31	21.85	28	0.24
6-9	76	17.36	22.18	21	0.28
9-12	100	19.16	24.02	34	0.34
12-15	103	17.06	22.11	20	0.19
15-18	63	17.60	22.44	14	0.22
18-21	28	20.39	26.37	9	0.32
>=21	35	17.48	22.77	10	0.28
Average	**(540)**	**17.73**	**22.56**	**(138)**	**0.26**

Table 13: The average upper fiducial limit and yardstick for CV % for Vegetable experiments

Name of Crops	No. of experiments	Average CV %	Upper fiducial limit of CV %0.95	Overall yardstick of CV%
Vegetables	**540**	**17.73**	**22.56**	22.56 = **23**

The experimental results showed maximum variation due to crops, followed by treatments, location, design, plot size and replications. Experiments on chilli and tomato yielded high CV (27.13 and 21.70 % respectively) due to which half number of experiments crossed the upper limit of CV % i.e. 23 %, means a great loss of resources. It is worth to evolve proper plot techniques for these crops to help increase experimental efficiency.

Experiments with more than 30 treatments conducted with 3 to 4 replications yielded high CV. The results of Anand centre indicated that there is a need to bring in uniformity in the experimental area/fields.

The plot size 6 - 9 sq.m is the proper size for field experiments at Navsari, SK Nagar and Waghai.. The smallest size (3 sq.m) is desirable at Anand and Junagadh. Three to four replications are sufficient for studying treatments up to 30. As far as possible FRBD3 may not be used for Vegetable experiments.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV% for accepting the results of Vegetable crops experiments is 23 per cent for yield character.

"Statistics are the heart of democracy."
- Simeon Strunsky

2.7 CASTOR

The information of 530 experiments conducted at the Main Castor and Mustard research station, S.K.Nagar, Oil seed Research Station, Junagadh and other research stations of Gujarat Agriculture University for the period 1984-1998 were utilized to study the variability in the experimental results of Castor crop.

Table 1: Treatment and Replication- wise distribution of CV% of Castor experiments

Treatments	Replications					Average
	2	3	4	5	6	
≤ 5	-	-	6.67	18.01	10.62	**13.76**
6 – 10	14.51	15.12	13.53	10.58	10.17	**14.31**
11 - 15	3.43	15.06	16.00	-	-	**15.12**
16 - 20	21.55	15.88	16.80	-	-	**16.16**
21 – 25	11.35	18.40	22.41	-	-	**18.26**
26 - 30	21.47	12.17	29.80	-	-	**14.34**
>30	19.35	16.11	-	-	-	**18.20**
Average	**17.63 (39)**	**15.45 (352)**	**14.35 (117)**	**17.33 (11)**	**10.54 (11)**	**15.31 (530)**

Table 2: Plot size and Design- wise distribution of CV % of Castor experiments

	Design						
Plot Size (m^2)	**RBD**	**FRBD2**	**FRBD3**	**SPT11**	**SPT12**	**Other**	**Average**
≤ 3	20.98	-	-	-	-	-	**20.98**
3- 6	17.25	-	-	-	-	-	**17.25**
6- 9	19.91	-	-	19.27	-	-	**19.83**
9-12	17.06	-	-	-	-	-	**17.06**
12-15	14.41	17.05	-	5.92	7.93	18.01	**14.06**
15-18	15.30	20.75	-	14.32	15.09	-	**15.50**
18-24	13.99	-	-	17.13	-	-	**14.04**
24-30	14.30	10.21	-	-	11.22	-	**13.46**
30-45	12.75	-	-	5.79	-	3.10	**12.49**
> 45	23.15	-	28.75	7.20	-	-	**17.30**
Average	**15.40 (486)**	**15.41 (16)**	**28.75 (2)**	**12.45 (17)**	**12.06 (6)**	**12.06 (3)**	**15.31 (530)**

Table 3: Design and Treatment- wise distribution of Castor experiments

	Treatments							Average
Design	**Up to 5**	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	
RBD	13.76	14.21	15.05	16.94	18.93	14.68	18.20	**15.40**
FRBD2	-	10.23	19.44	-	-	-	-	**15.41**
FRBD3	-	28.75	-	-	-	-	-	**28.75**
SPT11	-	16.64	10.58	11.15	9.50	7.38	-	**12.45**
SPT21	-	-	-	12.06	-	-	-	**12.06**
Other	-	-	-	13.04	-	-	-	**13.04**
Average	**13.76 (21)**	**14.31 (187)**	**15.12 (166)**	**16.16 (60)**	**18.26 (42)**	**14.34 (21)**	**18.20 (33)**	

"Statistics are no substitute for judgment."
- Henry Clay

Table 4: Plot size and Treatment- wise distribution of CV % of Castor experiments

Treatments								
Plot Size (m^2)	**Up to 5**	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	**Average**
1-3	-	-	-	-	25.85	-	11.23	**20.98**
3- 6	-	8.74	17.61	15.43	18.85	-	24.46	**17.25**
6- 9	-	22.79	20.01	19.46	18.61	14.47	-	**19.83**
9-12	-	19.09	17.11	17.13	15.86	13.55	17.74	**17.06**
12-15	8.33	14.57	15.42	12.64	-	-	-	**14.06**
15-18	14.48	14.79	16.15	14.87	15.98	15.39	15.91	**15.50**
18-24	10.81	14.07	13.48	21.86	24.40	-	-	**14.04**
24-30	11.34	11.63	17.65	11.22	17.50	-	-	**13.46**
30-45	16.87	12.32	6.02	13.10	-	-	-	**12.49**
> 45	-	14.38	12.35	32.90	-	-	24.20	**17.30**
Average	**13.76 (21)**	**14.31 (187)**	**15.12 (166)**	**16.16 (60)**	**18.26 (42)**	**14.34 (21)**	**18.20 (33)**	**15.31 (530)**

Upper fiducial limit and yard stick of CV%

Table 5: Upper fiducial limit of CV % for different design of Castor experiments

Design	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
RBD	486	15.40	19.22	137	0.28
FRBD2	16	15.41	19.51	5	0.31
FRBD3	2	28.75	37.78	1	0.50
SPT11	17	12.45	15.98	3	0.17
SPT12	6	12.06	14.56	1	0.17
Other	3	12.04	15.80	1	0.22
Average	**(530)**	**15.31**	**19.12**	**(148)**	**0.28**

Table 6: Upper fiducial limit of CV % for different location of Castor experiments

Location	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
Amreli	6	16.37	21.48	2	0.33
Anand	6	7.67	9.56	0	0.00
Bhachau	27	23.78	30.21	19	0.77
Derol	5	20.52	25.53	2	0.40
Jamnagar	9	20.95	26.95	5	0.55
Junagadh	151	13.06	16.00	26	0.17
Navsari	6	16.57	21.84	2	0.33
SK Nagar	254	16.08	20.09	79	0.31
Talod	47	12.24	15.28	8	0.17
Targhadia	4	23.29	30.82	3	0.75
Vijapur	12	13.85	17.98	1	0.08
Other	3	14.98	18.67	1	0.33
Average	**(530)**	**15.31**	**19.12**	**(148)**	**0.28**

Table 7: Upper fiducial limit of CV % for different discipline of Castor experiments

Discipline	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
Agronomy	93	14.35	18.24	21	0.22
Entomology	29	12.49	16.13	5	0.17
Pl breeding	402	15.71	19.50	119	0.29
Pl pathology	1	24.06	30.97	1	1.00
Soil science	5	15.69	20.69	2	0.40
Average	**(530)**	**15.31**	**19.12**	**(148)**	**0.28**

Table 8: Upper fiducial limit of CV % for different location of Castor experiments

Treatments	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
<5	21	13.76	18.65	4	0.19
5-10	187	14.31	18.72	42	0.22
11-15	166	15.12	18.89	50	0.30
16-20	60	16.16	19.43	17	0.28
21-25	42	18.26	21.57	16	0.38
26-30	21	14.34	16.64	6	0.25
>-30	33	18.20	20.77	13	0.39
Average	**(530)**	**15.31**	**19.12**	**(148)**	**0.28**

Table 9: Upper fiducial limit of CV % for different replication of Castor experiments

Replication	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
2	39	17.63	21.02	17	0.43
3	352	15.45	19.30	100	0.28
4	117	14.35	18.05	27	0.23
5	11	17.33	23.52	3	0.27
>=6	11	10.54	13.89	1	0.09
Average	**530**	**15.31**	**19.12**	**148**	**0.28**

Table 10: Upper fiducial limit of CV % for different plot size of Castor experiments

Plot size	No. of experiment	CV %	U L	Expt. having CV % > 19.12	
			(0.95)	No. of exp.	Proportion
< 3	3	20.98	24.45	1	0.33
3-6	37	17.25	20.84	12	0.32
6-9	40	19.83	24.77	22	0.55
9-12	82	17.06	20.91	28	0.34
12-15	43	14.06	17.86	12	0.28
15-18	97	15.50	19.14	27	0.28
18-24	122	14.04	17.83	27	0.22
24-30	33	13.46	16.72	6	0.18
30-45	64	12.49	16.23	10	0.16
> 45	9	17.30	21.72	3	0.33
Average	**530**	**15.31**	**19.12**	**148**	**0.28**

Table 11: The average upper fiducial limit and yardstick for CV % for Castor experiments

Name of Crops	No. of experiments	Average CV %	Upper fiducial limit of CV %	Overall yardstick of CV%
			0.95	
Castor	**530**	**15.31**	**19.12**	**19.12 = 20**

The average upper fiducial limit of CV % at 95 % confidence of all 530 experiments was 19.12 % which covers the region related to average CV % of all the experimental factors and locations except for Bhachau, Derol, Jamnagar and Targhadia and FRBD3 design. This design resulted the highest average CV (28.75%) probably because of plot size (> 45 sq.m) used in the conduct of the experiments. The locations showing large variation in experimental data need refinement in plot technique and use of proper statistical tool(s) in analyzing the data.

The results revealed that the proper plot size for Castor experiments is 12-15 sq.m. Four replications are sufficient.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV% for accepting the results of Castor crop experiments is 20 per cent for yield character.

2.8 FORAGE CROPS

In all 1058 field experiments of forage crops conducted at 19 Research stations of GAU during 1995 to 2005 in plant breeding, agronomy and plant protection disciplines were utilized for variability study.

Table 1: Treatment and replication- wise distribution of CV% of forage experiments

Treatments	Replications					Average
	2	3	4	5	6	
up to 5	-	10.40	13.47	11.03	9.73	**12.35**
6 - 10	-	10.08	10.58	11.40	-	**10.18**
11 - 15	8.75	10.03	10.49	-	-	**10.10**
16 - 20	8.20	13.55	14.62	-	-	**13.59**
21 - 25	9.80	12.24	-	-	-	**12.07**
26 - 30	-	17.42	-	-	-	**17.42**
> 30	13.63	-	-	-	-	**13.63**
Average	**11.73**	**10.81**	**11.55**	**11.09**	**9.73**	**10.97**

Table 2: Design and treatment- wise distribution of CV % of forage experiments

Design	Treatments							
	≤5	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	**Average**
RBD	12.35	10.21	10.13	13.67	12.07	17.42	13.63	**10.93 (984)**
FRBD2	-	5.81	9.76	16.61	-	-	-	**12.38 (44)**
SPT11	-	6.80	10.16	-	-	-	-	**9.85 (11)**
SPT12	-	-	-	8.43	-	-	-	**8.43 (13)**
SPT21	-	-	-	13.89	-	-	-	**13.89 (6)**
Average	**12.35 (78)**	**10.18 (460)**	**10.10 (311)**	**13.59 (161)**	**12.07 (30)**	**17.42 (6)**	**13.63 (12)**	**10.97 (1058)**

Table 3: Design and replication- wise distribution of CV % of forage experiments

Design	Replications					Average
	2	3	4	5	6	
RBD	11.73	10.74	11.75	11.09	9.73	**10.93 (984)**
FRBD2	-	15.10	9.67	-	-	**12.38 (44)**
SPT11	-	7.57	10.70	-	-	**9.85 (11)**
SPT12	-	8.43	-	-	-	**8.43 (13)**
SPT21	-	-	13.89	-	-	**13.89 (6)**
Average	**11.73 (20)**	**10.81 (800)**	**11.55 (205)**	**11.09 (23)**	**9.73 (10)**	**10.97 (1058)**

Table 4: Discipline and treatment- wise distribution of CV% of forage experiments

Discipline	Treatments							
	≤5	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	**Average**
Agronomy	-	9.03	9.90	13.34	-	-	-	**10.46 (249)**
Pl. Protection	15.32	10.74	15.48	-	-	-	-	**14.38 (57)**
Pl. Breed.	9.67	10.39	9.99	13.73	12.07	17.42	13.63	**10.88 (752)**
Average	**12.35 (78)**	**10.18 (460)**	**10.10 (311)**	**13.59 (161)**	**12.07 (30)**	**17.42 (6)**	**13.63 (12)**	**10.97 (1058)**

Table 5: Discipline and replication- wise distribution of CV% of forage experiments

Discipline	Replications					Average
	2	3	4	5	6	
Agronomy	-	10.54	10.34	-	-	**10.46 (249)**
Pl. Protection	-	11.48	15.51	-	-	**14.38 (57)**
Pl. Breed.	11.73	10.87	10.85	11.09	9.73	**10.88 (752)**
Average	**11.73 (20)**	**10.81 (800)**	**11.55 (205)**	**11.09 (23)**	**9.73 (10)**	**10.97 (1058)**

Table 6: Design and plot size- wise distribution of CV% of forage experiments

Design	Plot size (m^2)								Average
	< 3	**3-6**	**6-9**	**9-12**	**12-15**	**15-18**	**18-21**	**> 21**	
RBD	13.84	8.82	11.43	11.25	11.23	11.95	7.90	8.38	**10.93(984)**
FRBD2	-	-	9.67	-	15.10	-	-	-	**12.38(44)**
SPT11	-	-	-	-	10.27	-	7.96	-	**9.85(11)**
SPT12	-	-	8.43	-	-	-	-	-	**8.43(13)**
SPT21	-	-	-	-	13.89	-	-	-	**13.89(6)**
Average	**13.84 (16)**	**8.62 (30)**	**11.13 (258)**	**11.25 (247)**	**11.46 (400)**	**11.95 (9)**	**7.93 (89)**	**8.38 (9)**	**10.97 (1058)**

Table 7: Plot size and treatment- wise distribution of CV% of forage experiments

Plot size (m^2)	Treatments							
	≤5	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	**Average**
<3	-	20.75	-	8.20	-	-	13.63	**13.84 (16)**
3 - 6	-	8.91	10.77	8.17	-	8.01	-	**8.82 (30)**
6 - 9	8.10	9.88	10.96	13.85	11.49	36.25	-	**11.13 (258)**
9 -12	9.55	12.11	8.76	14.04	14.75	-	-	**11.25 (247)**
12 -15	13.28	10.36	11.57	14.41	9.61	-	-	**11.46 (400)**
15 -18	-	10.88	13.56	13.00	-	-	-	**11.95 (9)**
18 -21	-	6.67	7.67	16.35	-	-	-	**7.90 (89)**
> 21	-	-	8.38	-	-	-	-	**8.38 (9)**
Average	**12.35 (78)**	**10.18 (460)**	**10.10 (311)**	**13.59 (161)**	**12.07 (30)**	**17.42 (6)**	**13.63 (12)**	**10.97 (1058)**

Table 8: Plot size and replication- wise distribution of CV% of forage experiments

Plot size (m^2)	Replications					Average
	2	3	4	5	6	
<3	12.85	20.75	-	-	-	**13.84 (16)**
3 - 6	8.75	8.80	8.91	-	-	**8.82 (30)**
6 - 9	9.80	11.50	9.75	8.40	-	**11.13 (258)**
9 -12	-	11.44	10.48	-	9.73	**11.25 (247)**
12 -15	-	10.91	12.71	11.66	-	**11.46 (400)**
15 -18	-	13.56	11.49	-	-	**11.95 (9)**
18 -21	-	7.90	-	-	-	**7.90 (89)**
> 21	-	8.38	-	-	-	**8.38 (9)**
Average	**11.73(20)**	**10.81(800)**	**11.55(205)**	**11.09(23)**	**9.73(10)**	**10.97(1058)**

Table 9: Discipline and plot size- wise distribution of CV% of forage experiments

Discipline	Plot size (m^2)								Average
	< 3	3-6	6-9	9-12	12-15	15-18	18-21	> 21	
Agronomy	-	10.10	11.25	8.76	11.52	11.95	8.18	8.38	**10.46 (249)**
Pl. Protection	-	-	-	-	14.38	-	-	-	**14.38 (57)**
Pl. Breed.	13.84	8.35	11.09	12.18	10.79	-	7.87	-	**10.88 (752)**
Average	**13.84 (16)**	**8.82 (30)**	**11.13 (258)**	**11.25 (247)**	**11.46 (400)**	**11.95 (9)**	**7.90 (89)**	**8.38 (9)**	**10.97 1058)**

Table 10: Location and plot size- wise distribution of CV% of forage experiments

Location	Plot size (m^2)								Average
	< 3	3-6	6-9	9-12	12-15	15-18	18-21	> 21	
Anand	13.84	8.47	9.82	10.94	11.22	11.95	7.90	8.38	**10.47(873)**
Arnej	-	-	8.63	8.80	-	-	-	-	**8.68(6)**
Aseda	-	-	-	5.85	21.55	-	-	-	**13.70(4)**
Chharodi	-	-	-	4.55	-	-	-	-	**4.55(2)**
Deesa	-	-	5.35	10.40	-	-	-	-	**6.36(10)**
Dhandhuka	-	-	7.85	7.60	-	-	-	-	**7.73(4)**
Dhari	-	13.67	23.47	18.84	29.32	-	-	-	**22.87(36)**
Jamkhambhaliya	-	-	19.75	-	-	-	-	-	**19.75(2)**
Khapat	-	-	7.90	3.30	-	-	-	-	**5.60(4)**
Khedbrahma	-	-	-	10.90	-	-	-	-	**10.90(2)**
Ladol	-	-	-	18.00	5.60	-	-	-	**11.80(4)**
Navsari	-	-	6.60	10.78	4.63	-	-	-	**9.56(22)**
Radhanpur	-	-	12.10	29.80	-	-	-	-	**20.95(4)**
SK Nagar	-	-	12.94	9.94	10.97	-	-	-	**10.79(50)**
Surat	-	-	5.88	-	10.25	-	-	-	**6.97(8)**
Targhadia	-	-	9.70	7.30	-	-	-	-	**8.50(4)**
Valbhipur	-	-	8.95	16.35	-	-	-	-	**12.65(4)**
Vijapur	-	-	-	7.90	13.90	-	-	-	**11.90(3)**
Viramgam	-	-	17.76	20.55	-	-	-	-	**18.46(16)**
Average	**13.84 (16)**	**8.62 (30)**	**11.13 (258)**	**11.25 (247)**	**11.46 (400)**	**11.95 (9)**	**7.90 (89)**	**8.38 (9)**	**10.97 (1058)**

Table 11: Location and treatment- wise distribution of CV% of forage experiments

Location	Treatments							Average
	≤5	6-10	11-15	16-20	21-25	26-30	>30	
Anand	12.57	9.53	9.78	12.61	12.07	17.42	13.63	**10.47(873)**
Arnej	-	8.68	-	-	-	-	-	**8.68(6)**
Aseda	13.70	-	-	-	-	-	-	**13.70(4)**
Chharodi	-	-	-	4.55	-	-	-	**4.55(2)**
Deesa	-	6.60	6.10	5.90	-	-	-	**6.36(10)**
Dhandhuka	-	7.73	-	-	-	-	-	**7.73(4)**
Dhari	-	22.96	25.12	21.95	-	-	-	**22.87(36)**
Jamkhambhaliya	-	19.75	-	-	-	-	-	**19.75(2)**
Khapat	-	5.60	-	-	-	-	-	**5.60(4)**
Khedbrahma	-	10.90	-	-	-	-	-	**10.90(2)**
Ladol	11.80	-	-	-	-	-	-	**11.80(4)**
Navsari	5.90	11.28	9.11	-	-	-	-	**9.56(22)**
Radhanpur	-	20.95	-	-	-	-	-	**20.95(4)**
SK Nagar	10.98	10.69	9.64	13.75	-	-	-	**10.79(50)**
Surat	-	5.35	8.60	-	-	-	-	**6.97(8)**
Targhadia	-	8.50	-	-	-	-	-	**8.50(4)**
Valbhipur	-	12.65	-	-	-	-	-	**12.65(4)**
Vijapur	11.90	-	-	-	-	-	-	**11.90(3)**
Viramgam	-	17.07	18.18	25.95	-	-	-	**18.46(16)**
Average	**12.35 (78)**	**10.18 (460)**	**10.10 (311)**	**13.59 (161)**	**12.07 (30)**	**17.42 (6)**	**13.63 (12)**	**10.97 (1058)**

Table 12: Location and discipline wise distribution of CV% of forage experiments

Location	Discipline			Average
	Agronomy	Plant Protection	Plant Breeding	
Anand	10.24	14.38	10.18	**10.47(873)**
Arnej	-	-	8.68	**8.68(6)**
Aseda	-	-	13.70	**13.70(4)**
Chharodi	-	-	4.55	**4.55(2)**
Deesa	-	-	6.36	**6.36(10)**
Dhandhuka	-	-	7.73	**7.73(4)**
Dhari	19.91	-	23.71	**22.87(36)**
Jamkhambhalia	-	-	19.75	**19.75(2)**
Khapat	-	-	5.60	**5.60(4)**
Khedbrahma	-	-	10.90	**10.90(2)**
Ladol	-	-	11.80	**11.80(4)**
Navsari	9.78	-	9.24	**9.56(22)**
Radhanpur	-	-	20.95	**20.95(4)**
SK Nagar	9.56	-	11.93	**10.79(50)**
Surat	-	-	6.97	**6.97(8)**
Targhadia	-	-	8.50	**8.50(4)**
Valbhipur	-	-	12.65	**12.65(4)**
Vijapur	-	-	11.90	**11.90(3)**
Viramgam	-	-	18.46	**18.46(16)**
Average	**10.46 (249)**	**14.38 (57)**	**10.88 (752)**	**10.97(1058)**

Table 13: Location and design wise distribution of CV% of forage experiments

Location	Design					Average
	RBD	FRBD2	SPT11	SPT12	SPT21	
Anand	10.38	12.38	9.85	8.43	13.89	**10.47(873)**
Arnej	8.68	-	-	-	-	**8.68(6)**
Aseda	13.70	-	-	-	-	**13.70(4)**
Chharodi	4.55	-	-	-	-	**4.55(2)**
Deesa	6.36	-	-	-	-	**6.36(10)**
Dhandhuka	7.73	-	-	-	-	**7.73(4)**
Dhari	22.87	-	-	-	-	**22.87(36)**
Jamkhambhalia	19.75	-	-	-	-	**19.75(2)**
Khapat	5.60	-	-	-	-	**5.60(4)**
Khedbrahma	10.90	-	-	-	-	**10.90(2)**
Ladol	11.80	-	-	-	-	**11.80(4)**
Navsari	9.56	-	-	-	-	**9.56(22)**
Radhanpur	20.95	-	-	-	-	**20.95(4)**
SK Nagar	10.79	-	-	-	-	**10.79(50)**
Surat	6.97	-	-	-	-	**6.97(8)**
Targhadia	8.50	-	-	-	-	**8.50(4)**
Valbhipur	12.65	-	-	-	-	**12.65(4)**
Vijapur	11.90	-	-	-	-	**11.90(3)**
Viramgam	18.46	-	-	-	-	**18.46(16)**
Average	**10.93 (984)**	**12.38 (44)**	**9.85 (11)**	**8.43 (13)**	**13.89 (6)**	**10.97 (1058)**

Upper fiducial limit and yardstick for CV %

Table 14: Upper fiducial limit of CV % for different location of forage experiments

Location	No. of experiment	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
Anand	873	10.47	13.28	177	0.20
Arnej	6	8.68	11.14	0	0.00
Aseda	4	13.70	18.81	2	0.50
Chharodi	2	4.55	5.50	0	0.00
Deesa	10	6.36	8.03	1	0.10
Dhandhuka	14	7.73	9.91	0	0.00
Dhari	36	22.87	29.24	33	0.92
Jamkhambhalia	2	19.75	25.58	2	1.00
Khapat	4	5.60	7.18	0	0.00
Khedbrahma	2	10.90	14.00	0	0.00
Ladol	4	11.80	15.59	2	0.50
Navsari	22	9.56	12.02	4	0.18
Radhanpur	4	20.95	27.30	3	0.75
SK Nagar	50	10.79	13.40	11	0.22
Surat	8	6.97	8.84	0	0.00
Targhadia	4	8.50	10.91	0	0.00
Valbhipur	4	12.65	16.28	2	0.50
Vijapur	3	11.90	16.21	1	0.33
Viramgam	16	18.46	23.63	12	0.75
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

"Facts are stubborn things, but statistics are pliable."
- Mark Twain

Table 15: Upper fiducial limit of CV % for different design of forage experiments

Design	No. of experiment	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
RBD	984	10.93	13.94	225	0.23
FRBD2	44	12.38	15.05	18	0.41
SPT11	11	9.85	12.00	0	0.00
SPT12	13	8.43	10.08	3	0.23
SPT21	6	13.89	16.19	4	0.67
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

Table 16 : Upper fiducial limit of CV % for different discipline of forage experiments

Discipline	No. of experiment	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
Agronomy	249	10.46	12.92	51	0.20
Pl. protection	57	14.38	19.46	27	0.47
Pl. breeding	752	10.88	13.85	172	0.23
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

Table 17: Upper fiducial limit of CV % for different replication of forage experiments

Replications	No. of experiment	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
2	20	11.73	13.86	6	0.30
3	800	10.81	13.68	186	0.23
4	205	11.55	14.89	51	0.25
5	23	11.09	14.96	5	0.22
6	10	9.73	12.64	2	0.20
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

Table 18: Upper fiducial limit of CV % for different treatments of forage experiments

Treatments	No. of experiments	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
<5	78	12.35	16.97	27	0.35
6-10	460	10.18	13.37	84	0.18
11-15	311	10.10	12.50	58	0.19
16-20	161	13.59	16.42	66	0.41
21-25	30	12.07	14.25	7	0.23
26-30	6	17.42	20.21	2	0.33
>30	12	13.63	15.65	6	0.50
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

If your experiment needs statistics, you ought to have done a better experiment.
- Ernest Rutherford

Table 19: Upper fiducial limit of CV % for different plot size of forage experiments

Plot size (m^2)	No. of experiments	CV %	U L	Expt. having CV % > 13.94	
			(0.05)	No. of exp.	Proportion
<3	16	13.84	16.36	8	0.50
3-6	30	8.82	10.88	3	0.10
6-9	258	11.13	14.00	59	0.23
9-12	247	11.25	14.10	63	0.26
12-15	400	11.46	14.86	108	0.27
15-18	9	11.95	14.84	0	0.00
18-21	89	7.90	9.97	9	0.10
>21	9	8.38	10.48	0	0.00
Average	**(1058)**	**10.97**	**13.94**	**(250)**	**0.24**

Table 20: The average upper fiducial limit and yardstick for CV % for the experiments of forage experiments

Crop	No. of experiments	Average CV %	Upper fiducial limit of CV %	Overall yardstick of CV%
			0.95	
Forage	**1058**	**10.97**	**13.94**	**13.94 = 14**

The location factor showed maximum deviation in forage crops experiments, the next in line were treatments, plot size, design, disciplines and replications. All the locations barring Dhari, Radhanpur, Jamkhambhaliya and Viramgam had CV within upper limit of 14 %. At these four locations the experiments were conducted in RBD only and that with less than 20 treatments. It is advised to try other design(s) at these locations, also adjust the yield by other influencing variable(s) to increase the efficiency of the experimentation. At Anand also change in design is required for the experiments with 26-30 treatments.

Results revealed that the proper plot size for forage crops experiments is 3-9 sq.m. Three replications are sufficient.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yard stick of CV% for accepting the results of forage crops experiments is 14 per cent for yield character.

"Models should be as simple as possible, but not more so."
- Attributed to Einstein

2.9 MUSTARD

The information of 554 experiments conducted on Mustard crop at different research stations of the Gujarat Agricultural University for the period of 1984 to 1998 were utilized in the present study.

Table 1: Treatment and replication- wise distribution of CV% of Mustard experiments

Treatments	Replications					Average
	2	3	4	5	>=6	
≤ 5	-	-	12.03	13.45	29.46	**14.67**
6 - 10	-	11.29	12.31	-	-	**12.07**
11 - 15	-	12.99	12.36	16.86	-	**12.54**
16 - 20	19.10	14.09	15.47	-	-	**15.07**
21 - 25	-	14.48	14.08	-	-	**14.32**
26 - 30	-	15.49	14.57	-	-	**15.14**
> 30	11.24	19.11	-	-	-	**15.17**
Average	**11.67**	**14.54**	**13.49**	**13.88**	**29.46**	**13.42**

Table 2: Design and treatment- wise distribution of CV % of Mustard experiments

Design	Treatments							Average
	≤ 5	6-10	11-15	16-20	21-25	26-30	30	
RBD	14.67	12.08	12.49	14.91	13.77	15.39	16.26	**13.70**
FRBD2	-	11.76	11.69	15.67	-	-	-	**14.64**
Lattice	-	-	-	-	-	-	11.24	**11.24**
SPT11	-	-	16.86	24.30	22.30	7.53	-	**19.99**
SPT111	-	-	-	16.70	-	-	40.45	**27.52**
Average	**14.67**	**12.07**	**12.54**	**15.07**	**14.32**	**15.14**	**15.17**	**13.42**

Table 3: Location and plot size- wise distribution of CV % of Mustard experiments

Location	Plot Size (m^2)								
	< 3	3-6	6-9	9-12	12-15	15-18	18-24	24-30	Average
Amreli	-	7.70	8.67	6.30	8.42	4.77	-	-	**8.06 (20)**
Anand	-	11.70	13.17	15.38	11.65	15.88	-	12.22	**12.63 (32)**
Arnej	-	36.20	34.22	29.63	14.32	17.33	-	-	**23.91 (13)**
Bhachau	-	10.70	-	24.70	29.83	-	-	-	**21.74 (3)**
Deesa	6.33	6.90	15.60	-	-	-	-	-	**8.30 (5)**
Derol	-	10.30	-	35.70	8.98	7.76	-	-	**12.33 (8)**
Dhandhuka	-	41.17	13.60	15.52	21.33	24.16	-	-	**22.98 (9)**
Jamnagar	-	-	-	15.70	10.28	7.67	-	-	**11.65 (6)**
Junagadh	13.11	16.85	11.94	14.83	8.65	10.67	19.90	8.46	**13.31(124)**
Ladol	-	15.62	15.13	-	8.94	-	-	-	**14.34 (6)**
Navsari	-	15.97	15.05	17.76	12.60	12.01	-	-	**14.61 (26)**
Nawagam	-	9.23	-	21.13	-	18.08	-	-	**17.39 (4)**
SKNagar	14.73	12.96	12.28	15.38	10.09	8.76	8.87	12.48	**12.98(246)**
Talod	-	10.41	15.53	14.49	10.84	12.10	-	18.90	**13.17 (29)**
Vijapur	-	17.97	-	11.62	12.18	10.21	-	-	**13.08 (13)**
Waghai	-	-	-	15.50	16.70	-	-	-	**16.40 (4)**
Other	-	19.60	12.30	13.31	10.07	11.27	-	-	**13.30 (6)**
Average	**11.38 (8)**	**14.66 (131)**	**12.79 (153)**	**16.15 (103)**	**10.83 (116)**	**12.90 (33)**	**12.55 (3)**	**11.93 (7)**	**13.42 (554)**

Table 4: Plot size and discipline- wise distribution of CV % of Mustard experiments

Plot size (m^2)	Disciplines					
	Agronomy	Entomology	Pl. Breeding	Pathology	Pl. Physiology	Average
< 3	-	-	16.52	-	-	**16.52**
03-06	-	-	14.77	-	-	**14.77**
06-09	13.96	7.43	13.21	14.88	-	**13.23**
09-12	15.13	23.41	19.83	9.59	15.72	**17.70**
12-15	19.74	-	10.38	-	9.29	**10.64**
15-18	7.53	-	13.35	-	-	**13.16**
18-21	9.43	-	-	-	-	**9.43**
>21	11.97	-	14.93	-	-	**14.19**
Average	**14.93**	**17.01**	**13.72**	**14.12**	**10.90**	

Table 5: Plot size and replication- wise distribution of CV % of Mustard experiments

Plot size (m^2)	Replications					
	2	3	4	5	6	Average
< 3	-	-	16.52	-	-	16.52
03-06	-	14.88	14.29	-	-	14.77
06-09	11.67	13.94	13.41	11.26	-	13.23
09-12	-	18.46	16.86	27.80	29.46	17.70
12-15	-	9.66	10.69	12.36	-	10.64
15-18	-	12.80	13.19	-	-	13.16
18-21	-	9.43	-	-	-	9.43
21-31	-	-	14.19	-	-	14.19
Average	**11.67**	**14.54**	**13.49**	**13.88**	**29.46**	

Table 6: Plot size and treatment- wise distribution of CV % of Mustard experiments

Plot size (m^2)	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
0 – 3	-	-	-	-	16.52	-	-	16.52
3 – 6	-	16.26	15.48	12.84	13.30	17.12	17.31	14.77
6 – 9	14.00	10.64	17.03	13.82	13.95	13.77	11.65	13.23
9 – 12	28.91	15.40	13.54	17.39	24.70	-	40.45	17.70
12 – 15	10.29	9.17	11.04	13.16	15.70	-	-	10.64
15 – 18	-	-	12.04	16.28	-	7.53	-	13.16
18 – 2 1	-	9.43	-	-	-	-	-	9.43
>21	-	14.19	-	-	-	-	-	14.19
Average	**14.67**	**12.07**	**12.54**	**15.07**	**14.32**	**15.14**	**15.17**	**-**

Statisticians, like artists, have the bad habit of falling in love with their models.
- George Box

Upper fiducial limit and yard stick of CV%

Table 7: Upper fiducial limit of CV% for different location of Mustard experiments

Location	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.28	
			(0.95)	No.	Proportion
Amreli	20	8.06	9.60	0	0.00
Anand	32	12.63	15.39	6	0.19
Arnej	13	23.91	29.00	9	0.69
Bhachau	3	21.74	26.06	2	0.67
Deesa	5	8.30	9.61	0	0.00
Derol	8	12.33	14.72	1	0.13
Dhandhuka	9	22.98	27.77	4	0.44
Jamnagar	6	11.65	14.02	1	0.17
Junagadh	124	13.31	15.93	34	0.27
Ladol	6	14.34	16.82	3	0.50
Navsari	26	14.61	17.47	9	0.35
Nawagam	4	17.39	21.44	3	0.75
Sknagar	246	12.98	15.95	52	0.21
Talod	29	13.17	15.61	6	0.21
Vijapur	13	13.08	15.62	3	0.23
Waghai	4	16.40	20.39	2	0.50
Other	6	13.30	16.65	2	0.33
Average	**(554)**	**13.42**	**16.28**	**(137)**	**0.25**

Other :Achhalia, Dahod, Kodinar, Tanchha, Vyara

Table 8: Upper fiducial limit of CV% for different designs of Mustard experiments

Design	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.28	
			(0.95)	No.	Proportion
RBD	496	13.28	16.14	120	0.24
FRBD2	19	14.86	18.10	5	0.26
SPT11	19	17.18	20.30	9	0.47
LATTICE	19	11.38	13.24	2	0.11
ABBA	1	21.76	29.28	1	1.00
Average	**(554)**	**13.42**	**16.28**	**(137)**	**0.25**

Table 9: Upper fiducial limit of CV% for different discipline of Mustard experiments

Discipline	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.28	
			(0.95)	No.	Proportion
Agronomy	67	13.35	16.40	16	0.24
Entomology	13	15.40	20.06	4	0.31
Pl. Physiology	16	12.92	16.46	2	0.13
Pl.Breeding	445	13.41	16.15	111	0.25
Pl.Pathology	13	12.51	15.99	4	0.31
Average	**(554)**	**13.42**	**16.28**	**(137)**	**0.25**

Table 10: Upper fiducial limit of CV % for different treatment of Mustard experiments

Treatment	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.28	
			(0.95)	No.	Proportion
< 5	30	12.95	17.93	9	0.30
5-10	116	12.04	15.59	17	0.15
11-15	120	12.49	15.20	24	0.20
16-20	128	14.63	17.32	41	0.32
21-25	63	13.89	16.17	15	0.24
26-30	46	14.55	16.71	16	0.35
> 30	51	14.36	16.51	15	0.29
Average	**(554)**	**13.42**	**16.28**	**(137)**	**0.25**

Table 11: Upper fiducial limit of CV% for different plot size of Mustard experiments

Plot size (m^2)	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >16.28	
			(0.95)	No.	Proportion
< 3	8	11.38	13.04	1	0.13
3-6	131	14.66	17.38	43	0.33
6-9	153	12.79	15.33	31	0.20
9-12	103	16.15	19.97	38	0.37
12-15	116	10.83	13.53	14	0.12
15-18	33	12.90	15.38	7	0.21
18-24	3	12.55	15.61	1	0.33
24-30	7	11.93	15.62	2	0.29
Average	**(554)**	**13.42**	**16.28**	**(137)**	**0.25**

Table12: The average upper fiducial limit and yardstick of CV% for Mustard experiments

Total no of Experiments	Average CV%	Average upper fiducial limit of CV% (0. 95)
544	**13.42**	**16.28%**
Overall yardstick of CV % at 0.95 confidence is 16.28 = 17 %		

The results reported here in above are within the acceptable range of variability (CV = 17 %) except for Arnej, Bhachau, Dhandhuka and Navagam locations. Soil problems might have influenced the experimental errors.

The findings revealed that the mustard experiments should be conducted using 6-9 sq.m plot with minimum four replications.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yardstick of CV % for accepting the results of mustard crop experiments is 17 per cent for yield character.

2.10 WHEAT

The information of 1037 experiments conducted on Wheat crop at Main Research Station, Vijapur and other research stations of the Gujarat Agricultural University for the period of 1992 to 2003 was utilized to study the variability in the experimental results of Wheat crop.

Table 1 : Design and discipline- wise distribution of CV% of Wheat experiments

Design	Disciplines				
	Agronomy	Ag. Ento.	Pl. Breed.	Pl. Path.	Average
RBD	11.25	10.78	10.57	19.00	**10.61 (859)**
FRBD	10.86	-	-	-	**10.86 (10)**
Lattice	-	-	11.88	-	**11.88 (62)**
SPT	9.82	14.58	-	15.76	**10.21 (106)**
Average	**10.24 (143)**	**11.27 (39)**	**10.66 (851)**	**16.57(4)**	**10.65(1037)**

Table 2 : Design and treatment- wise distribution of CV% of Wheat experiments

Design	Treatments							
	≤5	6-10	11-15	16-20	21-25	26-30	>30	Average
RBD	12.37	10.72	9.97	9.52	11.92	13.84	10.46	**10.61 (859)**
FRBD	-	12.73	10.30	8.25	-	-	-	**10.86 (10)**
Lattice	-	-	-	-	-	16.58	10.38	**11.88 (62)**
SPT	-	8.70	9.35	12.91	10.14	11.62	13.13	**10.21 (106)**
Average	**12.37 (5)**	**10.45 (158)**	**9.90 (330)**	**9.90 (145)**	**11.76 (127)**	**14.25 (73)**	**10.53 (199)**	**10.65 (1037)**

Table 3 : Design and replication- wise distribution of CV% of Wheat experiments

Design	Replications				Average
	2	3	4	6	
RBD	11.31	10.95	10.39	11.18	**10.61 (859)**
FRBD	-	8.54	12.41	-	**10.86 (10)**
Lattice	11.88	-	-	-	**11.88 (62)**
SPT	-	9.58	11.36	8.68	**10.21 (106)**
Average	**11.54 (158)**	**10.38 (200)**	**10.48 (629)**	**11.13 (50)**	**10.65 (1037)**

Table 4: Design and treatment- wise distribution of CV% of Wheat experiments

Design	Treatments							Average
	≤5	6-10	11-15	16-20	21-25	26-30	>30	
RBD	10.32	15.68	8.68	15.88	13.72	11.07	11.68	**10.61 (859)**
FRBD	-	-	11.46	8.48	-	-	-	**10.86 (10)**
Lattice	9.85	16.13	-	-	-	-	-	**11.88 (62)**
SPT	10.92	13.55	9.77	8.33	-	6.50	4.61	**10.21 (106)**
Average	**12.37 (5)**	**10.45 (158)**	**9.90 (330)**	**9.90 (145)**	**11.76 (127)**	**14.25 (73)**	**10.53 (199)**	**10.65 (1037)**

Table 6: Irrigation and design- wise distribution of CV% of Wheat experiments

Irrigation condition	Design				Average
	RBD	FRBD	SPT	Lattice	
Irrigated	9.51	10.67	10.21	9.85	**9.63 (834)**
Un irrigated	15.00	11.33	-	16.13	**14.86 (203)**
Average	**10.61(859)**	**10.86(10)**	**10.21(106)**	**11.88(62)**	**10.65 (1037)**

Table 7: Irrigation and species- wise distribution of CV% of Wheat experiments

Irrigation condition	Species				Average
	T. astivum	T. durum	T. astiv + T. durum	T.dicoccum	
Irrigated	9.72	9.55	8.98	11.99	**9.63 (834)**
Un irrigated	14.40	15.13	14.46	15.23	**14.86 (203)**
Average	**9.97(538)**	**11.90(328)**	**10.25(151)**	**11.65(20)**	**10.65(1037)**

Table 8: Treatment and replication- wise distribution of CV% of Wheat experiments

Treatments	Replications				Average
	2	3	4	6	
up to 5	-	-	13.62	11.54	**12.37 (5)**
6-10	-	10.23	10.49	10.64	**10.45 (158)**
11-15	13.98	9.02	9.92	10.82	**9.90 (330)**
16-20	8.44	10.73	9.75	15.13	**9.90 (145)**
21-25	11.49	10.91	12.35	-	**11.76 (127)**
26-30	15.32	10.00	14.50	-	**14.25 (73)**
>30	10.28	11.06	10.25	-	**10.53 (199)**
Average	**11.54 (158)**	**10.38 (200)**	**10.48 (629)**	**11.13 (50)**	**10.65 (1037)**

Table 9: Plot size and treatment-wise distribution of CV% of Wheat experiments

Plot size (m^2)	Treatments							
	≤ 5	6-10	11-15	16-20	21-25	26-30	>30	Average
3 – 6	13.77	14.78	10.04	8.71	10.25	10.52	10.29	**10.26 (336)**
6 – 9	-	11.64	11.64	18.06	15.69	15.99	14.04	**15.37 (144)**
9 -12	8.24	8.85	9.21	7.82	8.54	9.86	-	**8.87 (420)**
12- 15	19.00	9.67	10.05	9.65	-	-	-	**10.17 (33)**
15- 18	-	13.57	13.49	15.59	-	-	-	**13.72 (73)**
21- 24	-	10.87	-	-	-	-	-	**10.87 (23)**
> 24	7.07	10.82	-	5.55	-	-	-	**9.03 (8)**
Average	**12.37 (5)**	**10.45 (158)**	**9.90 (330)**	**9.90 (145)**	**11.76 (127)**	**14.25 (73)**	**10.53 (199)**	**10.65 (1037)**

Prediction is very difficult, especially about the future.
- Niels Bohr

Table 10: Plot size and replication- wise distribution of CV% of Wheat experiments

Plot size (m^2)	Replications				Average
	2	3	4	6	
3 – 6	9.98	10.72	10.21	13.77	**10.26 (336)**
6 – 9	15.40	13.04	16.02	15.37	**15.37 (144)**
9 -12	12.90	9.57	8.69	8.74	**8.87 (420)**
12- 15	-	8.60	11.83	8.68	**10.17 (33)**
15- 18	-	-	13.42	14.58	**13.72 (73)**
21- 24	-	10.90	10.86	10.87	**10.87 (23)**
> 24	-	5.37	10.89	7.07	**9.03 (8)**
Average	**11.54 (158)**	**10.38 (200)**	**10.48 (629)**	**11.13 (50)**	**10.65 (1037)**

Table 11: Discipline and plot size- wise distribution of CV% of Wheat experiments

Disciplines	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	21-24	>24	
Agronomy	11.51	13.10	10.00	9.29	-	8.60	5.23	**10.24 (143)**
Pl. Breeding	10.23	16.03	8.60	-	13.72	-	-	**10.66 (851)**
Ag. Entomology	-	12.26	8.97	-	-	11.09	12.84	**11.27 (39)**
Pl. Pathology	-	-	-	16.57	-	-	-	**16.57 (4)**
Average	**10.26 (336)**	**15.37 (144)**	**8.87 (420)**	**10.17 (33)**	**13.72 (76)**	**10.87 (20)**	**9.03 (8)**	**10.65 (1037)**

Table 12: Species and plot size- wise distribution of CV% of Wheat experiments

Species	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	21-24	>24	
T astivum				10.60	-	10.59	8.11	**9.97 (538)**
T. durum				8.57	13.42	-	-	**11.90 (328)**
T. astiv + T. durum	9.98	14.38	8.00	-	14.32	11.24	15.50	**10.25 (151)**
T.dicoccum	13.67	14.26	8.60	-	10.36	-	-	**11.65 (20)**
Average	**10.26 (336)**	**15.37 (144)**	**8.87 (420)**	**10.17 (33)**	**13.72 (76)**	**10.87 (20)**	**9.03 (8)**	**10.65 (1037)**

Table 13: Irrigation and plot size-wise distribution of CV% of Wheat experiments

Irrigation	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	21-24	>24	
Irrigated	10.26	13.13	8.77	8.76	10.36	10.87	10.19	**9.63 (834)**
Un Irrigated	-	16.09	12.12	13.92	13.81	-	5.55	**14.86 (203)**
Average	**10.26 (336)**	**15.37 (144)**	**8.87 (420)**	**10.17 (33)**	**13.72 (76)**	**10.87 (20)**	**9.03 (8)**	**10.65(1037)**

Table 14: Location and plot- size wise distribution of CV% of Wheat experiments

Location	Plot size (m^2)							Average
	3-6	6-9	9-12	12-15	15-18	21-24	>24	
Amareli	-	-	8.54	-	-	-	-	**8.54 (16)**
Anand	11.93	-	9.85	-	-	-	-	**10.27 (64)**
Arnej	-	19.93	2.77	-	15.20	-	-	**17.67 (59)**
Bardoli	9.39	-	8.03	-	-	-	-	**8.46 (70)**
Bhachau	-	-	10.91	-	-	-	-	**10.91 (5)**
Dahod	-	-	8.39	-	-	-	-	**8.39 (6)**
Dhandhuka	-	13.83	10.92	13.92	10.99	-	5.55	**12.81 (94)**
Dhari	12.19	-	16.53	-	-	-	-	**15.08 (9)**
Jamnagar	13.33	-	11.91	-	-	-	-	**12.07 (9)**
Junagadh	8.60	11.90	6.98	7.01	11.86	-	7.07	**8.21 (209)**
Ladol	13.96	-	-	-	-	-	-	**13.96 (11)**
Navsari	15.80	-	16.43	-	-	-	-	**16.38 (12)**
Sknagar	11.73	-	6.84	-	-	-	-	**8.71 (86)**
Talod	-	-	10.08	-	-	-	-	**10.01 (5)**
Tanchha	-	16.14	-	-	11.94	-	-	**14.04 (42)**
Valbhipur	-	-	-	-	21.23	-	-	**21.23 (9)**
Vijapur	10.72	13.29	9.18	9.49	8.85	10.78	10.82	**10.23 (317)**
Others	23.80	16.40	-	-	-	-	-	**18.87 (6)**
Average	**10.26 (336)**	**15.37 (144)**	**8.87 (420)**	**10.17 (33)**	**13.72 (73)**	**10.87 (20)**	**9.03 (8)**	**10.65(1037)**

Table 15 : Zones and year-wise distribution of CV% of Wheat experiments

Zone	Year											Avg.
	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	
II	9.48	13.17	9.24	8.59	10.86	16.19	14.97	8.77	11.35	10.05	11.73	**11.19 (126)**
III	12.27	12.70	11.35	14.88	13.76	11.65	5.97	5.22	7.25	8.02	7.22	**10.00 (74)**
IV	10.73	10.85	9.68	8.69	7.90	8.09	9.31	11.25	11.47	10.23	11.39	**10.03 (417)**
V	17.77	13.97	30.83	14.32	12.03	11.82	13.20	14.01	19.92	15.97	13.09	**14.87 (166)**
VI	9.15	7.58	10.36	9.35	8.44	7.76	7.85	7.89	7.21	8.62	10.54	**8.65 (239)**
VII	8.03	-	11.45	13.42	-	7.23	9.29	-	-	14.99	14.67	**12.34 (10)**
VIII	-	-	-	18.40	7.01	5.34	11.10	12.68	-	-	-	**10.91 (5)**
Avg.	**11.87 (85)**	**11.12 (89)**	**11.64 (92)**	**10.37 (90)**	**9.62 (98)**	**9.26 (93)**	**1016 (95)**	**10.12 (97)**	**11.02 (88)**	**10.56 (105)**	**11.33 (105)**	**10.65**

Zone II South Gujarat Medium Rainfall
Zone III Middle Gujarat
Zone IV North Gujarat
Zone V Bhal and costal area
Zone VI South Saurashtra
Zone VII North Saurashtra
Zone VIII North-West Saurashtra

Table 16: Irrigation and Zone- wise distribution of CV% of Wheat experiments

Irrigation condition	Zone							Average
	II	III	IV	V	VI	VII	VIII	
Irrigated	9.76	10.00	10.04	7.68	8.65	12.34	10.91	**9.63 (834)**
Un irrigated	14.04	-	5.23	15.14	-	-	-	**14.86(203)**
Average	**11.19 (126)**	**10.00 (74)**	**10.03 (417)**	**14.87 (166)**	**8.65 (239)**	**12.34 (10)**	**10.91 (5)**	**10.65 (1037)**

Upper fiducial limit and yard stick of CV%

Table 17 : Upper fiducial limit of CV % for different location of Irrigated Wheat experiments

Location	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
Amareli	16	8.54	10.14	03	0.19
Anand	64	10.27	12.14	22	0.34
Bardoli	70	8.46	10.00	18	0.25
Bhachau	05	10.91	13.00	02	0.40
Dahod	06	8.39	10.09	01	0.17
Derol	04	8.09	9.66	00	0.00
Dhari	09	15.08	18.28	05	0.55
Jamnagar	09	12.07	14.77	05	0.55
Junagadh	210	8.21	9.71	22	0.10
Ladol	11	13.96	16.40	07	0.63
Navsari	12	16.38	19.82	08	0.65
Sanosara	04	7.52	8.83	00	0.00
S k Nagar	86	8.71	10.20	16	0.18
Talod	05	10.01	11.87	01	0.20
Vijapur	317	10.23	12.27	110	0.35
Other	06	18.87	24.26	06	1.00
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Other : Danti (1) , Jamkhambhalia (2), Khapat (2) and Vyara (1)

Table 18: Upper fiducial limit of CV % for different design of Irrigated Wheat experiments

Design	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
RBD	686	9.51	11.32	178	0.26
FRBD	07	10.67	13.42	03	0.43
SPT11	99	10.28	12.48	32	0.32
LATTICE	42	9.85	11.33	13	0.30
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Table 19: Upper fiducial limit of CV% for different discipline of Irrigated Wheat experiments

Discipline	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
Agronomy	126	9.98	12.31	38	0.30
Entomology	39	11.27	14.43	17	0.43
Pl. Breeding	665	9.42	11.08	167	0.25
Pl. Pathology	04	16.57	21.07	04	1.00
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Table 20: Upper fiducial limit of CV % for different treatment of Irrigated Wheat experiments

Treatments	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
up to 5	05	12.37	16.75	03	0.60
6-10	128	9.88	12.63	43	0.33
11-15	274	9.04	10.91	58	0.21
16-20	120	8.69	10.22	19	0.16
21-25	90	10.23	11.97	31	0.34
26-30	24	10.68	12.20	07	0.29
> 30	193	10.39	11.82	65	0.34
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Table 21: Upper fiducial limit of CV% for different replication of Irrigated Wheat experiments

Replications	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
2	109	9.89	11.64	34	0.31
3	196	10.30	12.31	69	0.35
4	499	9.34	11.15	117	0.23
6	20	14.28	16.84	05	0.25
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Table 22: Upper fiducial limit of CV% for different plot size of Irrigated wheat experiments

Plot size (m^2)	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >11.47	
			(0.95)	No.	Proportion
3-6	336	10.26	11.87	108	0.32
6-9	35	13.13	15.91	16	0.46
9-12	408	8.77	10.61	86	0.21
12-15	24	8.76	10.87	05	0.21
15-18	02	10.36	12.52	01	0.50
21-24	23	10.87	14.22	07	0.30
≥ 24	06	10.19	13.33	03	0.50
Average	**(834)**	**9.63**	**11.47**	**(226)**	**0.27**

Table 23: The average upper fiducial limit and yardstick for CV % for Wheat experiments

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV %	Overall yardstick of CV%
			0.95	
Wheat (Irrigated)	834	9.63	11.47	**12**
Wheat (Un irrigated)	203	14.86	17.62	**18**

The upper limits of CV % worked out are 12 % and 18 % respectively for irrigated and un irrigated wheat experiments. Under both the situations, the variability in wheat experiments (barring few cases) was within the range of upper limits. Pl. Pathology experiments and experiments having plot size 6-9 sq.m gave high CV. Irrigated wheat experiments conducted at Dhari, Ladol and Navsari centres also showed large variation in yield. Such experiments require more care at the planning stage of experiments and in recording attributes affecting yield.

The concluding finding are

(1) plot size 9-12 sq.m area is proper/optimum for all locations,

(2) three replications are sufficient and

(3) designs used for experimentation are proper and efficient.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yardstick of CV % for accepting the results of irrigated wheat crop experiment is 12 per cent and of un-irrigated wheat crop experiments is 18 per cent for grain yield.

2.11 COTTON

The information of 1786 experiments conducted on Cotton crop at the Main Cotton Research Station, Surat and other Research Stations of the Gujarat Agricultural University during 1990-91 to 1999-2000 were utilized to study the variability in the experimental results of Cotton crop and to decide the upper fiducial limit and yard stick for accepting the results of the experiments conducted on Cotton.

Table 1: Design and discipline- wise distribution of CV % of Cotton experiments

Design	Disciplines						
	Agron.	Entomology	Pl.Breed.	Pathology	Ag. Chem.	Pl. Physio.	Average
RBD	17.34	13.74	16.85	13.80	18.94	22.18	**16.86(1528)**
FRBD2	26.52	20.15	-	9.18	49.90	23.18	**26.97 (86)**
FRBD3	16.62	11.70	-	-	12.33	15.63	**16.12 (49)**
FRBD4	17.71	-			-	-	**17.71 (29)**
Lattice	-	-	13.22	-	-	-	**13.22 (4)**
SPT11	22.28	-	-	14.95	-	25.20	**22.28 (37)**
SPT12	19.18	16.99	-	-	-	-	**19.08 (41)**
Other	15.31	24.72	-	-	-	-	**16.10 (12)**
Average	**19.17 (381)**	**13.98 (118)**	**16.83 (1145)**	**13.30 (23)**	**25.96 (29)**	**21.74 (90)**	**17.49 (1786)**

Table 2: Design and replication- wise distribution of C V % of Cotton experiment

Design	Replications					
	2	**3**	**4**	**5**	**≥ 6**	**Average**
RBD	15.22	17.51	16.29	15.01	16.37	**16.86 (1528)**
FRBD2	29.36	26.24	26.41	38.00	-	**26.97(86)**
FRBD3	14.05	16.02	18.41	-	-	**16.12 (49)**
FRBD4	19.02	17.03	-	-	-	**17.71(29)**
Lattice	-	12.95	13.50	-	-	**13.22 (4)**
SPT11	33.09	18.39	32.51	-	-	**22.28 (37)**
SPT12	18.55	18.97	20.27	-	-	**19.08 (41)**
Other	-	16.78	12.70	-	-	**16.10 (12)**
Average	**16.53 (165)**	**17.75 (999)**	**17.40 (551)**	**22.67 (6)**	**16.37 (65)**	**17.49 (1786)**

Table 3: Treatment and replication- wise distribution of CV % of Cotton experiment

Treatments	Replications					Average
	2	**3**	**4**	**5**	**≥ 6**	
Up to 5	-	17.08	13.56	7.21	13.54	**13.59(52)**
6 - 10	15.87	17.70	17.95	38.40	19.66	**17.68(637)**
11 - 15	13.64	17.43	16.99	38.00	14.01	**17.21(490)**
16 - 20	18.58	18.38	17.62	-	17.96	**18.24(376)**
21 - 25	18.04	17.89	16.38	-	15.50	**17.42(155)**
26 - 30	18.25	17.41	16.65	-	-	**17.43(49)**
> 30	20.30	15.46	18.05	-	-	**16.01(27)**
Average	**16.53(165)**	**17.75(999)**	**17.40(551)**	**22.67(6)**	**16.37(65)**	**17.49(1786)**

Table 4: Plot size and design- wise distribution of CV % of Cotton experiments

Plot Size (m^2)	Design								
	RBD	**FRBD2**	**FRBD3**	**FRBD4**	**Lattice**	**SPT11**	**SPT12**	**Other**	**Average**
< 3	28.06	49.90	-	-	-	-	-	-	**37.06 (17)**
3 – 6	20.76	18.23	-	-	-	26.40	-	-	**20.70 (31)**
6 – 9	17.38	31.66	-	10.40	-	25.12	-	-	**17.78 (153)**
9 – 12	16.55	24.31	11.42	17.92	-	19.16	-	17.10	**16.85 (270)**
12 – 15	17.15	41.12	9.82	-	14.06	31.69	18.45	16.74	**18.21 (411)**
15 – 18	16.50	22.77	19.60	19.97	-	17.80	18.20	9.60	**17.22 (257)**
18 – 24	17.50	16.74	19.66	14.56	10.70	14.05	22.00	-	**17.68 (372)**
24-30	15.90	20.80	11.27	16.30	-	25.02	16.09	-	**16.11 (156)**
>30	14.08	20.76	11.66	-	-	-	-	15.80	**14.30 (119)**
Average	**16.86 (1528)**	**26.97 (86)**	**16.12 (49)**	**17.371 (29)**	**13.22 (4)**	**22.28 (37)**	**19.08 (41)**	**16.1 (12)**	**17.49 (1786)**

Table 5: Plot size and treatment- wise distribution of CV % of Cotton experiments

Plot Size(m^2)	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
< 3	-	25.69	-	45.01	-	-	-	**37.06 (17)**
3 – 6	-	16.49	28.51	18.45	22.06	-	22.10	**20.70 (31)**
6 – 9	16.90	18.20	19.54	13.96	14.45	19.89	21.28	**17.78 (153)**
9 – 12	18.80	16.80	16.19	17.85	15.43	17.47	7.10	**16.85 (270)**
12 – 15	5.20	21.86	16.27	18.13	17.02	17.72	14.92	**18.21 (411)**
15 – 18	15.24	16.93	16.37	18.67	20.59	14.60	11.9	**17.22 (257)**
18 – 24	14.93	18.19	17.94	17.37	17.51	18.43	6.40	**17.68 (372)**
24-30	13.01	15.89	16.10	17.53	20.84	-	-	**16.11 (156)**
>30	10.21	14.83	16.46	13.64	5.20	18.90	-	**14.30 (119)**
Average	**13.59 (52)**	**17.68 (637)**	**17.21 (490)**	**18.24 (376)**	**17.42 (155)**	**17.43 (49)**	**16.10 (27)**	**17.49 (1786)**

Table 6 : Plot size and replication- wise distribution of CV % of Cotton experiments

Plot Size (m^2)	Replications					Average
	2	3	4	5	6	
< 3	-	37.06	-	-	-	**37.06 (17)**
3-6	18.23	21.15	15.92	-	-	**20.70 (31)**
6-9	21.16	16.85	17.58	38.13	18.67	**17.78 (153)**
9-12	16.59	18.29	14.92	-	15.53	**16.85 (270)**
12-15	14.90	17.94	18.99	5.20	20.72	**18.21 (411)**
15-18	18.70	17.41	16.63	-	15.95	**17.22 (257)**
18-24	12.49	17.95	17.88	-	18.43	**17.68 (372)**
24-30	19.69	14.21	18.03	11.25	13.42	**16.11 (156)**
>30	15.39	12.93	16.50	-	9.59	**14.30 (119)**
Average	**16.53 (165)**	**17.75 (999)**	**17.40 (551)**	**22.67 (6)**	**16.37 (65)**	**17.49 (1786)**

Table 7: Variety and plot size- wise distribution of CV % of Cotton experiments

Variety	Plot size (m^2)									Average
	< 3	3-6	6-9	9-12	12-15	15-18	18-24	24-30	>30	
Hirsutam	-	16.47	21.01	14.50	16.28	15.11	16.71	17.50	18.57	**16.15(381)**
Arboreum	-	-	13.65	20.20	18.79	-	16.02	-	-	**16.92 (51)**
Herbaceum	-	16.86	18.53	18.40	20.10	16.88	17.21	20.99	15.97	**17.75(505)**
Barbense	-	-	27.23	-	30.37	33.35	-	-	-	**30.27 (17)**
Hybrid	40.05	16.86	16.97	15.70	19.08	18.12	16.87	14.70	12.97	**17.10(594)**
Multi Species cross	-	25.34	17.84	17.97	16.41	18.08	19.57	8.80	-	**18.29(101)**
Deshi hybrid	23.10	25.92	19.02	22.01	16.52	18.41	22.20	16.68	-	**19.87 (98)**
Deshi Cotton	-	-	22.20	36.55	47.50	13.90	23.10	-	14.10	**27.42 (11)**
Budded & color Cotton	-	-	-	8.72	14.15	-	19.35	-	-	**18.02 (34)**
Average	**37.06 (17)**	**20.70 (31)**	**17.78 (153)**	**16.85 (270)**	**18.21 (411)**	**17.22 (257)**	**17.68 (372)**	**16.11 (156)**	**14.30 (119)**	**17.49 (1786)**

Table 8: Location and plot size- wise distribution of CV % of Cotton experiments

Location	Plot size (m^2)									
	< 3	3-6	6-9	9-12	12-15	15-18	18-24	24-30	>30	Average
Achhalia	-	-	12.48	15.17	15.37	15.10	19.53	33.15	17.77	**16.49 (91)**
Amareli	-	32.00	16.19	22.50	26.96	-	17.20	15.91	13.68	**17.15 (77)**
Anand	-	-	23.54	24.10	27.67	20.89	32.42	-	15.95	**24.20 (34)**
Arnej	-	-	5.90	-	-	11.30	13.07	-	-	**12.36 (20)**
Bhachau	-	-	17.90	32.07	31.40	23.18	30.47	23.54	22.21	**26.86 (35)**
Bharuch	-	12.91	12.07	12.75	11.34	12.06	11.02	11.62	10.97	**11.72 (287)**
Chharodi	-	-	23.84	29.91	39.88	16.99	25.47	19.35	23.49	**24.75 (108)**
Dbaria	-	15.82	25.20	15.82	24.53	16.25	19.94	12.96	-	**17.87 (52)**
Dhandhka	-	16.80	25.77	16.37	19.06	21.17	18.29	-	11.96	**18.75 (77)**
Junagadh	-	24.23	15.16	13.68	14.97	15.66	16.06	17.35	12.75	**15.43 (149)**
Khebhrma	-	-	8.55	-	18.81	9.30	17.69	15.33	15.84	**16.47 (50)**
Navsari	-	-	-	34.80	42.25	34.13	13.72	15.93	-	**33.24 (46)**
Porbander	-	-	22.75	22.85	3.30	24.06	23.30	30.09	-	**23.61 (44)**
Surat	37.1	21.84	20.28	16.37	17.93	16.37	17.21	15.38	15.11	**17.97 (504)**
Talod	-	-	14.65	15.88	15.65	17.22	17.25	14.45	9.32	**15.50 (152)**
Thasra	-	-	-	14.13	-	-	-	-	-	**14.13 (8)**
Viramgam	-	24.10	14.65	21.16	13.30	21.80	13.41	14.57	10.90	**14.81 (33)**
Other	-	-	-	18.16	4.40	11.50	17.00	19.08	11.52	**15.52 (19)**
Average	**37.06 (17)**	**20.70 (31)**	**17.78 (153)**	**16.85 (270)**	**18.21 (411)**	**17.22 (257)**	**17.68 (372)**	**16.11 (156)**	**14.30 (119)**	**17.49 (1786)**

Upper fiducial limit and yard stick of CV%

Table 9: Upper fiducial limit of CV % for different location of Cotton experiments

Location	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >22.27	
			(0.95)	No.	Proportion
Achhalia	91	16.49	21.04	19	0.21
Amareli	77	17.13	21.56	15	0.19
Anand	34	24.20	30.86	18	0.52
Arnej	20	12.36	15.30	2	0.10
Bhachau	35	26.86	35.39	23	0.65
Bharuch	287	11.72	14.78	22	0.08
Chharodi	108	24.75	32.19	55	0.51
Devgadhbaria	52	17.87	22.86	14	0.26
Dhandhuka	77	18.75	24.09	16	0.21
Junagadh	149	15.43	19.33	25	0.16
Khedbrahma	50	16.47	20.71	12	0.24
Navsari	46	33.24	45.39	29	0.63
Porbandar	44	23.61	30.53	19	0.43
Surat	504	17.97	22.66	130	0.26
Talod	152	16.50	19.19	23	0.15
Thasra	8	14.13	18.56	1	0.13
Viramgam	33	14.81	18.91	4	0.12
Other	19	15.52	19.98	2	0.11
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 10: Upper fiducial limit of CV % for different zones of Cotton experiments

Zone	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >22.27	
			(0.95)	No.	Proportion
1	46	33.24	45.39	29	0.63
2	891	15.78	19.92	172	0.19
3	94	19.85	25.39	33	0.35
4	316	18.83	23.90	90	0.28
5	68	21.02	27.39	27	0.39
6	77	17.16	21.56	15	0.19
7	197	17.29	21.87	45	0.23
8	97	17.44	22.28	18	0.18
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Figures in the parentheses indicate the number of experiments.

Zone I South Gujarat heavy rain
Zone II South Gujarat medium rain
Zone III Middle Gujarat
Zone IV North Gujarat
Zone V North-West Saurashtra
Zone VI North Saurashtra
Zone VII South Saurashtra
Zone VIII Bhal and costal area

Table 11: Upper fiducial limit of CV % for different design of Cotton experiments

Design	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >22.27	
			(0.95)	No.	Proportion
RBD	1528	16.86	21.44	345	0.23
FRBD2	86	26.97	35.72	40	0.46
FRBD3	49	16.12	20.50	8	0.16
FRBD4	29	17.71	21.24	10	0.34
SPT11	37	22.28	28.50	13	0.35
SPT12	41	19.08	23.63	11	0.27
Lattice	4	13.22	15.20	0	0.00
Other	12	16.10	19.27	2	0.16
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 12: Upper fiducial limit of CV% for different discipline of Cotton experiments

Discipline	No. of Expt.	Average CV %	Upper fiducial limit	Expt. having CV % >22.27	
			(0.95)	No.	Proportion
Agronomy	381	19.17	25.65	105	0.28
Ag. Chem.	29	25.96	33.18	11	0.37
Entomology	118	13.98	18.61	18	0.15
Physiology	90	21.75	28.69	34	0.38
Pl.Breeding	1145	16.83	20.83	260	0.22
Pl.Pathology	23	13.30	17.53	1	0.04
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 13: Upper fiducial limit of CV % for different treatment of Cotton experiments

Treatment	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV % >22.27	
				No.	Proportion
< 5	52	13.59	18.87	5	0.10
5-10	637	17.68	23.98	155	0.24
11-15	490	17.21	21.50	122	0.25
16-20	376	18.24	22.13	91	0.24
21-25	155	17.42	20.47	37	0.24
26-30	49	17.43	20.23	12	0.24
> 30	27	16.01	18.29	7	0.26
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 14: Upper fiducial limit of CV % for different replication of Cotton experiments

Replication	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV % >22.27	
				No.	Proportion
2	165	16.53	23.02	36	0.22
3	999	17.75	22.36	254	0.25
4	551	17.40	21.98	122	0.22
5	6	22.67	28.80	3	0.50
≥ 6	65	16.37	20.68	14	0.21
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 15: Upper fiducial limit of CV% for different plot size of Cotton experiments

Plot size (m^2)	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV % >22.27	
				No.	Proportion
< 3	17	37.06	48.43	13	0.76
3-6	31	20.70	25.94	13	0.42
6-9	153	17.78	22.12	40	0.26
9-12	270	16.85	21.18	49	0.18
12-15	711	18.21	22.84	109	0.26
15-18	257	17.22	21.76	62	0.24
18-24	372	17.68	22.35	93	0.25
≥ 24	275	15.33	20.86	50	0.18
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 16: Upper fiducial limit of CV % for different varieties of Cotton experiments

Variety	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV% >22.27	
				No.	Proportion
Hirsutam	381	16.15	19.90	81	0.21
Arboreum	51	16.92	20.60	10	0.20
Herbaceum	505	17.75	22.70	126	0.25
Barbadense	17	30.27	38.20	13	0.76
Hybrid	594	17.10	22.10	125	0.21
Multi Species	101	18.29	22.99	27	0.27
Desi Hybrid	107	19.88	25.61	39	0.36
Desi Cotton	11	27.42	37.59	3	0.27
Budded & Color	19	16.57	22.04	5	0.26
Average	**1786**	**17.50**	**22.27**	**429**	**0.24**

Table 17: Upper fiducial limit of CV % for irrigation condition of Cotton experiments

Irrigation	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV% >22.27	
				No.	Proportion
Irrigated	1155	17.85	22.64	284	0.25
Un irrigated	631	16.84	21.85	145	0.23
Average	**(1786)**	**17.50**	**22.27**	**429**	**0.24**

Table 18 : Upper fiducial limit of CV% for different season of Cotton experiments

Season	No. of Expt.	Average CV %	Upper fiducial limit (0.95)	Expt. having CV % >22.27	
				No.	Proportion
Kharif	1756	17.04	21.60	405	0.23
Rabi	30	43.90	61.00	24	0.80
Average	**(1786)**	**17.50**	**22.27**	**(429)**	**0.24**

Table 19: Average upper fiducial limit and yardstick of CV % for Cotton experiments

Average of 1786 experiments	Average CV%	Upper fiducial limit of CV% (0.95)
	17.50	**22.27**
Overall yard stick of CV % 22.27 = (23 %)		

Analysis of 1786 Cotton experiments indicated that the plot size and locations were the prime factors contributing large variation in yield data. Other factors in line were crops, design and disciplines. The experiments conducted in ≤ 3 sq.m plot size showed high CV %. Cotton experiments conducted at Anand, Arnej, Chharodi, Navsari and Porbander centers crossed the upper limit of CV % (23%). These locations need to work on uniformity trials - repeated over years and on different experimental fields to workout optimum plot size, number of replications and to identify the most one or two biometrical characters influencing directly the yield character. Similar exercise is necessary for Barbence and deshi Cotton.

While planning factorial experiments - FRBD2 and SPT 11, due attention is necessary, especially selecting plot size, because all the plot sizes used in laying these two designs (in general) had high CV %. Plot size group 0-3 and 3-6 sq.m.gave larger variation.in the experiments of Ag. Chemistry, Agronomy and Pl. Physiology in FRBD2 and Pl. Physiology and Agronomy in SPT11 showed very high CV %. Rabi season experiments also yielded more than double variation than that of *kharif* experiments.

Based on the results reported here in above, the concluding findings are (1) proper plot size for Cotton experiments is 9-12 sq.m size,(2) four replications are enough and (3) Lattice design (though number of experiments are four only) proved its efficacy over RBD.

Uniformity trial on SRT 1 cotton at Targhadia (Appendix VI) revealed that the optimum plot size for cotton experiments is 10.8 sq.m, which is within the range of 9-12 sq.m. size, as referred above.

RECOMMENDATION FOR SCIENTIFIC COMMUNITY

The yardstick of CV % for accepting the results of *kharif* Cotton crop experiments is 23 per cent for yield character.

2.12 Medicinal and Aromatic plant Crops

The information of 534 experiments conducted on Medicinal and Aromatic crops at Anand during 1989-90 to 2011-12 was utilized to study the variability in the experimental results.

Table 1: Year wise- distribution of CV % of Medicinal and Aromatic plant experiments

Year	No. of experiment	Average CV %
1989-90	02	17.15
1990-91	03	34.15
1991-92	05	21.50
1992-93	08	17.38
1993-94	07	16.47
1994-95	16	23.85
1995-96	28	20.85
1996-97	20	30.78
1997-98	14	25.39
1998-99	07	11.89
1999-00	14	17.19
2000-01	15	18.21
2001-02	48	15.48
2002-03	94	16.86
2003-04	67	16.02
2004-05	36	17.53
2005-06	18	15.87
2006-07	30	15.03
2007-08	43	15.33
2008-09	24	14.22
2009-10	16	13.28
2010-11	10	11.16
2011-12	09	12.11
Total	**534**	

Table 2: Discipline- wise distribution of CV % of Medicinal and Aromatic plant experiments

Discipline	Average CV %
Agronomy	**16.81 (216)**
Plant Breeding	**16.30 (257)**
Plant Pathology	**16.42 (29)**
Plant Physiology	**26.32 (15)**
Entomology	**32.51 (17)**

Table 3: Crop -wise distribution of CV % of Medicinal and Aromatic plant experiments

Name of crop	No. of experiments	Average CV %
Aloe	1	**23.00**
Asalio	1	**05.59**
Ashwagandha	106	**17.14**
Basil	7	**11.10**
Bhumi amali	3	**08.35**
Cress	9	**14.87**
Dodi	21	**13.81**
Glycyrhiza	7	**38.07**
Isabgul	159	**17.06**
Kalmegh	34	**17.22**
Liquorice	19	**37.03**
Madhunashi	3	**07.50**
Periwinkle	10	**14.11**
Safed musali	99	**15.28**
Senna	44	**17.31**
Shankhpushpi	11	**15.20**
Total	**534**	

Table 4: Treatment and replication- wise distribution CV % of Medicinal and Aromatic plant experiments

Treatments	Replications					Average
	2	**3**	**4**	**5**	**6**	
≤ 5	-	15.36 (6)	17.74 (40)	17.65 (3)	17.55 (79)	**17.51 (128)**
6 - 10	-	16.94 (94)	17.21 (116)	20.07 (9)	-	**17.21 (221)**
11 - 15	-	17.12 (88)	16.48 (28)	-	-	**16.97 (116)**
16 - 20	15.91(7)	17.53 (42)	14.81 (7)	-	-	**16.99 (56)**
21 - 25	-	-	-	-	-	**-**
26 - 30	-	23.96 (6)	25.00 (1)	-	-	**24.10 (7)**
> 30	-	18.56 (6)	-	-	-	**18.56 (6)**
Average	**15.91 (7)**	**17.28 (244)**	**17.17 (192)**	**19.47 (12)**	**17.55 (79)**	**17.28 (534)**

Table 5 : Plot size and treatment- wise distribution of CV % of Medicinal and Aromatic plant experiments

Plot Size (m^2)	Treatments							Average
	≤ 5	**6-10**	**11-15**	**16-20**	**21- 25**	**26-30**	**>30**	
< 3	-	18.50(28)	-	-	-	23.96(6)	-	**19.46(34)**
3-6	15.47(51)	14.37(56)	16.92(45)	16.58(17)	-	-	-	**15.60(169)**
6-9	18.55(32)	16.88(72)	14.89(31)	11.74(2)	-	25(1)	-	**16.80(138)**
9-12	15.05(22)	17.60(42)	14.65(23)	17.57(35)	-	-	18.56(6)	**16.67(128)**
12-15	18.12(10)	23.75(11)	20.21(2)	-	-	-	-	**20.99(23)**
15-18	26.66(13)	18.12(10)	24.51(15)	-	-	-	-	**23.56(38)**
18-21	-	-	-	15.47(2)		-	-	**15.47(2)**
>21	-	42.08(2)	-	-	-	-	-	**42.08(2)**
Avg.	**17.51 (128)**	**17.21 (221)**	**16.97 (116)**	**16.99 (56)**	**-**	**24.10 (7)**	**18.56 (6)**	**17.28 (534)**

Table 6: Plot size and replication-wise distribution of CV % of Medicinal and Aromatic plant experiments

Plot Size(m^2)	Replications					Average
	2	3	4	5	6	
< 3	-	19.46(34.0)	-	-	-	**19.46 (34)**
3 – 6	15.91(7)	15.08(75)	16.64(40)	13.85(4)	15.67(43)	**15.60 (169)**
6 – 9	-	14.21(46)	18.32(83)	-	16.04(9)	**16.80 (138)**
9 – 12	-	17.21(72)	16.32(49)	-	13.42(7)	**16.67 (128)**
12 – 15	-	21.83(5)	22.41(3)	22.28(8)	18.33(7)	**20.99 (23)**
15 – 18	-	38.28(8)	14.28(17)	-	26.66(13)	**23.56 (38)**
18 – 2 1	-	15.47(2)	-	-	-	**15.47 (2)**
> 21	-	42.08(2)	-	-	-	**42.08 (2)**
Average	**15.91 (7)**	**17.28 (244)**	**17.17 (192)**	**19.47 (12)**	**17.55 (79)**	**17.28 (534)**

Table 7: Design and replication- wise distribution of CV % of Medicinal and Aromatic plant experiments

Design	Replications					Average
	2	3	4	5	6	
RBD	15.91(7)	17.35(172)	17.38(163)	19.47(12)	17.66(73)	**17.45 (427)**
FRBD	-	16.83(68)	15.66(21)	-	-	**16.55 (89)**
SPT	-	-	16.71(8)	-	16.23(6)	**16.50 (14)**
Others	-	21.95(4)	-	-	-	**21.95(4)**
Average	**15.91 (7)**	**17.28 (244)**	**17.17(192)**	**19.47 (12)**	**17.55(79)**	**17.28 (534)**

Table 8: Design and treatment- wise distribution of CV % of Medicinal and Aromatic plant experiments

Design	Treatments							Average
	Up to 5	6 - 10	11 -15	16 - 20	21 - 25	26- 30	> 30	
RBD	17.57 (122)	17.24 (208)	17.23 (72)	17.50 (13)	-	23.96 (6)	18.56 (6)	**17.45 (427)**
FRBD	-	16.83 (13)	16.43 (41)	16.35 (34)	-	25.00 (1)	-	**16.55 (89)**
SPT	16.23 (6)	-	17.83 (3)	16.04 (5)	-	-	-	**16.50 (14)**
Others	-	-	-	21.95 (4)	-	-	-	**21.95 (4)**
Average	**17.51 (128)**	**17.21 (221)**	**16.97 (116)**	**16.99 (56)**	**-**	**24.10 (7)**	**18.56 (6)**	**17.28 (534)**

Table 9: Design and plot size- wise distribution of CV % of Medicinal and Aromatic plant experiments

Design	Plot size (m^2)								
	< 3	**3 - 6**	**6 - 9**	**9 - 12**	**12 - 15**	**15 -18**	**18-21**	**> 21**	**Average**
RBD	19.46 (34)	15.37 (143)	16.74 (111)	16.74 (76)	20.99 (23)	23.56 (38)	-	42.08 (2)	**17.45 (427)**
FRBD	-	16.69 (20)	17.66 (19)	16.11 (48)	-	-	15.47 (2)	-	**16.55 (89)**
SPT	-	17.61 (6)	15.67 (8)	-	-	-	-	-	**16.50 (14)**
Others	-	-	-	21.95 (4)	-	-	-	-	**21.95 (4)**
Average	**19.46 (34)**	**15.60 (169)**	**16.80 (138)**	**16.67 (128)**	**20.99 (23)**	**23.56 (38)**	**15.47 (2)**	**42.08 (2)**	**17.28 (534)**

Table 10: Discipline and replication- wise distribution of CV % of Medicinal and Aromatic plant experiments

Disciplines	Replications					Average
	2	**3**	**4**	**5**	**6**	
Agronomy	-	16.72(95)	16.44(67)	17.65(3)	17.41(51)	**16.81(216)**
Pl. Breeding	15.91(7)	16.47(141)	15.06(78)	20.07(9)	18.26(22)	**16.30(257)**
Entomology	-	39.40(5)	29.64(12)	-	-	**32.51(17)**
Pathology	-	-	16.47(23)	-	16.23(6)	**16.42(29)**
Physiology	-	36.41(3)	23.79(12)	-	-	**26.32(15)**
Average	**15.91 (7)**	**17.28(244)**	**17.17(192)**	**19.47(12)**	**17.55(79)**	**17.28 (534)**

Table 11: Discipline and plot size- wise distribution of CV % of Medicinal and Aromatic plant experiments

Disciplines	Plot size (m^2)								
	< 3	**3 - 6**	**6 - 9**	**9- 12**	**12 - 15**	**15 -18**	**18-21**	**> 21**	**Average**
Agronomy	17.93 (4)	15.87 (61)	17.77 (44)	15.83 (91)	14.41 (7)	33.79 (7)	15.47 (2)	-	**16.81 (216)**
Pl. Breeding	19.67 (30)	15.53 (106)	12.89 (56)	18.48 (25)	22.23 (15)	15.34 (23)	-	42.08 (2)	**16.30 (257)**
Entomology	-	-	29.64 (15)	-	-	39.40 (5)	-	-	**32.51 (17)**
Pathology	-	11.75 (2)	14.81 (15)	19.22 (12)	-	-	-	-	**16.42 (29)**
Physiology	-	-	21.54 (11)	-	48.61 (1)	36.41 (3)	-	-	**26.32 (15)**
Average	**19.46 (34)**	**15.60 (169)**	**16.80 (138)**	**16.67 (128)**	**20.99 (23)**	**23.56 (38)**	**15.47 (2)**	**42.08 (2)**	**17.28 (534)**

Upper fiducial limit and yard stick of CV% of Medicinal and Aromatic plant experiments

Table 12 : Upper fiducial limit of CV % for different disciplines of Medicinal and Aromatic plants experiments

Discipline	No.of expt.	Average CV %	U L (0.05)	Experiments having CV % > 22.65	
				No.of expt.	Proportion
Agronomy	216	16.81	22.04	45	0.20
Pl.Breeding	257	16.31	21.24	53	0.20
Pl.Physiology	15	26.32	37.55	08	0.53
Pl.Protection	17	32.51	42.07	12	0.70
Pl.Pathology	29	16.43	21.39	02	0.06
Average	**(534)**	**17.28**	**22.65**		

Table 13: Upper fiducial limit of CV % for different design of Medicinal and Aromatic plants experiments

Design	No.of expt.	Average CV %	U L (0.05)	Experiments having CV % > 22.65	
				No.of expt.	Proportion
FRBD	89	16.56	20.40	17	0.19
RBD	427	17.46	23.21	100	0.23
SPT	14	16.51	20.34	02	0.14
Other	04	21.96	26.81	02	0.50
Average	**534**	**17.28**	**22.65**		

Table 14: Upper fiducial limit of CV % for different treatments of Medicinal and Aromatic plants experiments

Treatments	No.of expt.	Average CV %	U L (0.05)	Experiments having CV % > 22.65	
				No.of expt.	Proportion
< 6	128	17.38	24.25	30	0.23
6-10	221	17.22	22.93	52	0.23
11-15	116	16.97	21.13	19	0.16
16-20	56	16.99	20.52	14	0.25
21-25	0	-	-	0	0.00
26-30	07	24.11	27.84	04	0.57
> 30	06	18.57	21.13	02	0.33
Average	**(534)**	**17.28**	**22.65**		

Table 15: Upper fiducial limit of CV % for different plot size of Medicinal and Aromatic plants experiments

Plot size	No.of expt.	Average CV %	U L (0.05)	Experiments having CV % > 22.65	
				No.of expt.	Proportion
<3	34	18.91	24.70	13	0.37
3-6	169	15.61	20.37	26	0.15
6-9	138	16.81	22.13	32	0.23
9-12	128	16.67	21.60	26	0.20
12-15	23	21.00	27.97	8	0.34
15-18	38	23.57	31.15	14	0.36
18-21	02	15.47	18.34	0	00
21-24	0	-	-	0	00
> 24	02	42.08	63.84	02	1.00
Average	**534**	**17.28**	**22.65**		

Table16: Upper fiducial limit of CV % for different replications of Medicinal and Aromatic plants experiments

Replications	No. of expt.	Average CV %	U L	Experiments having CV % > 22.65	
			(0.05)	No.of exp.	Proportion
2	7	15.91	20.38	1	0.14
3	244	17.29	22.40	56	0.22
4	192	17.17	22.61	43	0.22
5	12	19.47	25.71	4	0.33
6	7	15.90	21.64	0	00
8	39	20.01	27.05	12	0.30
11	6	16.23	20.96	0	00
13	27	14.75	19.54	5	0.18
Average	534	17.28	22.65		

Table17: Average upper fiducial limit and yardstick for CV % for Medicinal and Aromatic plants experiments

Name of the crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV %
Medicinal and Aromatic	534	17.28	22.65	23 %

ISABGUL

Table 18: Upper fiducial limit of CV % for different disciplines of Isabgul experiments

Discipline	No. of expt.	Average CV %	U L	Experiments having CV % > 22.39	
			(0.95)	No. of expt.	Proportion
Agronomy	29	19.87	26.03	12	0.41
Pl.Breeding	106	16.30	21.42	27	0.25
Pl. Physiology	03	24.40	33.09	2	0.66
Pl.Protection	02	11.74	13.57	0	00
Pl.Pathology	19	16.44	21.47	1	0.05
Average	**(159)**	**17.06**	**22.39**	**-**	**-**

Table 19: Upper fiducial limit of CV % for different treatments of Isabgul experiments

Treatments	No. of expt.	Average CV %	U L	Experiments having CV % > 22.39	
			(0.95)	No. of expt.	Proportion
Up to 5	28	18.35	25.21	7	0.25
6-10	101	17.45	22.90	31	0.30
11-15	28	14.75	18.37	4	0.14
16-20	1	11.74	13.57	-	-
Average	**(159)**	**17.06**	**22.39**	**-**	**-**

Table 20: Upper fiducial limit of CV % for different plot size of Isabgul experiments

Plot size (m^2)	No. of expt.	Average CV %	U L (0.95)	Experiments having CV % > 22.39	
				No. of expt.	Proportion
< 3	28	18.51	24.92	10	0.35
3-6	22	14.46	19.24	05	0.22
6-9	72	16.58	21.49	17	0.23
9-12	15	18.49	23.97	03	0.20
12-15	15	22.23	29.38	07	0.46
15-18	7	10.29	13.08	00	00
Average	**(159)**	**17.06**	**22.39**	-	-

Table 21: Upper fiducial limit of CV % for different replications of Isabgul experiments

Replications	No. of expt.	Average CV %	U L (0.95)	Experiments having CV % > 22.39	
				No. of expt.	Proportion
3	77	15.49	20.34	16	0.20
4	63	18.28	23.90	21	0.33
5	05	25.06	32.74	03	0.60
6	05	16.40	22.46	00	00
8	03	21.35	28.88	02	0.66
10	06	16.23	20.96	00	00
Average	**(159)**	**17.06**	**22.39**	-	-

Table 22: The average upper fiducial limit and yardstick for CV % for the experiments of Isabgul experiments

Name of Crop	No.of experiments	Mean CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Isabgul	**159**	**17.06**	**22.39**	**23 %**

SAFED MUSALI

Table 23: Upper fiducial limit of CV % for different disciplines of Safed musali experiments

Discipline	No. of experiments	Average CV %	U L (0.95)	Experiments having CV % > 20.61	
				No. of exp.	Proportion
Agronomy	76	14.54	19.78	15	0.19
Pl. Breeding	23	17.72	23.36	11	0.47
Average	**(99)**	**15.28**	**20.61**	-	-

Table 24: Upper fiducial limit of CV % for different design Safed musali experiments

Design	No. of experiment	Average CV %	U L (0.95)	Experiments having CV % > 20.61	
				No. of exp.	Proportion
FRBD	20	13.32	16.71	01	0.05
RBD	75	15.45	21.32	22	0.29
Other	4	21.96	26.81	03	0.75
Average	**(99)**	**15.28**	**20.61**	-	-

Table 25: Upper fiducial limit of CV % for different treatments of Safed musali experiments

Treatments	No. of experiment	Average CV %	U L	Experiments having CV % > 20.61	
			(0.95)	No. of exp.	Proportion
Up to 5	62	15.02	21.21	16	0.25
6-10	-	-	-	-	-
11-15	20	13.32	16.71	1	0.05
16-20	17	18.55	23.02	9	0.52
Average	**(99)**	**15.28**	**20.61**	-	-

Table 26: Upper fiducial limit of CV % for different plot size of Safed musali experiments

Plot size (m^2)	No. of experiment	Average CV %	U L	Experiments having CV % > 20.61	
			(0.95)	No. of exp.	Proportion
< 3	00	-	-	-	-
3-6	68	15.06	19.92	14	0.20
6-9	00	-	-	-	-
9-12	31	15.77	22.13	09	0.29
Average	**(99)**	**15.28**	**20.61**	-	-

Table 27 : Upper fiducial limit of CV % for different replications of Safed musali experiments

Replications	No. of experiment	Average CV %	U L	Experiments having CV % > 20.61	
			(0.95)	No. of exp.	Proportion
2	07	15.91	20.38	02	0.28
3	36	15.62	20.25	10	0.27
4	14	15.48	24.44	03	0.21
8	15	14.93	19.97	02	0.13
13	27	14.75	19.54	09	0.33
Average	**(99)**	**15.28**	**20.61**	-	-

Table 28: The average upper fiducial limit and yardstick for CV % for Safed musali experiments

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Safed musali	**99**	**15.28**	**20.61**	**21 %**

ASHWAGANDHA

Table 29: Upper fiducial limit of CV % for different disciplines of Ashwagandha experiments

Discipline	No. of experiment	Average CV %	U L	Experiments having CV % > 21.78	
			(0.95)	No. of exp.	Proportion
Agronomy	50	18.95	24.07	15	0.30
Pl.Breeding	54	15.42	19.63	07	0.12
Pl.Protection	02	18.82	22.58	01	0.50
Average	**(106)**	**17.14**	**21.78**	-	-

Table 30: Upper fiducial limit of CV % for different design Ashwagandha experiments

Design	No. of experiment	Average CV %	U L	Experiments having CV % > 21.78	
			(0.95)	No. of exp.	Proportion
FRBD	29	19.61	23.73	11	0.37
RBD	77	16.22	21.05	12	0.15
Average	**(106)**	**17.14**	**21.78**	-	-

Table 31: Upper fiducial limit of CV % for different treatments of Ashwagandha experiments

Treatments	No. of experiment	Average CV %	U L	Experiments having CV % > 21.78	
			(0.95)	No. of exp.	Proportion
Upto 5	02	11.65	16.02	0	00
6-10	49	15.10	20.63	4	0.08
11-15	19	19.46	24.37	6	0.31
16-20	23	17.59	20.93	7	0.30
21-25	-	--	--	-	-
26-30	07	24.11	27.84	4	0.57
>30	06	18.57	21.13	2	0.33
Average	**(106)**	**17.14**	**21.78**	-	-

Table 32: Upper fiducial limit of CV % for different plot size of Ashwagandha experiments

Plot size (m^2)	No. of experiment	Average CV %	U L	Experiments having CV % > 21.78	
			(0.95)	No. of exp.	Proportion
<3	06	23.96	27.76	03	0.50
3-6	30	16.34	21.58	04	0.13
6-9	19	14.77	19.34	03	0.15
9-12	51	17.71	22.11	13	0.25
Average	**(106)**	**17.14**	**21.78**	-	-

Table 33:Upper fiducial limit of CV % for different replications of Ashwagandha experiments

Replication	No. of experiment	Average CV %	U L	Experiments having CV % > 21.78	
			(0.95)	No. of exp.	Proportion
3	72	18.59	23.50	20	0.27
4	30	14.12	18.18	03	0.10
5	04	13.85	17.81	-	-
Average	**(106)**	**17.14**	**21.78**	-	-

Table 34: The average upper fiducial limit and yardstick for CV % for Ashwagandha experiments

Name of Crop	No. of expt.	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Ashwagandha	**106**	**17.14**	**21.78**	**22 %**

The analysis of 534 experiments revealed that the maximum deviation in average CV % was observed due to crops followed by disciplines, plot size, treatments and design. Experiments on Glycyrhiza and Liquorice crops gave more than 37 % CV suggesting that proper plot techniques are yet to be evolved for these two crops. Plant Physiology and Entomology experiments require care in selecting field layout including plot size.

RBD coupled with plot size > 12 sq.m had high CV. Similarly treatments group 26-30 showed high CV for which proper design is need (not RBD or FRBD)

The concluding findings are

(1) Proper plot size for experimentation is 3-6 sq.m. size and

(2) Four replications are sufficient for medicinal and aromatic plants experiments.

It appears to be a quite general principle that, whenever there is a randomized way of doing something, then there is a nonrandomized way that delivers better performance but requires more thought.

- Edwin Thompson Jaynes

2.13 Crops of Bhal and Coastal Zone (Wheat, Cotton, Gram and Safflower)

The information of 511 experiments conducted at Arnej and 606 experiments conducted at Dhandhuka (Bhal and Costal Zone) research stations of the Gujarat Agricultural University for the period of 1989 to 2015 was utilized to study the variability in the experimental results of the experiments conducted on different crops of the Bhal and Coastal Zone of Gujarat State.

Table 1: Year-wise distribution of CV % of the experiments conducted at Arnej and Dhandhuka.

Year	Location			
	Arnej		Dhandhuka	
	No. of Expt.	Average CV %	No. of Expt.	Average CV %
1989-90	17	29.80	13	16.98
1990-91	24	17.21	17	18.14
1991-92	26	31.43	23	19.53
1992-93	28	18.01	26	19.43
1993-94	25	16.52	13	20.28
1994-95	34	17.49	24	13.98
1995-96	9	15.80	22	14.78
1996-97	11	15.87	25	13.25
1997-98	13	15.95	21	14.10
1998-99	16	11.15	15	18.14
1999-00	14	14.39	25	14.65
2000-01	8	11.70	22	13.63
2001-02	8	14.11	16	18.97
2002-03	6	14.37	21	14.88
2003-04	37	13.63	24	12.28
2004-05	31	9.01	35	11.92
2005-06	30	10.74	30	12.49
2006-07	31	11.45	34	12.28
2007-08	34	14.67	19	11.92
2008-09	23	13.33	38	10.22
2009-10	25	13.97	19	13.38
2010-11	9	13.05	29	7.21
2011-12	18	14.54	20	8.55
2012-13	21	12.06	30	10.54
2013-14	13	11.31	32	10.38
2014-15	-	-	13	14.59
Total	**511**		**606**	

Table 2: Crop and location- wise distribution of CV % of the experiments

Crop	Location		Average
	Arnej	Dhandhuka	
Dill seed	12.30 (12)	13.09 (2)	12.41 (14)
Paddy	8.90 (2)	-	8.90 (2)
Sun flower	30.90 (1)	12.04 (3)	16.75 (4)
Castor	12.59 (7)	-	12.59 (7)
Cotton	15.17 (59)	16.53 (165)	16.17 (224)
Cumin	13.16 (12)	-	13.16 (12)
Gram	14.52 (131)	14.31 (57)	14.46 (188)
Mustard	16.14 (17)	17.10 (19)	16.65 (36)
Pigeonpea	18.52 (9)	-	18.52 (9)
Safflower	19.71 (61)	17.82 (55)	18.81 (116)
Sesame	15.43 (8)	12.86 (29)	13.42 (37)
Sorghum	14.52 (48)	10.85 (39)	12.88 (87)
Spices	13.11 (2)	-	13.11 (2)
Vegetable	32.16 (5)	-	32.16(5)
Wheat	14.11 (137	10.34 (237)	11.72 (374)
Average	**15.32 ((511))**	**13.46 ((606))**	**14.31 (1117)**

Table 3: Location and discipline- wise distribution of CV % of the experiments

Location	Discipline				Average
	Agronomy	Entomology	Pl. Breeding	Soil Science	
Arnej	14.76 (141)	16.77 (70)	15.35 (263)	14.44 (37)	**15.32 (511)**
Dhandhuka	16.92 (29)	-	13.28 (574)	15.17 (3)	**13.46 (606)**
Average	**15.13 (170)**	**16.77 (70)**	**13.93 (837)**	**14.50 (40)**	**-**

Location : Arnej

Table 4: Treatment and replication- wise distribution of CV % of the experiments

Treatments	Replications					Average
	2	3	4	5	6	
≤ 5	-	-	19.08(19)	36.46(10)	10.49(14)	**20.46(43)**
6 - 10	-	9.94(34)	14.58(96)	-	11.72(5)	**13.30(135)**
11 - 15	15.48(3)	16.95(38)	15.61(103)	-	7.70(1)	**15.91(145)**
16 - 20	11.85(14)	16.49	14.34(45)	-	-	**14.65(88)**
21 - 25	14.12(14)	18.54(29)	11.89(8)	-	-	**15.25(35)**
26 - 30	15.60(22)	13.72(13)	22.56(7)	-	-	**15.71(52)**
> 30	27.73(2)	13.52(11)	-	-	-	**15.71(13)**
Average	**14.70(55)**	**14.63(148)**	**15.35(278)**	**36.46(10)**	**10.94(20)**	**15.32(511)**

Table 5: Design and replication- wise distribution of CV % of the experiments

Design	Replications					Average
	2	3	4	5	6	
RBD	14.70(55)	14.98(132)	15.77(181)	36.46(10)	11.67(10)	**15.78(388)**
FRBD	-	12.49(12)	16.83(31)	-	-	**15.62(43)**
CRD	-	-	5.41(1)	-	10.50(9)	**9.99(10)**
SPT	-	9.39(4)	13.64(65)	-	7.70(1)	**13.31(70)**
Average	**14.70(55)**	**14.63(148)**	**15.35(278)**	**36.46(10)**	**10.94(20)**	**15.32 (511)**

Table 6: Plot size and treatment- wise distribution of CV % of the experiments

Plot Size (m^2)	Treatments							Average
	≤ 5	6 - 10	11-15	16 - 20	21 –25	26 -30	>30	
< 3	-	10.98 (1)	-	-	-	-	23.63 (1)	**17.30 (2)**
3 – 6	9.16 (5)	8.03 (22)	13.57 (7)	16.37 (7)	12.80 (6)	15.10 (10)	15.05 (12)	**12.18 (69)**
6 – 9	18.02 (6)	14.61 (18)	17.10 (47)	16.29 (29)	17.11 (22)	15.55 (36)	-	**16.35 (158)**
9 – 12	21.14 (8)	16.25 (40)	15.70 (32)	12.89 (25)	11.50 (7)	18.72 (5)	-	**15.54 (117)**
12 – 15	13.81 (2)	13.55 (36)	13.16 (24)	13.52 (13)	-	12.19 (1)	-	**13.41 (76)**
15 – 18	32.73 (12)	12.20 (8)	16.37 (24)	13.45 (10)	-	-	-	**18.85 (54)**
18 – 2 1	15.00 (1)	12.94 (4)	17.76 (10)	11.23 (3)	-	-	-	**15.44 (18)**
21 – 31	13.91 (6)	12.81 (3)	19.09 (1)	36.00 (1)	-	-	-	**16.09 (11)**
>31	12.62 (3)	6.70 (3)	-	-	-	-	-	**9.66 (6)**
Average	**20.46 (43)**	**13.30 (135)**	**15.91 (145)**	**14.65 (88)**	**15.25 (35)**	**15.71 (52)**	**15.71 (13)**	**15.32 (511)**

Table 7: Plot size and replication- wise distribution of CV % of the experiments

Plot Size(m^2)	Replications					Average
	2	3	4	5	6	
< 3	23.63 (1)	10.98 (1)	-	-	-	**17.30 (2)**
3 – 6	21.47 (4)	11.74 (55)	13.87 (1)	-	10.50 (9)	**12.18 (69)**
6 – 9	13.66 (42)	18.40 (40)	16.92 (75)	-	4.63 (1)	**16.35 (158)**
9 – 12	15.65 (8)	14.79 (29)	15.38 (75)	30.45 (3)	9.37 (2)	**15.54 (117)**
12 – 15	-	15.16 (14)	13.09 (60)	13.96 (1)	7.70 (1)	**13.41 (76)**
15 – 18	-	14.62 (9)	16.09 (40)	58.24 (4)	9.84 (1)	**18.85 (54)**
18 – 2 1	-	-	15.44 (18)	-	-	**15.44 (18)**
21 – 31	-	-	18.70 (5)	-	13.91 (6)	**16.09 (11)**
>31	-	-	7.90 (4)	13.18 (2)	-	**9.66 (6)**
Average	**14.70 (55)**	**14.63 (148)**	**15.35 (278)**	**36.46 (10)**	**10.94 (20)**	**15.32 (511)**

Table 8: Design and treatment- wise distribution of CV % of the experiments

Design	Treatments							Average
	Up to 5	6 - 10	11 -15	16 - 20	21 - 25	26 – 30	>30	
RBD	21.95 (38)	13.45 (113)	15.96 (96)	15.73 (50)	16.11 (29)	15.89 (49)	15.71 (13)	**15.78 (388)**
FRBD	-	13.35 (7)	17.56 (21)	13.96 (15)	-	-	-	**15.62 (43)**
CRD	9.16 (5)	10.83 (5)	-	-	-	-	-	**9.99 (10)**
SPT	-	12.82 (10)	14.49 (28)	12.74 (23)	11.11 (6)	12.75 (3)	-	**13.31 (70)**
Average	**20.46 (43)**	**13.30 (135)**	**15.91 (145)**	**14.65 (88)**	**15.25 (35)**	**15.71 (52)**	**15.71 (13)**	**15.32 (511)**

Table 9: Design and plot size- wise distribution of CV % of the experiments

Design	Plot size (m²)									Avg.
	<3	3 - 6	6 - 9	9 - 12	12 - 15	15 -18	18-21	21-31	>31	
RBD	17.30 (2)	12.43 (60)	16.75 (131)	15.96 (78)	13.75 (49)	19.73 (48)	16.27 (6)	13.25 (11)	13.25 (3)	**15.78 (388)**
FRBD	-	-	17.73 (14)	15.11 (16)	12.92 (9)	22.60 (1)	14.26 (3)	-	-	**15.62 (43)**
CRD	-	10.50 (9)	-	-	-	-	-	-	5.41 (1)	**9.99 (10)**
SPT	-	-	10.86 (13)	14.40 (23)	12.74 (18)	9.69 (5)	15.29 (9)	-	22.00 (2)	**13.31 (70)**
Average	**17.30 (2)**	**12.18 (69)**	**16.35 (158)**	**15.54 (117)**	**13.41 (76)**	**18.85 (54)**	**15.44 (18)**	**13.25 (11)**	**14.86 (6)**	**15.32 (511)**

Table10: Discipline and replication- wise distribution of CV % of experiments

Disciplines	Replications					Average
	2	3	4	5	6	
Agronomy	13.90 (2)	12.82 (17)	15.31 (111)	13.18 (2)	12.21 (9)	**14.76 (141)**
Entomology	-	9.19 (32)	21.29 (21)	42.28 (8)	10.50 (9)	**16.77 (70)**
Pl. Breeding	14.73 (53)	17.00 (94)	14.41 (114)	-	7.23 (2)	**15.35 (263)**
Soil Science	-	11.12 (5)	14.96 (32)	-	-	**14.44 (37)**
Average	**14.70 (55)**	**14.63 (148)**	**15.35(278)**	**36.46 (10)**	**10.94(20)**	**15.32 (511)**

Table 11: Discipline and plot size- wise distribution of CV % of the experiments

Plot size (m^2)	Disciplines				Average
	Entomology	Agronomy	PBG	Soil Sci.	
< 3	10.98 (1)	-	23.63 (1)	-	**17.30(2)**
3-6	9.00 (32)	-	14.93 (37)	-	**12.18(69)**
6-9	13.56 (7)	15.56 (32)	17.11 (110)	12.03 (9)	**16.35 (158)**
9-12	24.23 (13)	15.05(39)	13.37 (39)	15.17(26)	**15.54(117)**
12-15	15.91 (6)	14.51 (35)	11.88 (35)	-	**13.41 (76)**
15-18	36.44 (10)	11.95 (5)	15.19(37)	18.85 (2)	**18.85(54)**
18-21	-	14.59 (15)	19.73 (3)	-	**15.44 (18)**
21-31	-	15.79 (10)	19.09 (1)	-	**13.25 (11)**
>31	5.41(1)	10.51(5)	-	-	**14.86 (6)**
Average	**16.77 (70)**	**14.76(141)**	**15.35(263)**	**14.44(37)**	**15.32(511)**

Upper fiducial limit and yard stick of CV% (Arnej)

Table 12: Upper fiducial limit of CV % for different disciplines of the experiments

Discipline	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 19.22	
				No. of expt.	Proportion
Agronomy	141	14.76	18.50	28	0.19
Entomology	70	16.77	23.85	16	0.22
Pl.Breeding	263	15.35	18.59	62	0.23
Soil Science	37	14.44	17.63	7	0.18
Average	**(511)**	**15.32**	**19.22**		

Table 13: Upper fiducial limit of CV % for different design of the experiments

Design	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 19.22	
				No. of expt.	Proportion
CRD	10	10.00	12.91	0	00.0
FRBD	43	15.62	18.99	10	0.23
RBD	388	15.78	20.01	93	0.23
SPT	70	13.31	15.87	10	0.14
Average	**(511)**	**15.32**	**19.22**		

Table 14: Upper fiducial limit of CV % for different treatments of the experiments

Treatments	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 19.22	
				No. of expt.	Proportion
< 6	43	20.46	30.47	12	0.27
6-10	135	13.31	17.24	22	0.16
11-15	145	15.91	19.42	42	0.28
16-20	88	14.65	17.50	19	0.21
21-25	35	15.25	18.12	8	0.22
26-30	52	15.71	18.42	8	0.15
>30	13	15.71	18.01	2	0.15
Average	**(511)**	**15.32**	**19.22**		

Table 15: Upper fiducial limit of CV % for different plot size of the experiments

Plot size (m^2)	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 19.22	
				No. of expt.	Proportion
<3	2	17.30	20.89	1	0.50
3-6	69	12.18	14.72	4	0.05
6-9	158	16.36	19.96	49	0.31
9-12	117	15.54	19.69	24	0.20
12-15	76	13.41	16.70	13	0.17
15-18	54	18.50	25.85	18	0.33
18-21	18	15.45	18.76	3	0.16
21-24	0	-	-	-	0.00
24-31	11	16.09	20.57	1	0.09
>31	6	9.66	12.79	-	-
Average	**(511)**	**15.32**	**19.22**		

Table 16: Upper fiducial limit of CV % for different replications of the experiments

Replication	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 19.22	
				No. of expt.	Proportion
2	55	14.71	17.92	10	0.18
3	148	14.64	17.87	29	0.19
4	278	15.36	19.08	69	0.24
5	10	36.46	60.03	5	0.50
6	20	10.95	14.25	0	0.0
Average	**(511)**	**15.32**	**19.22**		

Table 17: The average upper fiducial limit and yardstick for CV % for the experiments of Arnej center crops

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV %
Arnej Center crops	**511**	**15.32**	**19.22**	**20**

Location: Dhandhuka

Table 18: Treatment and replication- wise distribution of CV % of the experiments

Treatments	Replications					Average
	2	**3**	**4**	**5**	**6**	
≤ 5	-	15.48 (1)	20.11 (4)	10.45 (1)	23.87 (2)	**19.26 (8)**
6 - 10	14.57 (16)	13.20 (80)	13.22 (67)	8.50 (1)	-	**13.31 (164)**
11 - 15	16.66 (14)	15.44 (72)	12.53 (81)	-	8.26 (2)	**14.06 (169)**
16 - 20	8.03 (37)	16.94 (370	14.72 (37)	-	-	**13.23 (111)**
21 - 25	10.37 (44)	15.59 (22)	13.75 (11)	-	-	**12.35 (77)**
26 - 30	12.26 (34)	13.51 (25)	13.74 (13)	-	-	**12.96 (72)**
> 30	18.93 (4)	-	16.30 (1)	--	-	**18.41 (5)**
Average	**11.49 (149)**	**14.73 (237)**	**13.42 (214)**	**9.47 (2)**	**16.06 (4)**	**13.46 (606)**

Table 19: Design and replication- wise distribution of CV % of the experiments

Design	Replications					Average
	2	**3**	**4**	**5**	**6**	
RBD	11.49(149)	14.69(235)	13.38(211)	9.47(2)	16.06(4)	**13.43(601)**
FRBD	-	18.97(2)	20.24(2)	-	-	**19.60(4)**
SPT	-	-	7.88(1)	-	-	**7.88(1)**
Average	**11.49 (149)**	**14.73 (237)**	**13.42 (214)**	**9.47 (2)**	**16.06 (4)**	**13.46 (606)**

Table 20: Plot size and treatment- wise distribution of CV % of the experiments

Plot Size(m^2)	Treatments							Average
	≤ 5	6-10	11-15	16-20	21-25	26 -30	>30	
< 3	-	-	-	-	-	9.21(2)	-	**9.21(2)**
3 – 6	-	20.15(4)	16.40(9)	21.49(3)	23.45(1)	26.32(2)	33.16(1)	**20.10(20)**
6 – 9	15.0(2)	11.20(14)	13.38(30)	10.22(63)	11.70(63)	12.32(63)	14.72(4)	**11.74(239)**
9 – 12	19.65(1)	12.78(55)	15.34(23)	16.13(17)	11.61(6)	12.17(4)	-	**13.85(106)**
12 – 15	-	12.11(21)	14.90(28)	16.71(5)	17.38(5)	36.94(1)	-	**14.65(60)**
15 – 18	26.30(1)	13.62(20)	11.42(40)	7.77(5)	-	-	-	**12.04(66)**
18 – 21	22.57(3)	14.00(48)	15.61(38)	20.18(18)	16.62(2)	-	-	**15.86(109)**
21 – 31	10.45(1)	33.40(1)	7.29(1)	-	-	-	-	**17.04 (3)**
>31	-	10.90(1)	-	-	-	-	-	**10.9 (1)**
Average	**19.26 (8)**	**13.31 (164)**	**14.06 (169)**	**13.23 (111)**	**12.35 (77)**	**12.96 (72)**	**18.41 (5)**	**13.46 ((606))**

Table 21: Plot size and replication- wise distribution of CV % of the experiments

Plot Size(m^2)	Replications					Average
	2	3	4	5	6	
< 3	-	9.21(2)	-	-	-	9.21(2)
3 – 6	20.16(14)	19.11(5)	24.13(1)	-	-	20.10(20)
6 – 9	9.90(114)	14.08(55)	13.02(68)	-	8.26(2)	11.74(239)
9 – 12	12.41(7)	13.50(73)	15.22(26)	-	-	13.85(106)
12 – 15	18.13(4)	15.73(23)	13.47(33)	-	-	14.65(60)
15 – 18	-	17.66(11)	10.91(55)	-	-	12.04(66)
18 – 2 1	14.17(10)	15.46(66)	17.04(30)	8.5(1)	23.87(2)	15.86(109)
21 – 31	-	20.34(2)	-	10.45(1)	-	17.04(3)
>31	-	-	10.90(1)	-	-	10.90(1)
Average	**11.49(149)**	**14.73(237)**	**13.42(214)**	**9.47(2)**	**16.06(4)**	**13.46((606))**

Table 22: Design and treatment- wise distribution of CV % of the experiments

Design	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26-30	>30	
RBD	19.26 (8)	13.26 (161)	14.06 (169)	13.12 (109)	12.35 (77)	12.96 (72)	18.41 (5)	**13.43 (601)**
FRBD	-	20.24 (2)	-	18.97 (2)	-	-	-	**19.60 (4)**
SPT	-	7.88 (1)	-	-	-	-	-	**7.88 (1)**
Average	**19.26 (8)**	**13.31 (164)**	**14.06 (169)**	**13.23 (111)**	**12.35 (77)**	**12.96 (72)**	**18.41 (5)**	**13.46 ((606))**

Table 23: Design and plot size- wise distribution of CV % of the experiments

Design	Plot size (m^2)									Average
	< 3	3- 6	6 - 9	9-12	12-15	15-18	18-21	21-31	>31	
RBD	9.21 (2)	20.1 (20)	11.74 (239)	13.64 (103)	14.64 (59)	12.10 (65)	15.86 (109)	15.51 (3)	10.9 (1)	**13.43 (601)**
FRBD	-	-	-	21.10 (3)	15.12 (1)	-	-	-	-	**19.60 (4)**
SPT	-	-	-	-	-	7.88(1)	-	-	-	**7.88(1)**
Average	**9.21 (2)**	**20.1 (20)**	**11.74 (239)**	**13.85 (106)**	**14.65 (60)**	**12.04 (66)**	**15.86 (109)**	**17.04 (3)**	**10.9 (1)**	**13.46 ((606))**

Table 24: Discipline and replication- wise distribution of CV % of the experiments

Disciplines	Replications					Average
	2	3	4	5	6	
Agronomy	17.74(5)	18.19(10)	14.37(12)	-	23.87(2)	**16.92(29)**
PBG	11.28(144)	14.58(227)	13.34(199)	9.47(2)	8.26(2)	**13.28(574)**
Soil Science	-	-	15.17(3)	-	-	**15.17(3)**

Table 25: Plot size and disciplines- wise distribution of CV % of the experiments

Plot size (m^2)	Disciplines			Average
	Agronomy	Plant Breeding	Soil Science	
< 3	-	9.21 (2)	-	**9.21 (2)**
3-6	-	20.10 (20)	-	**20.10 (20)**
6-9	-	11.74 (239)	-	**11.74 (239)**
9-12	17.90 (6)	13.56 (97)	15.17 (3)	**13.85 (106)**
12-15	12.33 (8)	15.00 (52)	-	**14.65 (60)**
15-18	7.88 (1)	12.10 (65)	-	**12.04 (66)**
18-21	19.38 (12)	15.43 (97)	-	**15.86 (109)**
21-31	33.40 (1)	8.87 (2)	-	**17.04 (3)**
>31	10.90 (1)	-	-	**10.90 (1)**
Average	**16.92 (29)**	**13.28 (574)**	**15.17 (3)**	**13.46((606))**

Upper fiducial limit and yard stick of CV% (Dhandhuka Centre)

Table 26 : Upper fiducial limit of CV % for different disciplines of experiments

Discipline	No. of expt.	Average CV %	U L	Expt. having CV % > 13.57	
			(0.95)	No. of expt.	Proportion
Agronomy	29	16.93	16.93	20	0.68
Pl.Breeding	574	13.28	13.39	231	0.40
Soil Science	3	15.17	15.17	2	0.66
Average	**(606)**	**13.47**	**13.57**		

Table 27: Upper fiducial limit of CV % for different design of the experiments

Design	No. of expt.	Average CV %	U L	Expt. having CV % > 13.57	
			(0.95)	No. of expt.	Proportion
FRBD	4	19.61	19.61	4	1.00
RBD	601	13.44	13.54	249	0.41
Split plot	1	7.88	7.88	0	0.00
Average	**(606)**	**13.47**	**13.57**		

Table 28: Upper fiducial limit of CV % for different treatments of the experiments

Treatments	No. of expt.	Average CV %	U L	Expt. having CV % > 13.57	
			(0.95)	No. of expt.	Proportion
< 6	8	19.27	19.26	7	0.87
6-10	164	13.32	13.44	72	0.43
11-15	169	14.07	14.20	80	0.47
16-20	111	13.23	13.28	47	0.42
21-25	77	12.35	12.46	24	0.31
26-30	72	12.96	13.05	20	0.27
>30	5	18.41	18.41	3	0.60
Average	**(606)**	**13.47**	**13.57**		

Table 29: Upper fiducial limit of CV % for different plot size of the experiments

Plot size (m^2)	No.of expt.	Average CV %	U L (0.95)	Expt. having CV % > 13.57	
				No. of expt.	Proportion
< 3	2	9.21	9.21	-	-
3-6	20	20.10	20.10	15	0.75
6-9	239	11.74	11.94	66	0.27
9-12	106	13.85	13.85	55	0.51
12-15	60	14.65	14.65	27	0.15
15-18	66	12.04	12.27	24	0.36
18-21	109	15.87	15.87	65	0.59
21-24	0	-	-	-	-
24-31	3	17.05	17.04	1	0.33
>31	1	10.90	10.90	-	-
Average	**(606)**	**13.47**	**13.57**		

Table 30: Upper fiducial limit of CV % for different replications of the experiments

Replication	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 13.57	
				No. of expt.	Proportion
2	149	11.50	11.50	38	0.25
3	237	14.73	14.91	120	0.50
4	214	13.42	13.52	93	0.43
5	2	9.47	9.47	0	0.00
6	4	16.07	16.06	2	0.50
Average	**(606)**	**13.47**	**13.57**		

Table 31: The average upper fiducial limit and yardstick for CV % for the experiments of Dhandhuka centre crops.

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Dhandhuka center crops	**606**	**13.47**	**13.57**	**14**

Bhal and Coastal zone crops experiments

Table 32: Treatment and replication- wise distribution of CV % of the experiments

Treatments	Replications					Average
	2	3	4	5	6	
≤ 5	-	15.48(1)	19.26(23)	34.09(11)	12.52(16)	**20.27(51)**
6 - 10	14.57(16)	12.22(114)	14.02(163)	8.50(1)	11.72(5)	**13.31(299)**
11 - 15	16.45(17)	15.96(110)	14.26(184)	-	8.07(3)	**14.91(314)**
16 - 20	9.08(51)	16.74(66)	14.51(82)	-	-	**13.86(199)**
21 - 25	11.28(58)	16.68(35)	12.97(19)	-	-	**13.25(112)**
26 - 30	13.57(56)	13.61(48)	16.83(20)	-	-	**14.11(124)**
> 30	21.86(6)	13.52(11)	16.30(1)	-	-	**16.46(18)**
Average	**12.36(204)**	**14.69(385)**	**14.51(492)**	**31.96(12)**	**11.80(24)**	**14.31(1117)**

Table 33: Design and replication- wise distribution of CV % of the experiments

Design	Replications					Average
	2	3	4	5	6	
RBD	12.36 (204)	14.80(367)	14.49(392)	31.96 (12)	12.92 (14)	**14.35 (989)**
FRBD	-	13.42 (14)	17.04 (33)	-	-	**15.96 (47)**
CRD	-	-	5.41 (1)	-	10.50 (9)	**9.99 (10)**
SPT	-	9.39 (4)	13.58 (66)	-	7.7 (1)	**13.26 (71)**

Table 34: Plot size and treatment- wise distribution of CV % of the experiments

Plot Size (m^2)	Treatments							Average
	≤ 5	6 - 10	11-15	16 - 20	21 – 25	26 -30	>30	
< 3	-	10.98 (1)	-	-	-	9.21 (2)	23.63 (1)	**13.25 (4)**
3 – 6	9.16 (5)	9.89 (26)	15.16 (16)	17.90 (10)	14.32 (7)	16.97 (12)	16.44 (13)	**13.96 (89)**
6 – 9	17.27 (8)	13.12 (32)	15.65 (77)	12.13 (92)	13.10 (85)	13.50 (99)	14.72 (4)	**13.57 (397)**
9 – 12	20.97 (9)	14.24 (95)	15.55 (55)	14.20 (42)	11.55 (13)	15.81 (9)	-	**14.73 (223)**
12 – 15	13.80 (2)	13.02 (57)	14.10 (52)	14.41 (18)	17.38 (5)	24.56 (2)	-	**13.96 (136)**
15 – 18	32.23 (13)	13.21 (28)	13.28 (64)	11.56 (15)	-	-	-	**15.10 (120)**
18 – 21	20.67 (4)	13.92 (52)	16.06 (48)	18.90 (21)	16.62 (2)	-	-	**15.81 (127)**
21 – 31	13.42 (7)	17.95 (4)	13.19 (2)	36.00 (1)	-	-	-	**16.29 (14)**
> 31	12.62 (3)	7.75 (4)	-	-	-	-	-	**9.84 (7)**
Average	**20.27 (51)**	**13.31 (299)**	**14.91 (314)**	**13.86 (199)**	**13.25 (112)**	**14.11 (124)**	**16.46 (18)**	**14.31 (1117)**

Table 35: Plot size and replication- wise distribution of CV % of the experiments

Plot Size (m^2)	Replications					Average
	2	3	4	5	6	
< 3	23.63 (1)	9.80 (3)	-	-	-	**13.25 (4)**
3 – 6	21.45 (18)	12.36 60)	18.99 (2)	-	10.50 (9)	**13.96 (89)**
6 – 9	10.92 (156)	15.90 95)	15.07 (143)	-	7.05 (3)	**13.57 (397)**
9 – 12	14.14 (15)	13.87 (102)	15.34 (101)	30.45 (3)	9.37 (2)	**14.73 (223)**
12– 15	18.13 (4)	15.51(37)	13.22 (93)	13.96 (1)	7.70 (1)	**13.96 (136)**
15– 18	-	16.29 (20)	13.09 (95)	58.24 (4)	9.84 (1)	**15.10 (120)**
18 -21	14.17 (10)	15.46 (66)	16.44 (48)	8.50 (1)	23.87 (2)	**15.81 (127)**
21– 31	-	20.34 (2)	18.70 (5)	10.45 (1)	13.91 (6)	**16.29 (14)**
> 31	-	-	8.50 (5)	13.18 (2)	-	**9.84(7)**
Average	**12.36 (204)**	**14.69 (385)**	**14.51 (492)**	**31.96 (12)**	**11.80 (24)**	**14.31 (1117)**

Table 36: Design and Treatment- wise distribution of CV % of the experiments

Design	Treatments							Average
	Up to 5	6-10	11-15	16-20	21-25	26–30	>30	
RBD	21.48 (46)	13.34 (274)	14.75 (265)	13.95 (159)	13.37 (106)	14.14 (121)	16.46 (18)	**14.35 (989)**
FRBD	9.16 (5)	14.88 (9)	17.56 (21)	14.55 (17)	-	-	-	**15.96 (47)**
CRD	-	10.83 (5)	-	-	-	-	-	**9.99 (10)**
SPT	-	12.37 (11)	14.49 (28)	12.74 (23)	11.11 (6)	13.27 (3)	-	**13.26 (71)**
Average	**20.27 (51)**	**13.31 (299)**	**14.91 (314)**	**13.86 (199)**	**13.25 (112)**	**14.11 (124)**	**16.46 (18)**	**14.31 (1117)**

Table 37: Design and Plot size- wise distribution of CV % of the experiments

Design	Plot size (m^2)								Average
	<3	3 - 6	6 - 9	9 - 12	12-15	15-18	18-21	>21	
RBD	13.25 (4)	14.34 (80)	13.51 (370)	14.64 (181)	14.23 (108)	15.34 (113)	15.89 (115)	13.75 (18)	**14.35 (989)**
FRBD	-	-	17.73 (14)	16.06 (19)	13.14 (10)	22.60 (1)	14.26 (3)	-	**15.96 (47)**
CRD	-	10.50 (9)	-	-	-	-	-	5.41 (1)	**9.99 (10)**
SPT	-	-	10.79 (12)	14.40 (23)	12.74 (18)	9.38 (6)	15.29 (9)	22.00 (2)	**13.26 (71)**
Average	**13.25 (4)**	**13.96 (89)**	**13.57 (397)**	**14.73 (223**	**13.96 (136)**	**15.10 (120)**	**15.81 (127)**	**14.13 (21)**	**14.31 (1117)**

Table 38: Discipline and replication- wise distribution of CV % of the experiments

Disciplines	Replications					Average
	2	3	4	5	6	
Agronomy	16.64(7)	14.81(27)	15.22(123)	13.18(2)	14.33(11)	**15.13(170)**
Entomology	-	9.19(32)	21.29(21)	42.28(8)	10.50(9)	**16.77(70)**
Pl. Breeding	12.21(197)	15.28(321)	13.73(313)	9.47(2)	7.74(4)	**13.93(837)**
Soil Science	-	11.12(5)	14.98(35)	-	-	**14.50(40)**
Average	**12.36 (204)**	**14.69 (385)**	**14.51 (492)**	**31.96 (12)**	**11.80 (24)**	**14.31 (1117)**

Prediction is very difficult, especially about the future.
- Niels Bohr

Table 39: Plot size and discipline- wise distribution of CV % of the experiments

Plot size (m^2)	Disciplines				Average
	Entomology	Agronomy	Plant Breeding	Soil Sci.	
< 3	10.98(1)	-	14.01(3)	-	**13.25(4)**
3-6	9.00(32)	-	16.74(57)	-	**13.96(89)**
6-9	13.56(7)	15.56(32)	13.43(349)	12.03(9)	**13.57(397)**
9-12	24.23(13)	15.43(45)	13.50(136)	15.17(29)	**14.73(223)**
12-15	15.91(6)	14.10(43)	13.75(87)	-	**13.96(136)**
15-18	36.44(10)	11.27(6)	13.22(102)	15.85(2)	**15.10(120)**
18-21	-	16.72(27)	15.56(100)	-	**18.81(127)**
21-31	-	17.39(11)	12.27(3)	-	**16.29(14)**
>31	5.41(1)	10.5(6)	-	-	**9.84(7)**
Average	**16.77 (70)**	**15.13 (170)**	**13.93 (837)**	**14.50 (40)**	**14.31 (1117)**

Upper fiducial limit and yard stick of CV% (Bhal and Costal Zone)

Table 40: Upper fiducial limit of CV % for different disciplines of Bhal and Coastal Zone crops

Discipline	No. of expt.	Average CV %	U L	Expt. having CV % > 17.83	
			(0.95)	No. of expt.	Proportion
Agronomy	170	15.13	18.94	42	0.24
Entomology	70	16.77	23.86	19	0.27
Pl.Breeding	837	13.93	17.12	184	0.21
Soil Science	40	14.50	17.44	10	0.25
Average	**(1117)**	**14.31**	**17.83**		

Table 41: Upper fiducial limit of CV % for different design of Bhal and Coastal Zone crops

Design	No. of expt.	Average CV %	U L	Expt. having CV % > 17.83	
			(0.95)	No. of expt.	Proportion
CRD	10	10.00	12.91	-	-
FRBD	47	15.96	19.42	13	0.27
RBD	989	14.36	18.00	231	0.23
SPT	71	13.24	15.12	11	0.15
Average	**(1117)**	**14.31**	**17.83**		

Table 42: Upper fiducial limit of CV % for different treatments of Bhal and Coastal Zone crops

Treatments	No. of expt.	Average CV %	U L	Expt. having CV % > 17.83	
			(0.95)	No. of expt.	Proportion
< 6	51	20.27	30.20	20	0.39
6-10	299	13.31	17.37	58	0.19
11-15	314	14.91	18.27	88	0.28
16-20	199	13.86	16.60	48	0.24
21-25	112	13.25	15.69	19	0.16
26-30	124	14.11	16.49	16	0.12
>30	18	16.46	18.89	6	0.33
Average	**(1117)**	**14.31**	**17.83**		

Table 43: Upper fiducial limit of CV % for different plot size of Bhal and Coastal Zone crops

Plot size (m^2)	No. of expt.	Average CV %	U L	Expt. having CV % > 17.83	
			(0.95)	No. of expt.	Proportion
< 3	4	13.25	15.75	1	0.25
3-6	89	13.96	17.20	18	0.20
6-9	397	13.57	16.42	82	0.20
9-12	223	14.73	18.59	52	0.23
12-15	136	13.96	17.22	29	0.21
15-18	120	15.10	19.87	30	0.25
18-21	127	15.81	20.03	40	0.31
21-24	-	-	-	-	-
24-31	14	16.30	21.10	3	0.21
>31	7	9.84	13.04	0	00
Average	**(1117)**	**14.31**	**17.83**		

Table 44: Upper fiducial limit of CV % for different replications of Bhal and Coastal Zone crops

Replication	No. of expt.	Average CV %	U L	Expt. having CV % > 17.83	
			(0.95)	No. of expt.	Proportion
2	204	12.36	15.43	32	0.15
3	385	14.69	18.18	92	0.23
4	499	14.51	17.83	124	0.24
5	12	31.96	52.16	5	0.41
6	24	11.80	15.35	9	0.37
Average	**(1117)**	**14.31**	**17.83**		

Table 45: The average upper fiducial limit and yardstick for CV % for the experiments of Bhal and Coastal Zone crops

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV %
Bhal and Coastal Zone crops	**1117**	**14.31**	**17.83**	**18**

Wheat Crop (Bhal and Coastal Zone)

Table 46: Upper fiducial limit of CV % for different disciplines in the experiments

Discipline	No. of expt.	Average CV %	U L	Expt. having CV % >14.10	
			(0.95)	No. of expt.	Proportion
Agronomy	16	14.51	18.19	8	0.50
Pl. Breeding	344	11.61	13.90	77	0.22
Soil Science	13	11.66	14.33	3	0.23
Average	**(373)**	**11.74**	**14.10**		

Table 47: Upper fiducial limit of CV % for different design in the experiments

Design	No. of expt.	Average CV %	U L	Expt. having CV % >14.10	
			(0.95)	No. of expt.	Proportion
FRBD	5	12.34	14.66	2	0.40
RBD	361	11.76	14.15	85	0.23
SPT	7	10.06	11.36	1	0.14
Average	**(373)**	**11.74**	**14.10**		

Table 48: Upper fiducial limit of CV % for different treatments in the experiments

Treatments	No. of expt.	Average CV %	U L	Expt. having CV % >14.10	
			(0.95)	No. of expt.	Proportion
< 6	1	19.65	31.00	1	1.00
6-10	43	10.69	13.61	9	0.20
11-15	66	11.40	13.75	15	0.22
16-20	81	10.13	12.23	15	0.18
21-25	74	12.06	14.42	20	0.27
26-30	104	13.22	15.49	26	0.25
>30	4	14.72	16.75	2	0.50
Average	**(373)**	**11.74**	**14.10**		

Table 49: Upper fiducial limit of CV % for different plot size in the experiments

Plot size (m^2)	No. of expt.	Average CV %	U L	Expt. having CV % >14.10	
			(0.95)	No. of expt.	Proportion
< 3	2	9.21	10.62	0	0.00
3-6	3	17.13	20.64	1	0.33
6-9	252	12.07	14.43	63	0.25
9-12	37	11.87	14.49	10	0.27
12-15	11	10.78	13.28	2	0.18
15-18	65	10.27	12.41	10	0.15
18-21	3	14.26	16.90	2	0.66
Average	**(373)**	**11.74**	**14.10**		

Table 50: Upper fiducial limit of CV % for different replications in the experiments

Replication	No. of expt.	Average CV %	U L	Expt. having CV % >14.10	
			(0.95)	No. of expt.	Proportion
3	166	11.20	13.60	30	0.18
4	49	11.94	13.82	8	0.16
5	155	12.31	14.80	50	0.32
6	-	-	-	-	-
7	3	8.79	10.28	-	-
Average	**(373)**	**11.74**	**14.10**	**-**	**-**

Table 51: The average upper fiducial limit and yardstick for CV % for the experiments of Wheat (Bhal and Coastal Zone) experiments

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Wheat	**373**	**11.74**	**14.10**	**15**

Cotton (Bhal and Coastal Zone) Crop

Table 52 : Upper fiducial limit of CV % for different disciplines in the experiments

Discipline	No. of expt.	Average CV %	U L	Expt. having CV % >20.64	
			(0.95)	No. of expt.	Proportion
Agronomy	55	15.60	20.40	10	0.18
Pl.Breeding	161	16.16	20.51	32	0.19
Soil Science	8	20.48	24.70	4	0.50
Average	**(224)**	**16.18**	**20.64**		

Table 53: Upper fiducial limit of CV % for different design in the experiments

Design	No. of expt.	Average CV %	U L	Expt. having CV % >20.64	
			(0.95)	No. of expt.	Proportion
FRBD	10	18.02	22.06	3	0.30
RBD	199	16.19	20.80	40	0.20
SPT	15	14.77	17.51	3	0.20
Average	**(224)**	**16.18**	**20.64**		

Table 54: Upper fiducial limit of CV % for different treatments in the experiments

Treatments	No. of expt.	Average CV %	U L	Expt. having CV % >20.64	
			(0.95)	No. of expt.	Proportion
< 6	15	15.66	21.17	2	0.13
6-10	93	14.82	19.67	17	0.18
11-15	79	16.28	20.32	14	0.17
16-20	32	18.02	21.71	10	0.31
21-25	2	16.63	19.57	0	00.0
26-30	2	40.58	48.45	2	1.00
>30	1	33.16	38.99	1	1.00
Average	**(224)**	**16.18**	**20.64**		

Table 55: Upper fiducial limit of CV % for different plot size in the experiments

Plot size (m^2)	No. of expt.	Average CV %	U L	Expt. having CV % >20.64	
			(0.95)	No. of expt.	Proportion
<3	-	-	-	-	-
3-6	14	21.29	27.81	7	0.50
6-9	4	14.29	18.67	0	00.0
9-12	32	18.55	23.34	9	0.28
12-15	28	15.57	19.82	5	0.17
15-18	12	15.24	19.01	3	0.25
18-21	116	15.68	19.95	21	0.18
21-24	0	-	-	0	00.0
24-31	12	14.42	19.12	1	0.08
>31	6	10.58	14.02	0	00.0
Average	**(224)**	**16.18**	**20.64**		

Table 56: Upper fiducial limit of CV % for different replications in the experiments

Replication	No. of expt.	Average CV %	U L	Expt. having CV % >20.64	
			(0.95)	No. of expt.	Proportion
3	30	17.87	24.46	8	0.26
4	108	15.98	20.05	20	0.18
5	74	16.01	20.11	16	0.21
6	4	11.33	14.94	0	00.0
7	8	16.41	21.97	2	0.25
Average	**(224)**	**16.18**	**20.64**		

Table 57: The average upper fiducial limit and yardstick for CV % for the experiments of Cotton (Bhal and Coastal Zone) experiments

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV % (0.95)	Overall yardstick of CV%
Cotton	**224**	**16.18**	**20.64**	**21**

Gram (Bhal and Coastal Zone) crop

Table 58: Upper fiducial limit of CV % for different disciplines in the experiments

Discipline	No. of expt.	Average CV %	U L	Expt. having CV % >18.46	
			(0.95)	No. of expt.	Proportion
Agronomy	16	14.29	17.46	1	0.06
Entomology	51	15.25	22.04	9	0.17
Pl.Breeding	118	14.18	17.09	20	0.16
Soil Science	3	12.97	16.84	1	0.33
Average	**(188)**	**14.46**	**18.46**		

Table 59: Upper fiducial limit of CV % for different designs in the experiments

Design	No. of expt.	Average CV %	U L	Expt. having CV % >18.46	
			(0.95)	No. of expt.	Proportion
CRD	10	10.0	12.91	0	0.00
FRBD	10	13.57	16.45	0	0.00
RBD	166	14.76	18.90	31	0.18
Split plot	2	16.21	19.94	0	0.00
Average	**(188)**	**14.46**	**18.46**		

Table 60: Upper fiducial limit of CV % for different treatments in the experiments

Treatments	No. of expt.	Average CV %	U L	Expt. having CV % >18.46	
			(0.95)	No. of expt.	Proportion
< 6	19	24.62	39.19	7	0.36
6-10	41	11.18	14.39	5	0.12
11-15	46	12.92	15.72	4	0.08
16-20	48	14.95	17.86	11	0.22
21-25	13	14.54	17.08	3	0.23
26-30	9	13.20	15.19	0	0.00
>30	12	14.37	16.39	1	0.08
Average	**(188)**	**14.46**	**18.46**		

Table 61: Upper fiducial limit of CV % for different plot size in the experiments

Plot size (m^2)	No. of experiment	Average CV %	U L (0.95)	Expt. having CV % >18.46	
				No. of expt.	Proportion
<3	2	17.30	20.89	1	0.50
3-6	70	12.04	14.57	4	0.05
6-9	65	13.33	16.23	10	0.15
9-12	28	14.77	18.12	7	0.25
12-15	10	15.90	20.20	2	0.20
15-18	12	33.10	53.07	7	0.58
>31	1	5.41	7.17	0	0.00
Average	**(188)**	**14.46**	**18.46**		

Table 62: Upper fiducial limit of CV % for different replications in the experiments

Replication	No.of expt.	Average CV %	U L (0.95)	Expt. having CV % >18.46	
				No. of expt.	Proportion
3	4	15.19	18.63	2	0.50
4	97	13.63	16.65	14	0.14
5	73	13.62	16.81	12	0.16
6	5	49.38	86.31	3	0.60
7	9	10.51	13.55	0	0.00
Average	**(188)**	**14.46**	**18.46**		

Table 63: The average upper fiducial limit and yardstick for CV % for Gram experiments (Bhal and Coastal Zone)

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV %	Overall yardstick of CV%
			(0.95)	
Gram	**188**	**14.46**	**18.46**	**19**

Safflower (Bhal and Coastal Zone) Crop

Table 64 : Upper fiducial limit of CV % for different disciplines in the experiments.

Discipline	No.of expt.	CV %	U L (0.95)	Expt. having CV % > 23.45	
				No. of expt.	Proportion
Agronomy	15	15.69	19.20	1	0.06
Entomology	12	24.24	33.45	6	0.50
Pl.Breeding	89	18.61	22.87	24	0.26
Average	**(116)**	**18.82**	**23.45**		

Table 65: Upper fiducial limit of CV % for different design in the experiments

Design	No.of expt.	Average CV %	U L (0.95)	Expt. having CV % > 23.45	
				No. of expt.	Proportion
FRBD	2	18.97	22.80	0	0.00
RBD	107	18.83	23.55	30	0.28
SPT	7	18.57	22.10	1	0.14
Average	**(116)**	**18.82**	**23.45**		

There are no routine statistical questions, only questionable statistical routines.
- D.R. Cox

Table 66: Upper fiducial limit of CV % for different treatments in the experiments

Treatments	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 23.45	
				No. of expt.	Proportion
< 6	4	24.84	36.41	2	0.50
6-10	28	17.82	23.63	9	0.32
11-15	43	17.97	22.17	7	0.16
16-20	17	19.96	23.75	5	0.29
21-25	17	17.85	21.10	4	0.23
26-30	6	22.89	26.69	3	0.50
>30	1	31.83	37.38	1	1.00
Average	**(116)**	**18.82**	**23.45**		

Table 67: Upper fiducial limit of CV % for different plot size in the experiments

Plot size (m^2)	No. of experiment	Average CV %	U L (0.95)	Expt. having CV %> 23.45	
				No. of expt.	Proportion
<3	-	-	-	-	-
3-6	1	31.83	37.38	1	1.00
6-9	32	23.01	27.92	15	0.46
9-12	37	18.30	23.90	8	0.21
12-15	33	14.58	17.69	2	0.06
15-18	7	21.35	27.33	4	0.57
18-21	5	14.30	17.47	0	0.00
Average	**(116)**	**18.82**	**23.45**		

Table 68: Upper fiducial limit of CV % for different replications in the experiments

Replication	No. of expt.	Average CV %	U L (0.95)	Expt. having CV % > 23.45	
				No. of expt.	Proportion
3	4	16.49	20.52	1	0.25
4	61	18.18	22.34	13	0.21
5	48	19.10	23.76	15	0.31
6	3	30.45	44.88	2	0.66
Average	**(116)**	**18.82**	**23.45**		

Table 69: The average upper fiducial limit and yardstick for CV % for the experiments of safflower (Bhal and Coastal Zone) experiments

Name of Crop	No. of experiments	Average CV %	Upper fiducial limit of CV %	Overall yardstick of CV%
			(0.95)	
Safflower	**116**	**18.82**	**23.45**	**24**

The results of 1117 experiments conducted in Bhal zone at two locations viz., Arnej and Dhandhuka showed that the experimental variability - CV was within the acceptable range barring experiments conducted at Arnej on sunflower, safflower, Vegetables and entomology. For Arnej farm, experimental plot of 3-6 sq.m area and 3 replications are optimum and sufficient for field experimentation.

The optimum plot size for experiments at Dhandhuka is 6-9 sq.m ; 4 replications are sufficient at the same location.

3 FITTING OF THE DISTRIBUTION TO CV VALUES

Objectives:

(1) To fit the appropriate distribution to the data of CV values of the field experiments.

(2) To know the shape of the distribution

3.1 FORAGE YIELD

The data of coefficient of variation (CV) values of 1058 experiments conducted on forage crop during the years 1995-96 to 2004-05 were collected for the purpose. CV values of Dry fodder (526) and green fodder yield (532) were used for the present study. From these values a random sample of size 60 was taken from each category of fodder. Classified data are presented in Table 1 and Fig.1 & Fig.2. The figures indicated that the shape of distribution is positively skewed. Looking to the shape of the distribution and using maximum likelihood estimation (m.l.e.) method the Truncated Exponential, Normal and Lognormal distributions were tried. The Chi-square test indicated that the Lognormal distribution fitted well to the data of CV of Dry fodder as well as Green fodder of forage crop experiments.

Table 1: Frequency distribution of CV values for the sample data

Dry Fodder		Green fodder	
CV %	**Frequency**	**CV %**	**Frequency**
02.00-05.50	5	02.00-04.95	6
05.50-09.00	18	04.95-07.90	13
09.00-12.50	18	07.90-10.85	16
12.50-16.00	7	10.85-13.80	12
16.00-19.50	7	13.80-16.75	3
19.50-23.00	3	16.75-19.70	1
23.00-26.50	0	19.70-22.65	7
26.50-30.00	1	22.65-25.60	0
30.00-33.50	0	25.60-28.55	0
33.50-37.00	0	28.55-31.50	1
37.00-40.50	1	31.50-34.45	1
Total	**60**	**Total**	**60**

Table 2 : Chi-square values for goodness of fit of different distributions

Name of distribution	Chi-square	
	DFY	**GFY**
Truncated Exponential	20.85^{*}	18.46^{*}
Normal	11.84^{*}	10.99^{ns}
Log normal	1.50^{ns}	1.44^{ns}

* Significant, ns = not significant

The best thing about being a statistician is that you get to play in everyone's backyard.
- John Tukey

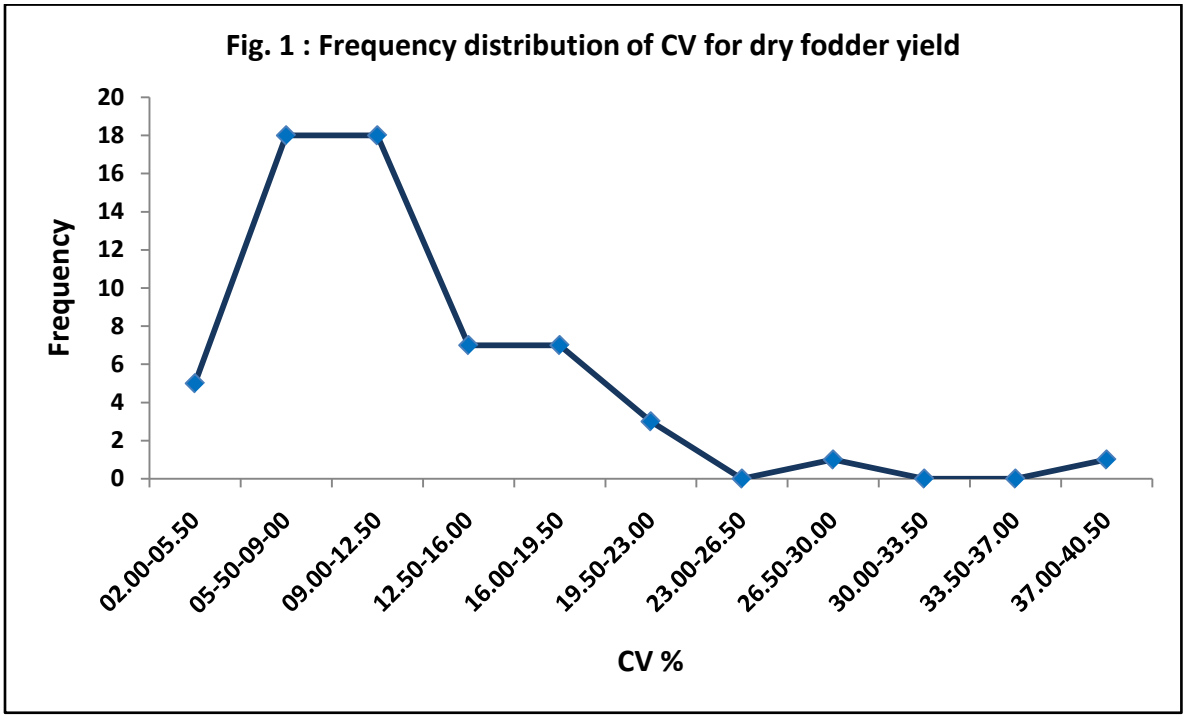


Fig. 1 : Frequency distribution of CV for dry fodder yield
Frequency
20
18
16
14
12
10
8
6
4
2
0
02.00-05.50
05-50-09-00
09.00-12.50
12.50-16.00
16.00-19.50
19.50-23.00
23.00-26.50
26.50-30.00
30.00-33.50
33.50-37.00
37.00-40.50
CV %

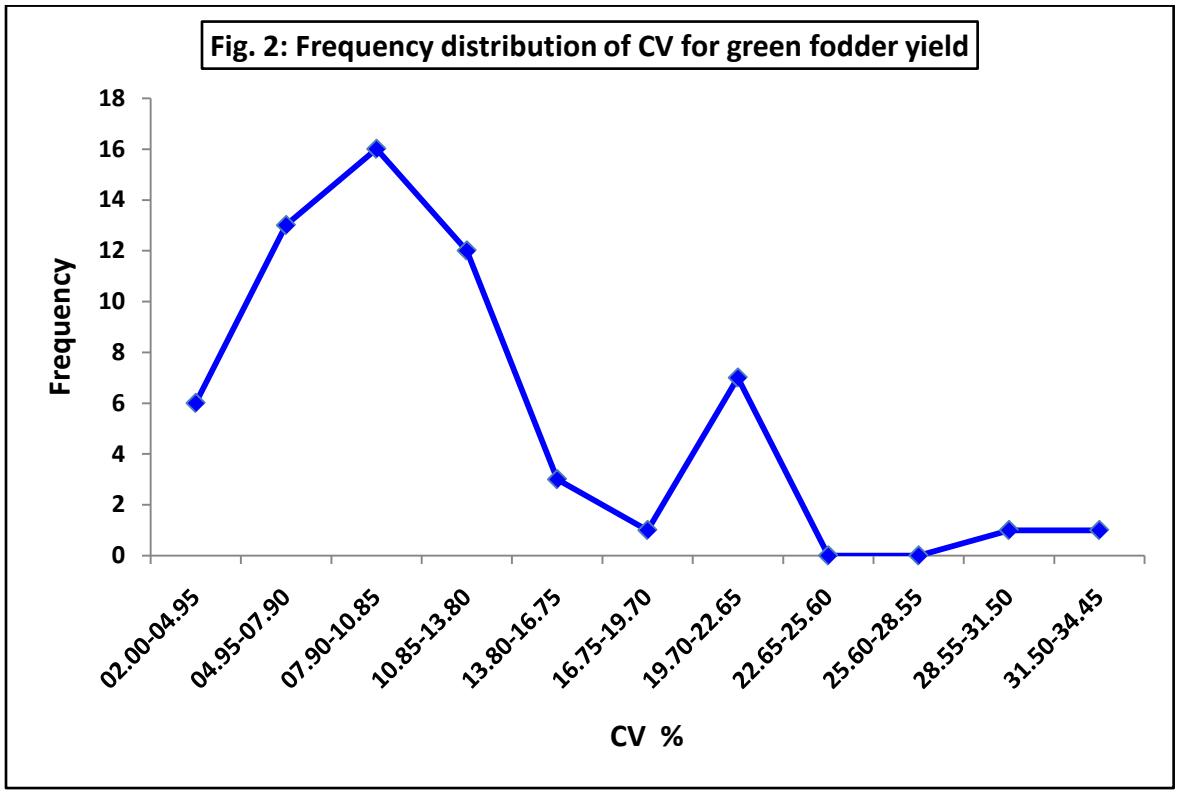
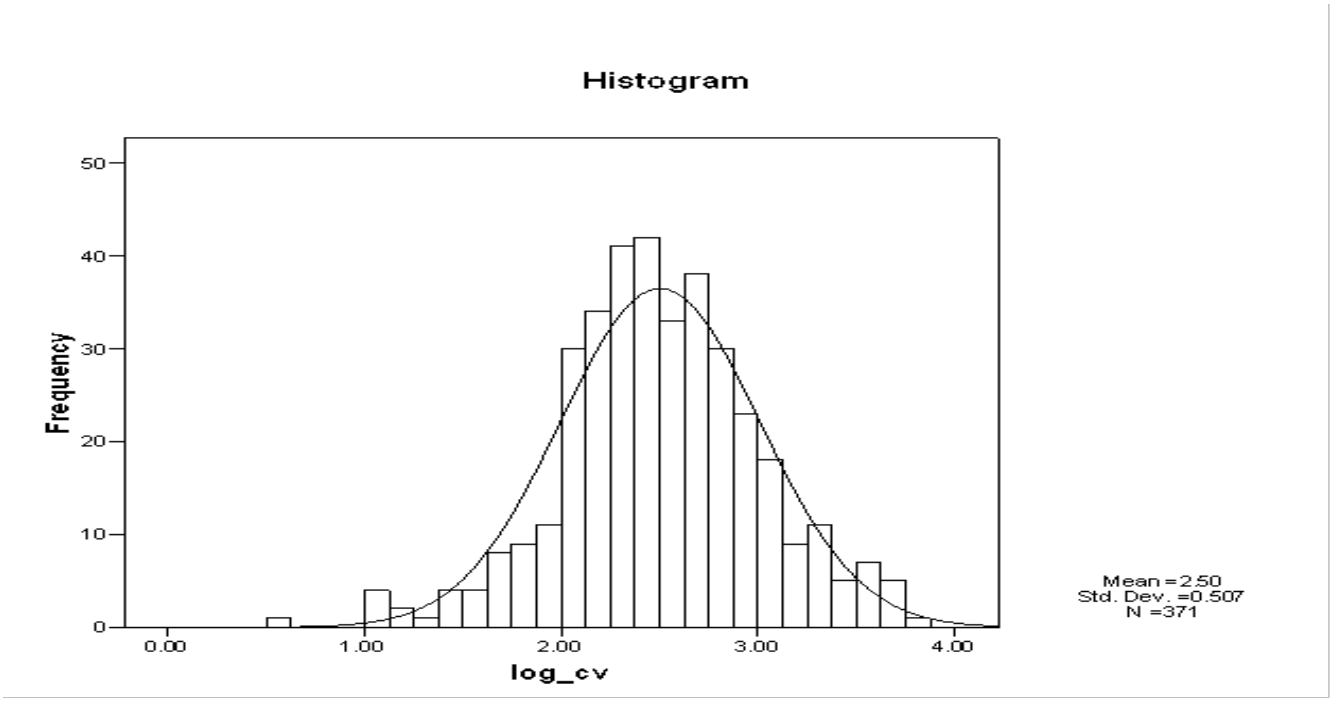


Fig. 2: Frequency distribution of CV for green fodder yield
Frequency
18
16
14
12
10
8
6
4
2
0
02.00-04.95
04.95-07.90
07.90-10.85
10.85-13.80
13.80-16.75
16.75-19.70
19.70-22.65
22.65-25.60
25.60-28.55
28.55-31.50
31.50-34.45
CV %

3.2 MUSTARD CROP GRAIN YIELD

The CV values of 371 field experiments of mustard crop conducted at different research stations of Gujarat Agricultural University were utilized for the purpose. The plotted graph of the data showed positive skewed distribution. The data were fitted to log normal distribution and parameters were estimated. The average CV was 13.89 with variance 56.68. The upper bound on CV was also calculated and it was 14.63. From the results of analysis, it is concluded that the lognormal distribution is well fitted to the CV data of the Mustard experiments.

Figure 1: Histogram of the log of CV of Mustard data



3.3 COTTON YIELD

The experimental data of 1786 cotton experiments collected for variability analysis were utilized for fitting the distribution of CV %. A random sample of size 90 was taken from a population size 1786. The frequency distribution of CV is presented in Table 1 and a frequency curve is depicted in Fig.1. Besides, by using Maximum Likelihood Estimation (m.l.e.) method, Truncated Exponential, Normal and Lognormal distributions are fitted. The goodness of fit to these distributions are presented in Table-2. Lognormal distribution is considered to be the best fit to the data of CV values of field experiments conducted on cotton crop.

Table 1: Frequency distribution of CV values of Cotton crop experiments

Classes of CV %	Frequency
3.00 - 6.50	07
6.50 -10.00	11
10.00 - 13.50	23
13.50 – 17.00	15
17.00 – 20.50	12
20.50 – 24.00	06
24.00 – 27.50	06
27.50-31.00	03
31.00-34.50	04
34.50-38.00	02
38.00-41.50	01
Total	**90**

Fig. 1: Frequency curve for CV values of cotton crop experiments (n=90)

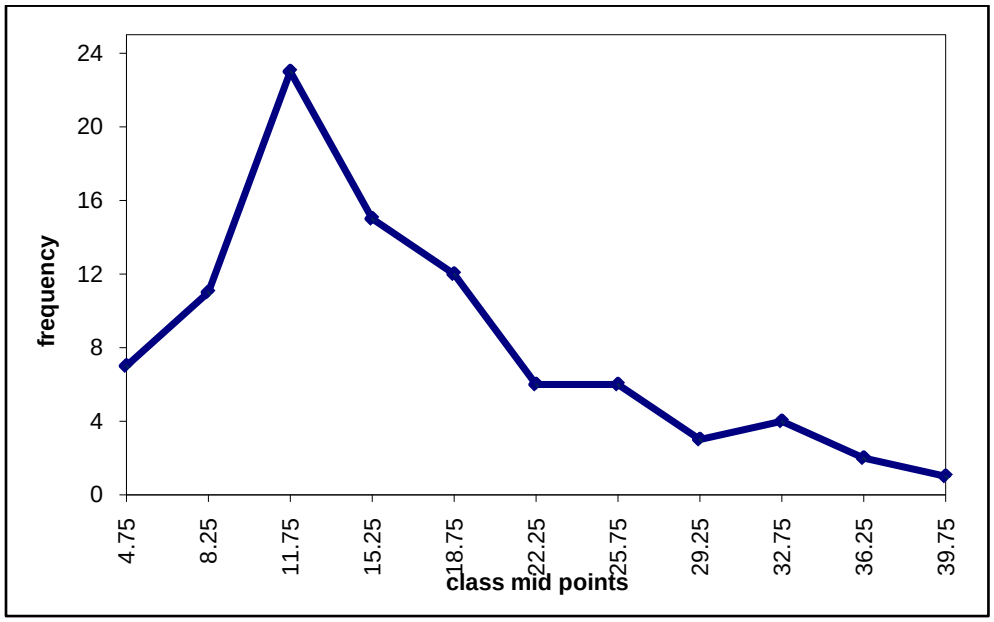


Table 2: Chi-square values for goodness of fit of different distributions

Name of distribution	Chi-square	Test
Truncated Exponential	22.395	Significant
Normal	11.658	Non significant
Log Normal	3.503	Non significant

Conclusion:

Based on the results of fitted distribution to CV % of field experiments especially of forage yield, mustard grain yield and cotton yield it is generalized that the Log Normal distribution fits well to CV of experimental data.

4. RESULTS AT A GLANCE

Table 1: Ranking to range in average CV % of factors causing variation (1= maximum, 7 = minimum) and other information

Crop(s)	Location	Crops	Plot size	No. of Repli.	Design	Treatment	Discipline	No. of Expt.	Av. CV of all Expt.	Upper limit of CV % Reco. *	Remarks
Pulses	2	1	3	4	5	6	-	1841	21.29	27	
Maize	-	-	1	2	-	3	-	231	31.98	41	No Reco.
Rice	1	-	3	5	2	6	4	1097	13.19	17	
Dry Farming	3	2	5	1	-	4	-	222	19.07	25	
Tobacco	-	6	3	2	5	1	4	544	14.02	18	
Vegetables	3	1	5	6	4	2	-	540	17.73	23	
Castor	2	-	4	5	1	6	3	530	15.31	20	
Forage	1	-	3	6	4	2	5	1058	10.97	14	
Mustard	1	-	3	6	2	5	4	554	13.42	17	
Wheat	1	5	2	7	6	4	3	1037	10.64	12/18	Irrigated/Dry
Cotton	2	3	1	7	4	6	5	1786	17.49	23	
M & AP	-	1	3	6	5	4	2	535			
Bhal and Costal	7	1	4	2	5	3	6	1117	14.31	18	
Arnej	-	2	3	1	5	4	6	511	15.32	20	
Dhandhuka	-	3	2	5	1	4	6	606	13.46	14	

*** Yardstick for CV %**

Table 2 : Optimize/ Proper plot size (sq.m.) and replications for different crops.

Crop	Plot Size	Replications	Location
Gaur	6-9	4	All except Arnej
Cowpea	9-12	4	All except Derol
Urid	9-12	4	All
Mung	9-12	4	All except SK Nagar
Gram	12-15	4	All except SK Nagar and Waghai
Rice	6-9	4	All
Dry Farming	>15	4	
Tobacco	6-9	3	Anand
Vegetables	6-9	3 or 4	Navsari, SK Nagar and Waghai
Vegetables	3	3 or 4	Anand, Junagadh
Castor	12-15	4	All except Bhachau, Derol, Jamnagar and Targhadia
Wheat	9-12	3	All
Forage	3-9	3	All except Dhari, Viramgam and Radhanpur
Mustard	6-9	4	All except Arnej, Bhachau, Dhandhuka and Navagam
Medicine & Aromatic	3-6	4	Anand
Cotton	9-12	4	All except Anand, Arnej, Chharodi, Navsari and Porbandar
Bhal Zone	3-6	3	Arnej
	6-9	4	Dhandhuka

(1) Plot Size and Replications indicated above are based on average CV % presented for respective crops in this bulletin.
(2) These are concluding findings hence it is worth to present them as recommendations.
(3) This may be circulated to all concerned stations.

OVER ALL:

Agricultural scientist conduct field experiments with a view to generate reliable results. reliability of the estimate (s) depends on experimental error, which is generally expressed in terms of CV % (CV). This report is the outcome of the work carried out on CV data of the field experiments of Pulse crops, Maize, rice, Dry farming, Tobacco, Vegetable crops, Castor, forage crops, mustard, wheat, cotton, medicinal and aromatic plants crops, Bhal and Coastal zone and of uniformity trials. Average CV data were tabulated experimental factor-wise and interpreted.

The results at a glance are presented in Tables 1 and 2. Table 1 represents the ranks of the experimental factor causing variability in the experimental data. Table 2 depicts the information on optimum plot size and replications for various crops/locations.

The theoretical distribution was also fitted to the CV of forage crops, mustard and cotton yield data. The results revealed that the CV of field experiments on these crops follow Log Normal distribution.

The findings presented here in will help utilizing resources available to the scientist (s) most effectively and thereby improve efficiency of the field experimentation on crop (s).

5. RESEARCH RECOMMENDATIONS

On the basis of research work carried out under the scheme "Statistical Evaluation of Experimental Variability for Improving Efficiency of Field Experimentation" following recommendations were made for scientific community.

Year: 1995

(1) The field experiments on maize crop at the Maize Research station, Godhra during kharif season should be conducted in Latin square design with 5-9 treatments and 6 sq.m. plot size *i.e.* 5 rows each of 2 m length.

(2) The optimum plot size for field experiments on Guar, Green gram and Black gram is 6 to 9 sq.m. and that of Arhar and Gram is 9 to 12 sq.m.

(3) Minimum four replications are must for better precision of experimental result in pulse crop.

(4) The upper limit of CV% for accepting the results of field experiments on pulse crop is 23 per cent.

Year: 1997

(5) A plot of 10.8 sq.m. size having shape of 2 m. length (S-N) and 5.4 m. cross width (E-W) is considered as optimum size and shape for Arhar crop field experiments at Derol.

(6) A plot of 7.2 sq.m. (8 unit) size having shape of 2 m. length (S-N) and 3.6 m. cross width (8 rows) in E-W is optimum size and shape for drilled paddy experiment at Derol.

Year: 1998

(7) A plot of 7.2 sq.m. size having shape of 2 m. length (N-S) and 3.6 m. cross width (6 rows in E-W) is optimum size and shape for Arhar crop (narrow distance) field experiments at Aseda, S.K. Nagar.

Year: 1999

(8) A plot of 10.8 sq.m. size having shape of 2 m.length (N-S) and 5.4 m. cross width (6 row in E-W) is optimum size (Net) and shape for cotton crop experiment at Dry farming research station, Targhadia, Rajkot.

(9) The upper limit of CV% for accepting the results of field experiment on vegetable crop is 23 per cent for yield character.

Year: 2000

(10) The yard stick of CV% for accepting the results of irrigated castor crop experiments is 20 per cent for yield character.

Year: 2001

(11) A plot of 10.8 sq.m. size having shape of 4 m. length (E-W) and 2.7 m. cross width (6 row in E-W) is optimum size (Net) and shape for cluster bean experiment at Pulse research station, Gujarat Agricultural University, S.K. Nagar.

(12) The yard stick of CV% for accepting the results of Mustard crop experiments is 17 per cent for yield character.

Year: 2003

(13) The yard stick of CV% for accepting the results of *kharif* cotton crop experiments is 23 per cent for yield character.

Year: 2005

(14) The yard stick of CV % for accepting the results of irrigated wheat crop experiment is 12 per cent and un irrigated wheat crop experiment is 18 per cent for yield characters.

Year: 2009

(15) The yard stick of CV for accepting the results of forage crop experiment is 14 per cent for green and dry fodder yield character.

Year: 2015

(16) The yard stick of CV% for accepting the results of Medicinal and Aromatic crops experiments is 23 per cent for yield character.

(17) The yard stick of CV% for accepting the results of Safed musali crop experiments is 21 per cent for economical yield character

(18) The yard stick of CV% for accepting the results of Ashwagandha crop experiments is 22 per cent for economical yield character.

(19) The yard stick of CV% for accepting the results of Isabgul crop experiments is 23 per cent for yield character.

Year: 2016

(20) The yard stick of CV% for accepting the results of wheat (Bhal and Coastal zone) crop experiments is 15 per cent for yield character.

(21) The yard stick of CV% for accepting the results of safflower (Bhal and Coastal zone) crop experiments is 24 per cent for yield character.

(22) The yard stick of CV% for accepting the results of gram (Bhal and Coastal zone) crop experiments is 19 per cent for yield character.

(23) The yard stick of CV% for accepting the results of Dhandhuka center (Bhal and Coastal zone) crop experiments is 14 per cent for yield character.

(24) The yard stick of CV% for accepting the results of cotton (Bhal and Coastal zone) crop experiments is 21 per cent for yield character.

(25) The yard stick of CV% for accepting the results of Bhal and Coastal zone crops experiments is 18 per cent for yield character.

(26) The yard stick of CV% for accepting the results of Arnej centre (Bhal and Coastal Zone) crops experiments is 20 per cent for yield character.

To consult the statistician after an experiment is finished is often merely to ask him to conduct a postmortem examination. He can perhaps say what the experiment died of.

-RA Fisher

Appendix – I

Uniformity trial on Arhar at S K Nagar

Variability study during 1980 to 1990 indicated high variation (>23 % CV) in Arhar experiments at S.K.Nagar. Therefore, uniformity trial on semi rabi Arhar was conducted at the Agricultural Research Station, Aseda, S. K. Nagar in the year 1997-98 to work out optimum size and shape of plot for Arhar crop experimentation. The crop was sown at 60 cm spacing between rows. The grain yield and plant stand was recorded for each of the 1296 basic units. Each basic unit was of 0.6 sq.m size - 1 m length of each raw. The total area harvested was 21.6 x 36 m.

Table 1: Coefficient of variation (CV %) for different plot sizes for grain yield and plant stand of Arhar

Plot size and shape			No of Units	CV % per unit area		Av. CV % per unit area		Per unit decrease in CV%	
U	**W**	**L**		**Yield**	**Pl. St.**	**Yield**	**Pl. St.**	**Yield**	**Pl. St.**
1	1	1	1296	30.25	33.04	30.25	33.04	-	-
2	2	1	648	22.86	25.13	24.25	25.76	6.00	7.28
	1	2		25.63	26.39				
3	3	1	432	19.75	22.22	21.10	22.66	3.15	3.10
	1	3		22.45	23.09				
4	4	1	324	17.21	19.92	19.48	20.44	1.62	2.22
	2	2		19.80	20.63				
	1	4		21.43	20.79				
6	6	1	216	14.50	17.04	16.85	17.25	1.31	1.60
	3	2		17.29	18.50				
	2	3		17.29	28.50				
	1	6		18.33	17.88				
8	4	2	162	15.30	16.83	16.32	17.03	0.26	0.11
	2	4		17.34	13.23				
9	9	1	144	10.88	15.12	14.64	15.89	0.27	1.14
	3	3		16.27	17.11				
	1	9		16.78	15.44				
12	12	1	108	9.29	13.87	13.83	15.14	0.27	0.25
	6	2		13.05	14.86				
	4	3		14.33	15.80				
	3	4		15.48	15.80				
	2	6		15.23	15.29				
	1	12		15.61	15.24				
16	4	4	81	13.83	14.78	13.83	14.78	0.00	0.12
18	18	1	72	7.04	10.42	11.86	13.41	0.98	0.69
	9	2		9.38	13.13				
	6	3		12.23	14.08				

Plot size and shape			No of Units	CV % per unit area		Av. CV % per unit area		Per unit decrease in CV%	
U	W	L		Yield	Pl. St.	Yield	Pl. St.	Yield	Pl. St.
	3	6		14.09	14.82				
	2	9		14.47	13.94				
	1	18		13.98	14.21				
24	12	2	54	8.20	12.28	11.53	13.25	0.05	0.03
	6	4		11.67	13.04				
	4	6		12.58	13.88				
	2	12		13.69	13.84				

U= Unit ; W = Width of plot ; L = Length of plot.

Table 2: Coefficient of variation for plot and blocks of different size and shape

Block size	Plot size		Plot Shape			Block Shape			CV % for Block size
	Unit	CV %	L	W	CV %	L	W	CV %	
4	1	19.48	1	1	19.48	1	4	21.43	11.76
						2	2	19.80	
						4	1	17.21	
	9	9.75	1	9	12.44	1	4	12.85	
						2	2	12.22	
						4	1	12.26	
			3	3	10.29	1	4	12.81	
						2	2	10.52	
						4	1	7.53	
			9	1	6.51	1	4	8.24	
						2	2	6.26	
						4	1	5.05	
	12	9.29	1	12	11.69	4	1	11.69	
			12	1	6.90	1	4	6.90	
6	1	16.98	1	1	16.98	1	6	18.33	10.66
						2	3	17.82	
						3	2	17.29	
						6	1	14.50	
	9	8.50	1	9	8.50	3	2	11.49	
			3	3		2	3	9.94	
			9	1		3	2	7.10	
						2	3	5.51	
	12	7.90	1	12	11.45	2	3	11.45	
			2	6	10.23	2	3	10.56	
			6	2	5.48	3	2	9.90	
			12	1	4.39	2	3	5.77	
						3	2	5.20	
						3	2	4.39	

Block size	Plot size		Plot Shape			Block Shape			CV % for Block size
	Unit	CV %	L	W	CV %	L	W	CV %	
9	1	14.64	1	1	14.64	1	9	16.78	8.93
						3	3	16.27	
						9	1	10.88	
	9	6.09	3	3	6.09	3	3	6.09	
	12	6.65	1	12	8.57	3	3	10.80	
						9	1	6.34	
			2	6	6.16	3	3	8.53	
						9	1	3.79	
12	12	6.11	4	3	7.57	1	12	10.03	6.11
						3	4	5.12	
			3	4	3.20	12	1	3.20	

U= Unit ; W = Width of plot ; L = Length of plot.

The results of the uniformity trial on semi rabi Arhar crop revealed that the CV % (variability) decreased with the increase in plot size up to 9 unit size, thereafter decrease was not proportional to the area added to form large size plot (s). The plot size adjacent to 9 unit size is 12 unit size i.e. 7.2 sq.m plot size, the optimum plot size for semi rabi Arhar crop experiments at S K Nagar. However, this requires confirmation through repeated uniformity trials.

Critical tests of this kind may be called tests of significance, and when such tests are available we may discover whether a second sample is or is not significantly different from the first.

Edinburgh: Oliver

Appendix II

Uniformity trial on Arhar at Derol

Variability study during 1997 to 1998 indicated high variation in Arhar experiments at Derol. Therefore, uniformity trial on semi rabi Arhar was conducted at the Agricultural research station Derol in the year 1997-98 to work out optimum size and shape of plot for Arhar crop experimentation. The crop was sown at 90 cm spacing between rows. The crop was harvested in continuous basic unit, each of 0.90m × 1.00 m consisting of one rows of 1 m length giving in all 864 units from 21.6 m × 36 m block.

Table 1: Coefficient of variation (CV %) for different plot sizes for grain yield of Arhar

Plot size			No. of unit	CV % for yield	Average CV %	Per unit decrease CV%
1	1	1	864	60.68	60.68	-
2	2	1	432	41.60	42.89	17.79
	1	2		44.19		
3	3	1	288	34.41	35.56	7.33
	1	3		36.72		
4	4	1		30.77	31.01	5.55
	2	2		29.36		
	1	4		32.91		
6	6	1	144	25.36	25.84	2.58
	3	2		24.11		
	2	3		26.35		
	1	6		27.58		
8	8	1	108	23.13	22.59	1.63
	4	2		22.22		
	2	4		22.43		
9	3	3	96	19.90	21.71	0.88
	1	9		23.52		
12	12	1	72	17.13	18.86	0.95
	6	2		17.53		
	4	3		18.98		
	3	4		17.79		
	2	6		19.49		
	1	12		22.25		
16	8	2	54	16.64	16.40	0.62
	4	4		16.17		
18	6	3	48	14.86	15.53	0.44
	3	6		14.04		
	2	9		15.93		
	1	18		17.29		
24	24	1	36	13.13	13.53	0.33
	12	2		12.09		

Plot size			No. of unit	CV % for yield	Average CV %	Per unit decrease CV%
	8	3		13.50		
	6	4		13.70		
	4	6		13.59		
	2	12		15.18		
27	3	9	32	11.54	11.54	0.66
32	8	4	27	13.50	13.50	-0.39
36	12	3	24	9.79	10.76	0.68
	6	6		10.72		
	4	9		9.56		
	3	12		10.00		
	2	18		10.99		
	1	36		13.47		

U= Unit ; W = Width of plot ; L = Length of plot.

The results indicated usual trend in CV %. The proportionate decrease was upto 9 unit size plot, thereafter decrease was not proportional to area added to form larger size plots. The 12 unit size plot (10.8 sq.m) adjacent to 9 unit size, is appared optimum size of plot for experiments on Arhar crop at Derol.

Among all combination of 12 units size plot, 12 × 1 units plot had minimum CV % and next in line was 6 × 2 units size. Therefore, plot of 12 units (10.8 sq.m.) having shape of 2 m along length (South to North) and 5.4 m cross width (6 row east to west) could be considered as optimum size and shape for field experiments on Arhar at Derol.

I could prove God statistically. Take the human body alone — the chances that all the functions of an individual would just happen is a statistical monstrosity.

\- ***George Gallup***

Appendix - III

Uniformity trial on Cluster bean (Guar) at S K Nagar

Variability study during 1992 indicated high variation (>20% CV) in cluster bean crop experiments at S K Nagar, Arnej and Bhachau. Therefore, uniformity trial on cluster bean was conducted at the Pulses Research Station, GAU., S K Nagar during kharif 2001 to work out optimum size and shape of plot for cluster bean crop experimentation. The crop was drilled at inter raw spacing of 45 cm. A block of 36m x 36m area was harvested unit wise, each unit was of 0.9 m (two rows) x 1 m = 0.9 sq, m area and grain yield was recorded.

Table 1: Coefficient of variation for different plot sizes for grain yield of cluster bean

Plot size and shape			No. of Units	CV% per unit area	Average CV % per unit area	Per unit decrease in CV %
U	W	L				
1	1	1	1296	28.83	28.83	-
2	2	1	648	23.55	22.69	6.14
	1	2		21.82		
3	3	1	432	22.04	20.70	1.99
	1	3		19.35		
4	4	1	324	21.02	18.90	1.80
	2	2		18.02		
	1	4		17.60		
6	6	1	216	19.26	17.20	0.85
	3	2		16.97		
	2	3		16.57		
	1	6		16.01		
8	4	2	162	16.21	15.71	0.74
	2	4		15.23		
9	9	1	144	18.43	15.91	-0.20
	3	3		15.62		
	1	9		13.69		
12	12	1	108	17.07	14.77	0.38
	6	2		14.83		
	4	3		15.29		
	3	4		14.49		
	2	6		14.29		
	1	12		12.77		

Plot size and shape			No. of Units	CV% per unit area	Average CV % per unit area	Per unit decrease in CV %
U	W	L				
16	4	4	81	14.04	14.04	0.12
18	18	1	72	15.33	13.56	0.24
	9	2		14.54		
	6	3		14.17		
	3	6		13.75		
	2	9		12.07		
	1	18		11.73		
24	12	2	54	13.12	12.77	0.13
	6	4		13.07		
	4	6		13.54		
	2	12		11.36		
27	9	3	48	13.93	12.86	-0.03
	3	9		11.80		

U= Unit ; W = Width of plot ; L = Length of plot.

CV % and CV % per unit area were worked out using standard method of analysis. The results followed normal trend. The decrease in CV due to increase in plot size was propositional up to 6 unit size plot, thereafter the decrease was not prepositional to the area added in forming large size plots. Therefore, 8 unit size plot (7.2 sq.m), adjacent to 6 unit size, is optimum plot for cluster bean experiment at SK Nagar.

Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin.

-John von Neumann

Appendix -IV
Uniformity trial on Maize

Variability study during 1983-1992 indicated high variation (>32 % CV) in maize experiments at Godhra. Therefore, uniformity trial on maize crop was conducted during 1991-93 at the Main Research Station (Maize) Godhra to work out optimum size and shape of plot for maize crop experimentation. The interraw distance was 0.6 m. Three variables were recorded unit wise; each unit was of 0.6 m. x 1 m size.

All the variables (Table 1) showed very high CV %. This being characteristic of Godhra farm, no conclusion on plot size and shape could be drawn. Shallow soil depth coupled with erosion is the major problems of this farm resulting high variability in the experimental data. Special efforts are required to bring in uniformity in fertility in each field (plot) of the farm before taking up any experiment.

Table 1: Coefficient of variation per unit size in per cent for various characters in Maize uniformity trial

Plot size and shape			CV %			Average CV %			Per unit decrease in CV % - Ear wt.
U	W	L	Ear weight	No. of plants	No of ears	Ear weight	No. of plants	No of ears	
1	1	1	56.25	36.89	47.81	56.25	36.89	47.81	-
2	2	1	42.11	25.72	35.27	42.78	27.19	35.54	13.47
	1	2	43.44	28.66	35.82				
4	2	2	35.58	19.59	26.72	34.44	21.20	27.08	4.17
	1	4	33.3	22.8	27.46				
5	5	1	28.56	16.96	22.27	30.62	19.56	23.65	3.82
	1	5	32.86	22.16	25.03				
8	2	4	25.79	14.36	20.53	26.66	16.64	21.5	1.32
	1	8	27.53	18.92	22.46				
10	10	1	22.89	13.05	17.33	24.38	14.68	18.53	1.13
	5	2	23.19	13.48	17.14				
	2	5	24.94	13.87	18.59				
	1	10	26.51	18.33	21.04				
16	2	8	21.29	11.15	16.72	21.29	11.15	16.72	0.52
20	10	2	19.29	10.12	13.68	17.49	11.71	14.84	0.95
	5	4	18.74	10.18	13.10				
	2	10	12.16	10.64	15.55				

Plot size and shape			CV %			Average CV %			Per unit decrease in CV % - Ear wt.
U	W	L	Ear weight	No. of plants	No of ears	Ear weight	No. of plants	No of ears	
	1	20	19.80	15.89	17.04				
25	25	1	17.05	9.02	10.24	17.72	9.65	11.26	-0.04
	5	5	18.39	10.27	12.28				
40	10	4	15.27	7.84	10.84	15.78	9.38	12.12	0.13
	5	8	15.28	7.63	10.34				
	2	20	14.68	8.71	12.34				
	1	40	17.9	13.34	14.98				
50	50	1	14.57	7.07	7.76	15.19	7.38	9.29	0.06
	25	2	14.58	6.98	8.47				
	10	5	15.77	7.92	10.53				
	5	10	15.85	7.56	10.45				
80	10	8	13.09	6.11	9.46	12.92	6.49	10.2	0.07
	2	40	12.74	6.87	10.94				
100	50	2	12.76	5.28	6.17	11.91	5.81	7.44	0.05
	25	4	11.46	5.47	6.65				
	10	10	13.96	6.25	9.25				
	5	20	9.45	6.22	7.7				
125	25	5	12.22	5.22	6.04	12.22	5.22	6.04	-0.01
200	50	4	10.52	3.86	5.14	8.9	4.46	6.12	0.02
	25	8	9.82	4.32	5.27				
	10	20	7.26	5.28	7.21				
	5	40	7.99	4.4	6.86				

U= Unit ; W = Width of plot ; L = Length of plot.

The results of three attributes of maize crop recorded in uniformity trial conducted at Godhra showed that the CV decreased with the increase in plot size. In case of ear weight the decrease was up to 16 unit size (9.6 sq.m.), thereafter decrease was not proportional to area added to form large size plots. Therefore, 20 unit size (12.0 sq.m.), adjacent to 16 unit size appears optimum plot size for field experiments on maize crop at Godhra. Looking to the large variation observed in the experimental results, it is advised to repeat the uniformity trila at Godhra farm.

Appendix – V

Uniformity trial on Drilled Paddy- Derol farm

The experiments on drilled paddy at Derol show large variation in experimental results (25 % CV). Therefore, it was thought worthwhile to work out optimum size and shape of plot for experimentation on drilled paddy (variety ; Sathi 34-36), The uniformity trial was conducted during kharif 1996 at the Agricultural Research Station, Derol. The crop was drilled keeping 45 cm. distance between lines. The crop was harvested in continuous basic unit of 0.9 m (two rows) x 1.0 m (length) from a block of 66 m x 21.6 m area. Grain yield and straw yield data were obtained for 1584 units and subjected to statistical analysis.

Table 1: Coefficient of variation for different plot size and shape in per cent for grain and straw yield of drilled paddy

Plot size and shape			CV %		AV. CV %		Per unit decrease in CV%	
U	W	L	Grain	Straw	Grain	Straw	Grain	Straw
1	1	1	22.91	23.94	22.91	23.94	-	-
2	1	2	20.01	20.86	19.45	20.16	3.46	3.78
	2	1	18.88	19.47				
3	1	3	18.42	19.19	17.44	18.03	2.01	2.13
	3	1	16.45	16.86				
4	2	2	17.08	17.49	16.47	16.78	0.97	1.25
	4	1	15.85	16.18				
6	1	6	16.36	16.88	15.35	15.7	0.56	0.54
	2	3	16.00	16.44				
	3	2	15.00	15.27				
	6	1	14.03	14.2				
8	4	2	14.61	14.8	14.22	14.31	0.56	0.70
	8	1	13.82	13.82				
9	3	3	14.47	14.71	14.47	14.71	- 0.25	- 0.40
12	2	6	14.64	14.86	13.54	13.59	0.312	0.37
	4	3	14.09	14.24				
	6	2	13.11	13.23				
	12	1	12.31	12.03				
16	8	2	13.24	13.23	13.20	13.23	0.07	0.09
18	3	6	13.31	13.31	13.11	13.13	0.06	0.10
	6	3	12.91	12.95				
22	1	22	13.29	13.88	13.49	13.87	- 0.09	- 0.19
	2	11	13.68	13.87				
24	4	6	13.20	13.25	12.13	11.76	0.68	1.05
	8	3	12.81	12.76				
	12	2	11.90	11.60				

Plot size and shape			CV %		AV. CV %		Per unit decrease in CV%	
U	**W**	**L**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**
	24	1	10.60	9.44				
36	6	6	12.08	11.99	11.88	11.63	0.02	0.01
		12	13.00	11.69	11.28			

U= Unit ; W = Width of plot ; L = Length of plot.

The result showed usual relation between plot size and CV % per unit area. The proportionate decrease was up to 6 unit size plot. Thereafter the decrease in CV % was not proportional to area added to form bigger size plots. Hence 8 unit size (7.2 sq.m) adjacent to 6 unit size could be considered as optimum size of plot for drill paddy experiments at Derol farm.

"There probably is a God. Many things are easier to explain if there is than if there isn't."

- (Genius Who Pioneered the Modern Computer, Game Theory, Nuclear Deterrence and Much More (1992)

Appendix – VI

Uniformity trial on Cotton at Targhadia, Rajkot

Variability study indicated high variation (>18 % CV) in Cotton experiments at different research stations of GAU. Therefore, uniformity trial on Cotton (Variety SRT-1) was conducted at the Dry Farming Research Station, Targhadia, Rajkot during kharif 1997-98 and 1998-99 to work out optimum size and shape of plot for Cotton crop experimentation. Row spacing was 0.9 m. A block of 32.4 m x 48m was harvested unit wise; each unit was of single row of one meter length (0.9 m x 1 m = 0.9 sq. m) cotton weight was recorded for analysis.

Table 1: Coefficient of variation for different plot sizes for seed cotton yield (average of two years)

Plot size and shape			No of Units	CV %	AV CV %	Per unit decrease in CV%
U	W	L				
1	1	1	1728	44.58	44.58	-
2	2	1	864	34.93	33.42	11.16
	1	2		31.90		
3	3	1	576	30.38	28.76	4.66
	1	3		27.12		
4	4	1	432	27.71	25.50	3.26
	2	2		24.94		
	1	4		24.05		
6	6	1	288	24.44	22.25	1.62
	3	2		22.08		
	2	3		21.38		
	1	6		20.76		
8	8	1	216	21.71	20.29	0.98
	4	2		20.19		
	2	4		18.93		
9	3	3	192	19.33	18.31	1.98
	1	9		17.29		
2	12	1	144	19.65	17.50	0.27
	6	2		17.88		
	4	3		18.02		
	3	4		16.88		
	2	6		16.69		
	1	12		15.84		
16	16	1	108	17.27	16.38	0.18
	8	2		16.23		
	4	4		15.65		
18	6	3	96	16.12	14.63	0.87
	3	6		15.14		
	2	9		14.60		

Plot size and shape			No of Units	CV %	AV CV %	Per unit decrease in CV%
U	W	L				
	1	18		13.07		
24	24	1	72	15.54	14.41	0.03
	12	2		14.51		
	8	3		14.90		
	6	4		14.05		
	4	6		14.40		
	2	12		13.09		

U= Unit ; W = Width of plot ; L = Length of plot.

Table 2: Coefficient of variation for plot and blocks of different size and shape

Block size	Plot size		Plot Shape			Block Shape			CV % for Block size
	Unit	CV %	L	W	CV %	L	W	CV %	
4	1	2.50	1	1	25.50	1	4	2.85	15.24
						2	2	24.94	
						4	1	27.71	
	3	17.50	1	3	16.85	1	4	15.84	
						2	2	16.69	
						4	1	18.02	
			3	1	18.12	1	4	16.88	
						2	2	17.85	
						4	1	19.65	
	6	14.41	2	3	14.13	1	4	13.09	
						2	2	14.40	
						4	1	14.90	
			3	2	14.28	2	2	14.05	
						4	1	14.51	
			6	1	16.04	4	1	16.04	
	9	11.87	9	1	11.09	1	4	9.26	
						2	2	11.19	
						4	1	12.83	
			3	3	12.75	1	4	12.07	
						2	2	12.90	
						4	1	13.30	
	12	11.94	1	12	11.71	4	1	11.71	
			4	3	12.33	2	2	12.58	
						4	1	12.08	
			12	1	11.78	1	4	11.70	
						2	2	11.59	
						4	1	12.07	
6	1	22.25	1	1	22.25	1	6	20.71	13.90
						2	3	21.38	

Block size	Plot size		Plot Shape			Block Shape			CV % for Block size
	Unit	CV %	L	W	CV %	L	W	CV %	
						3	2	22.08	
						6	1	24.44	
	3	14.74	1	3	14.74	1	6	13.07	
						2	3	14.60	
						3	2	15.14	
						6	1	16.12	
	6	11.87	1	6	10.84	1	6	9.26	
						2	3	11.19	
						3	2	12.07	
			2	3	12.83	2	3	12.86	
			3	2	12.90	3	2	12.90	
			6	1	13.35	6	1	13.35	
	9	10.97	1	9	10.20	3	2	10.20	
			3	3	11.74	2	3	11.74	
			1	12	7.74	2	3	7.74	
			2	6	10.31	2	3	9.93	
						3	2	10.69	
			4	3	11.24	2	3	11.38	
						3	2	11.09	
9	1	18.31	1	1	18.31	1	9	17.29	12.19
						3	3	19.33	
	3	13.34	3	1	13.34	1	9	13.34	
	6	10.97	1	6	10.20	3	3	10.20	
			2	3	11.74	3	3	11.74	
	12	8.87	1	12	6.84	3	3	6.84	
			2	3	9.01	3	3	9.01	
			4	3	9.80	3	3	9.80	
12	12	8.56	1	12	6.36	4	3	6.36	8.54
			2	6	8.72	4	3	8.72	
			3	4	9.50	4	3	9.50	
			4	3	9.60	4	3	9.60	
			6	2	9.30	4	3	9.30	
			12	1	7.80	4	3	7.80	

"Newton's law is nothing but the statistics of gravitation, it has no power whatever."

- Florence Nightingale

Table 3: Coefficient of variation for plot and blocks of different size and shape for cotton crop

Block size	Plot size	Plot Shape		Block Shape		CV %		Av. CV %	
		L	W	L	W	1998	1999	1998	1999
4	1	1	1	1	4	26.41	21.28	28.87	22.13
				2	2	28.2	21.68		
				4	1	31.98	23.44		
	3	1	3	1	4	17.84	13.84	20.09	14.91
				2	2	19.13	14.25		
				4	1	20.61	15.43		
		3	1	1	4	18.89	14.86		
				2	2	20.61	15.08		
				4	1	23.29	16		
	6	2	3	1	4	14.99	11.18	16.97	11.85
				2	2	16.77	12.03		
				4	1	17.4	12.4		
		3	2	2	2	16.33	11.76		
				4	1	16.76	12.25		
		6	1	4	1	19.59	12.49		
	9	1	9	1	4	9.81	8.71	13.13	10.61
				2	2	11.6	10.78		
				4	1	14.2	11.45		
		3	3	1	4	13.71	10.42		
				2	2	15.14	10.66		
				4	1	15.03	11.56		
	12	1	12	4	1	13.48	9.94	14.4	9.49
		4	3	2	2	14.72	10.44		
				4	1	13.74	10.42		
		12	1	1	4	13.4	10		
				2	2	13.71	9.46		
				4	1	17.45	6.68		
6	1	1	1	1	6	23.01	18.41	25.25	19.25
				2	3	24.57	18.19		
				3	2	24.91	19.24		
				6	1	28.52	20.35		
	3	1	3	1	6	13.61	12.52		
				2	3	16.04	13.15	16.13	13.12
				3	2	17.14	13.13		
				6	1	18.56	13.68		

Block size	Plot size	Plot Shape		Block Shape		CV %		Av. CV %	
		L	W	L	W	1998	1999	1998	1999
	6	1	6	1	6	9.81	8.71	13.13	10.61
				2	3	11.6	10.78		
				3	2	13.71	10.42		
		2	3	2	3	14.2	11.45		
		3	2	2	3	15.14	10.66		
		6	1	2	3	15.03	11.66		
	9	1	9	3	2	10.36	10.03	11.60	10.33
		3	3	2	3	12.83	10.64		
	12	1	12	2	3	7.97	7.5	11.29	9.2
		2	6	2	3	10.09	9.76		
				3	2	12.36	9.01		
		4	3	2	3	12.25	10.5		
				3	2	12.93	9.25		
	12	1	2	3		12.13	9.12		
9	1	1	1	1	9	18.76	15.82	20.20	16.42
				3	3	21.63	17.02		
	3	3	1	1	9	14.38	12.29	14.38	12.29
	6	1	6	3	3	10.36	10.03	11.60	10.33
		2	3	3	3	12.83	10.64		
	12	1	12	3	3	6.55	7.12	8.88	8.85
		2	3	3	3	8.99	9.02		
		4	3	3	3	10.1	9.5		
12	12	1	12	4	3	6.08	6.64	9.48	7.64
		2	6	4	3	8.32	9.11		
		3	4	4	3	10.84	8.15		
		4	3	4	3	10.39	8.8		
		6	2	4	3	10.54	8.05		
		12	1	4	3	10.69	4.9		

With standard method, CV%, CV % unit area and decrease in CV % per unit area were calculated for cotton yield. The result showed decrease in CV % with increase in plot size. The proportional decrease was up to 9 unit size plot. Therefore, the plot size adjacent to 9 unit plot size was considered as optimum plot size i.e. 12 unit size (10.8 sq.m. area) for field experiments on Cotton at Targhadia, Rajkot. Before advocating optimum plot size, it is worth to repeat uniformity trial.

From the above results it could be concluded that 10.8 sq. m. (12 unit) plot size having shape of 2 m length (N-S) and 5.4 m cross width (6 rows E-W) could be considered as optimum size and shape for cotton crop experiments at Targhadia Farm, Rajkot.

Appendix – VII

Uniformity trial on Chilli at Anand

Variability study in the year 2000 on vegetable crop experiments indicated high variability in chilli and tomato crops at Anand. Therefore uniformity trial on chilli was conducted during 2003 and 2004 at the Vegetable Research Station, Anand to work out optimum size and shape of plot and block for experimentation on chili crop. The crop was planted at a spacing 60 cm x 60 cm. The basic unit of 1.2 m x 1.2 m = 1.44 sq.m size was used to record green fruit yield, the total area covered was 25.2 m. x 25.2 m. making 441 units.

Table 1: Coefficient of variation for different plot sizes after Logarithmic transformation of total green fruit yield (year 2003)

Plot size and shape			Combinations	Total yield		
U	W	L		CV %	AV. CV %	Per unit decrease
1	1	1	441	31.75	31.75	
3	3	1	147	22.72	22.00	4.87
3	1	3	147	21.27		
7	7	1	63	17.54	17.53	1.12
7	1	7	63	17.52		
9	3	3	49	16.56	16.56	0.48
21	21	1	21	12.50	13.16	0.28
21	7	3	21	13.51		
21	3	7	21	14.85		
21	1	21	21	11.76		
49	7	7	9	12.53	12.53	0.02
63	21	3	7	9.35	10.82	0.12
63	3	21	7	12.29		
147	21	7	3	8.84	8.51	0.03
147	7	21	3	8.17		

U= Unit ; W = Width of plot ; L = Length of plot.

Using standard method, CV % per unit area was estimated for various sizes plots. Primary data collected during first year of study showed large variation hence log transformed data were used in estimation. (Table 1). Results showed normal trend, per unit decreased in CV was observed up to 9 unit size and thereafter the decrease in CV was not proportional to the area added to form large plots. Based on these results, 9 units size plot (12.96 sq.m.) could be taken as optimum plot size.(This is because the adjacent plot size is of 21 unit, which is 2.33 times larger - affecting cost function. Therefore, other combinations like 12,14,15 units etc require to work upon).

Table 2 presents the results of the uniformity trial conducted during 2004. These results also showed large variation (very high CV), however, trend remained the same as observed during the first year (Table 1) and 9 unit size plot (12.96 sq.m) seems to be optimum size for field experiments on chilli crop at Anand.

Table 2: Coefficient of variation (CV %) for different plot size for green fruit yield of chilli (year 2004)

Plot size and shape			Combi-nations	First Picking			Second picking			Third picking			Total		
U	W	L		CV %	AV. CV %	Per unit decrease	CV %	AV. CV %	Per unit decrease	CV %	AV. CV %	Per unit decrease	CV %	AV. CV %	Per unit decrease
1	1	1	441	91.18	91.18	-	65.96	65.96	-	87.73	87.73	-	58.51	58.51	
3	3	1	147	66.46	63.07	14.08	46.12	44.88	10.54	58.74	54.87	16.04	41.48	39.66	9.43
3	1	3	147	59.67			43.33						37.83		
7	7	1	63	54.12	49.63	3.96	37.1	36.04	2.21		41.87	3.25	32.72	31.95	1.93
7	1	7	63	45.05			34.97						31.18		
9	3	3	49	45.07	45.07	2.28	33.13	33.13	1.45		36.95	1.23	28.6	28.6	1.67
21	21	1	21	44.41	36.2	0.94	27.6	26.78	0.53		27.4	0.80	23.55	23.35	0.44
21	7	3	21	39.22			28.16						23.78		
21	3	7	21	36.4			29.02						25.42		
21	1	21	21	24.77			22.33						20.65		
49	7	7	9	32.52	32.52	0.13	25.5	25.5	0.05		22.97	0.16	22.1	22.10	0.04
63	21	3	7	32.59	25.46	0.50	19.83	19.37	0.44		15.64	0.52	16.17	16.93	0.37
63	3	21	7	18.33			18.91						17.68		
147	21	7	3	26.08	19.94	0.07	18.32	17.23	0.25		23.56	0.04	15.35	15.14	0.02
147	7	21	3	13.79			16.14						14.92		

"It appears to be a quite general principle that, whenever there is a randomized way of doing something, then there is a nonrandomized way that delivers better performance but requires more thought."

-Edwin Thompson Jaynes

Appendix - VIII

Research papers on variability and plot technique published in different journals

1.	Patel, N.M. and R.M.Patel. 1969. Plot size studies in Bajri-*Pennisetum typhoides.*BACA Mag.89-97.
2.	Prajapati, B.H. and N.M.Patel.1984. Estimate of optimum plot size from uniformity data of bidi Tobacco. *GAU Res. J.***9** (2): 36-39.
3.	Patel, N.M., R.B.Patel and A.S.Patel. 1985. Plot Size Studies in forage Oat Under Two Methods of Irrigation.*GAU Res. J.***10** (2) : 5 – 9
4.	Patel, N.M., R.B.Patel and A.S.Patel. 1985. Plot size studies in forage oat under two methods of irrigation.*GAURes.J.***10** (2) : 5 - 9
5.	Upadhyay, S.M., B.H. Prajapati; K.R.V. Raja and V.B. Darji. 1994. Optimum plot size for summer paddy in the Navsari zone of Gujarat. *GAU Res. J.***19**(2):92
6.	Patel, N.M., Purohit L.P. and U.J.Upadhyay. 1995. A note on experimental factors influencing variability in research data of Pulse crops, *J.Ind.Soc. Agril.Stat.***47** (3) : 249-252.
7.	Bhatt, H.M., P.R.Vaishnav, and V.B.Darji.1998. Plot techniques in potato (*Solanum tubersum*, L) *GAU Res. J.***24** (1) ; 67-72.
8.	Patel, K. M., K.P. Prajapati, C. J. Patel and N. P. Patel . 2003. Variability and Correlation Studies for Fatty Acids in Indian Mustard. *International J. of Brassicas*,**5**(3&4).
9.	Patel, J. K., N. M. Patel and J. S. Patel. 2004. Experimental factors influencing uncontrolled variation(CV%). *J. Maharashtra Agric. Univ.***29**(1) : 74-76.
10.	Patel, J.S., N. M. Patel, S. K. Dixit and D. J. Parmar. 2004. Effect of biparentalmating and extent of genetic variability in Tobacco (*Nicotiana tabacum* L.). *J. Maharashtra Agric. Univ.***29**(2):172-175.
11.	Patel, J.B., J.D.Awadaria, R.K.Parikh and J.S.Patel. 2008. Estimation of optimum plot size for field experiment on green gram (*Phaseolus rediatus* L.). *Bioscience Reporter*, **6**(2):393-397.
12.	Darji, V. B, S. K. Dixit, N. M. Patel and B. K. Bhatt. 2009. Removing spatial variability from field experiment data – A case study on Nagli yield trial. *Crop Res.***37**(1,2& 3):192-194.
13.	Motaka, G. N., and B. H. Prajapati. 2010. Plot size study from uniformity trial data in durum wheat (*Triticum durum* L.) for Bhal region. *Int. J. of Bioscience Reporter*, **8**(1):19-25.
14.	Darji, V. B., B. K. Bhatt and S.K. Dixit. 2010. Variability in forage crop field experiments and yardstick thereof. *Agric. Sci. Digest*,**30**(4):266-269.
15.	Naliyadar C. M.; S. M. Upadhyay and A. D. Kalolal. 2010. Optimum plot size for field experiments on tomato (*Lycopersicon esculentum* Mill.). *GAU Res. J.*,**35**(1):45-48.
16.	Shitap M. S. and V. B. Darji. 2014. On optimum plot size and shape for field experimentation on brinjal (*Solanumm elongena* L.) under middle Gujarat condition. *Internat. Res. J. Agric. Eco.& Stat.*, **5** (2): 148-152.

17.	Motaka, G.N.; D.J. Parmar, A.D. Kalola, V.B. Darji and P.R.Vaishnav. 2016. Study on variability in field experiments of Isubgul crop. *International Journal of Current Research*,**8**(3): 27195-27197.
18.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav. 2016. Development of yardstick and study on variability in field experiments of Gram (Bhal and Coastal Zone) crop. *Advances in life Sciences*,**5**(10): 4135-4140.
19.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav. 2016. Study on variability in field experiments of cotton crop (Bhal and Coastal Zone). *International Journal of Agricultural Science and Research*,**6**(3): 295-300.
20.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav. 2016. Study of variability in field experiments on Ashwagandha crop and yardstick thereof. *International Journal of Science, Environment and Technology*,**5**(3): 1349-1354.
21.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav.2016. Study of variability and development of yardstick in field experiments of Safflower (Bhal and Coastal Zone) crop. *Advances in life Sciences*,**5**(16): 6189-6193.
22.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav.2016. Variability study in medicinal and aromatic crop field experiments and yardstick thereof. *GAU Research Journal*, **41**(2): 103-109.
23.	Motaka, G.N., V.B. Darji, D.J. Parmar, A.D. Kalola and P.R.Vaishnav.2016. Study on variability in field experiments of wheat (Bhal and Coastal Zone) crop and yardstick. *International Journal of Agricultural Economics and Statistics*,**7**(2): 178-181.

CROPS COVERED UNDER VARIABILITY STUDIES


बंसीलाल अमृतलाल कृषि महाविद्यालय