Verdict of Efficient Seed Varieties and Fertilizer Application Methods for Chosen Regions on Paddy Cultivation in Sri Lanka

Kumari LPMB[1]
Dr. Ekanayake EMP[2]

ABSTRACT

The present study was carried out to the efficient seed varieties and fertilizer application methods to increase the yield of paddy in Sri Lanka. The sample was based on secondary data which was selected by the crop estimation survey on paddy by the Agriculture and Environment Statistics Division of the Department of Census and Statistics of Sri Lanka. The data of 2007/2008 and 2008/2009 Maha season was selected. For further analysis it has been categorized in to Agro-Ecological regions, such as Low Country of Dry Zone and Low Country of Intermediate Zone. SPSS statistical package and the Excel work sheets were used to analyze the selected sample and the statistical methods; Descriptive Statistics and One-Way ANOVA have been used.

KEYWORDS : Average Yield, Agro-Ecological Regions, Bushels, Acres, Crop Cutting Survey, Maha Season, Yala Season, Mode of Irrigations

INTRODUCTION

Agriculture and Environment Statistics Division (AESD) of the Department of Census and Statistics is responsible for the collection and derivation of statistical information about the nation's agriculture. Therefore the decisions which made by the government and other agricultural institutes are mainly based on the statistics which derived by AESD. At present, the government requests some details about the effective seed varieties, fertilizer types and other effective factors on paddy cultivation since the promotion of paddy cultivation towards self-sufficiency in rice is one of the main goals of the government. But the division was unable to provide that information since they have not done any further analysis under above topics.

By studying the CC3 form, the questionnaire used by (AESD)to collect the effective factors would be achieved by analyzing. Therefore this issue was chosen as the research area since those findings will be very important to the division as well as to the nation.

LITERATURE REVIEW

Seed Varieties

Table 1: Currently available Seed Varieties in Sri Lanka

Group I	Group II	Group III	Group IV	Group V
H-9	H-4	H-7	H-10	Bg 750
Bg 3-5	H-8	Bg 34-6	62-355	
Bg 407	Bg 11-11	Bg 94-1	Bg 34-8	
Bg 745	Bg 90-2*	Bg 94-2	Bg 276-5	
Bg 38	Bg 400-1	Bg 350	Bg 300	
	Bg 379-2	Bg 352	Bg 301	
	Bg 380	Bg 357	Bg 304	
	Bg 450	Bg 358	Bw 272-6B	
	Bg 403	Bg 359	Bw 302	
	Bw 78	Bg 360	At 303	
	Bw 100	Bw 266-7	(At 77-1)	
	Bw 451	Bw 267-3	Bg 305	
	Bw 400	Bg 351		
	Bw 452	At 16		
	Bw 453	At 353		
	Ld 66	At 35		
	MI 273	(At69-2)		
	At 401	Ld 355		
	At 405	Ld 356		
		At 353		

Group I: Five to Six month age group
Group II: Four to Four & half month age group

[1]Graduate, Mathematical Sciences, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

[2]Dean (Senior Lecturer), Department of Mathematical Sciences, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

Group III: Three and half month age group
Group IV: Three month age group
Group V: Two & half month age group

Sampling Design

The sampling design adopted in the survey is a stratified multistage sampling method with treating DS divisions as strata and mode of irrigation schemes namely; Major, Minor, and Rain-fed as sub strata. Number of villages to be selected for crop cutting experiments in each scheme is decided on the basis of following proportions.

Table 2: Table of Sample Design on Crop Cutting Survey on Paddy

Acreage sown in the previous corresponding season	Number of villages to be selected
< 500 Acres	3
500 - <1000 Acres	5
1000 - < 5000 Acres	10
5000 - < 10,000 Acres	15
10,000 - < 15,000 Acres	20
15,000 - < 20,000 Acres	25
20,000 Acres and above	30

In each selected village two crop cutting experiments are conducted.

Paddy Yields

In each selected village/ tract/ kandam two parcels are selected at random and each selected parcel a "Liyadde" (plot) is selected on the same basis to conduct the experiment. In each liyadde thus selected the standard experimental plot of size 16 1/2ft. x 16 1/2 ft. (5 metres x 5 metres) is laid out at random. Then the experimental plot is harvested, the grain threshed, winnowed and the yield is recorded separately. From these results average yield per net acre harvested is estimated at district level and island level.

Estimation of Average Yield of Paddy

Average Yield for a Given Stratum

For a given irrigation mode (i) in a DS division (j)

$$\text{Average Yield } \square_{ij} = \frac{\sum Y_{ijk}}{n_{ij}}$$

For a mode of irrigation (i) in a given district

$$\text{Average Yield } \bar{Y}_i = \frac{\sum (\square_{ij} \times a_{ij})}{\sum a_{ij}}$$

Y_{ijk} is the yield of k^{th} plot in j^{th} DS division and i^{th} mode of irrigation.
n_{ij} is the number of experiments in the j^{th} DS division and i^{th} mode of irrigation
a_{ij} is the harvested area under the j^{th} DS division and i^{th} irrigation mode

Variance for a given DS division (i) and a given irrigation mode

$$\sigma_s^2 = \frac{1}{(n-1)\sum_{i=1} m_i} \left\{ \sum_{i=1}^{n} \frac{}{m_i} - \left(\frac{T}{\sum m_i} \right)^2 \right\}$$

where $T_i = \sum_{j=1}^{mi} Y_{ij}$ sum of yields of all plots in the j^{th} village

$T = \sum_{I=1}^{n} \sum_{j=1}^{mi} Y_{ij}$ sum of plot yields in the i^{th} DS division

Variance for the given district

$$\sigma_d^2 = \frac{\sum (A_s^2 . \sigma_s^2)}{(\sum A_s)^2}$$

A_s = Area harvested for the J^{th} DS division

Total Variance

$$\sigma^2 = \frac{\sum (A_d^2 . \sigma_d^2)}{(\sum A_d)^2}$$

A_d = Area harvested for the district

In estimating the paddy production by district, driage (dry weight) factors ascertained in a survey some time back representing all seed varieties are being used for converting the wet grain to dry grain weights.

METHODOLOGY

Skewness

In statistics, skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable.

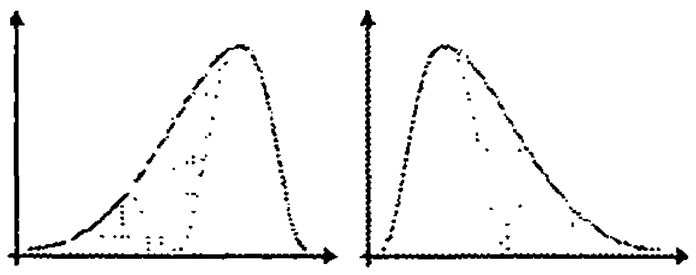

Figure 2: Skewness Diagram

One-way ANOVA

In statistics, one-way analysis of variance is a technique used to compare means of two or more samples (using the F distribution). This technique can be used only for numerical data.

Assumptions

The results of a one-way ANOVA can be considered reliable as long as the following assumptions are met:

- Response variable must be normally distributed Samples are independent.
- Variances of populations are equal.
- Responses for a given group are independent and identically distributed normal random variables (not a simple random sample (SRS)).

P-value Test

If P_ value > 0.05 then Ho is rejected
If P_ value ≤ 0.05 then Ho is accepted

More specifically, the p-value of a statistical significance test represents the probability of obtaining values of the test statistic that are equal to or greater in magnitude than the observed test statistic. To calculate a p-value, collect sample data and calculate the appropriate test statistic for the test performing.

Levene's test

In statistics, Levene's test is an inferential statistic used to assess the equality of variance in different samples. It tests the null hypothesis that the population variances are equal. If the resulting p-value of Levene's test is less than some critical value (typically .05), the obtained differences in sample variances are unlikely to have occurred based on random sampling. Thus, the null hypothesis of equal variances is rejected and it is concluded that there is a difference between the variances in the population.

DATA COLLECTION AND ANALYZING

Details of Data Collection

Secondary data play a vital role in this research. To collect the data of cultivation details and observation of crop cutting survey, filled CC3 forms were used by the enumerators. Statistics on average yields of each district in relation to the Maha Season of recent past were extracted from the publication of Paddy Statistics of 2008/2009 Maha. From that tabulation the areas which were contribute more than 5% to the total yield was selected. Then the selected areas were Anuradhapura, Polonnaruwa, Kurunegala, Ampara, Hambanthota and Mahaweli 'H'.

For further analysis, selected areas were categorized in to Agro-Ecological regions, then the selected areas fallen in to two categories namely Dry Zone Low Country and Intermediate Zone Low Country.

Some calculations have proceeded to estimate the average yield (number of bushels per acre) and the average amount of fertilizers (number of kilograms per acre) of each paddy parcel.

Number of Acres in each paddy parcel =
(((Acres*160) + (Roots*40) +
(Perches))/160) * Correction Factor

Equation 1: Number of Acres in a Paddy Parcel

Average Yield in each paddy parcel = (No. of seers per perch / 32) * 160

Equation 2: Average Yield of a Paddy Parcel

Fertilizer Application Methods

Method 1 = Application of only chemical fertilizers

Method 2 = Application of both chemical and
Organic fertilizers

Method 3 = Application of only organic fertilizers

Agro-Ecological regions

Region 1 = Low country of Dry Zone

Region 2 = Low country of Intermediate Zone

Analysis on Descriptive Statistics

Table 3: Table of Discriptive Statistics of Two Regions

Variables	Descriptives	Region 1	Region 2
Average Yield	Mean Median	105.809 104.85	89.459 88.9750
	Standard Deviation	26.4382	27.7573
	Skewness	0.026	0.116
	Kurtosis	-0.118	-0.172
Chemical Fertilizer (Amount)	Mean Median	152.418 160.00	166.981 160.00
	Standard Deviation	73.7271	75.5311
	Skewness	4.92	3.939
	Kurtosis	54.457	27.513
Organic Fertilizer (Amount)	Mean Median	228.854 1000.00	509.871 1000.00
	Standard Deviation	531.563	817.019
	Skewness	2.78	2.346
	Kurtosis	8.242	7.673

Analysis of One-Way ANOVA

Checking the normality

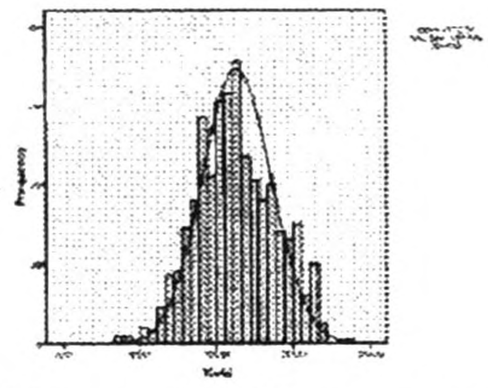

Figure 4 : Histogram of Average Yields in Region 1

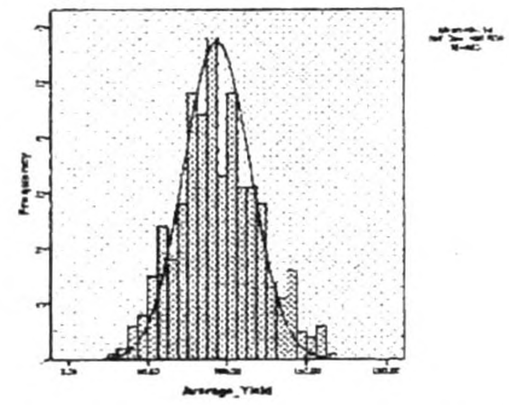

Figure 5: Histogram of Average Yields in Region 2

Table 4: Table of Skewness Values

	Skewness Values	
	Region 1	Region 2
Average Yield	0.041	0.205

The histograms of two regions, Figures 4 and 5, are represented a bell shaped curve. From the Table 4, skewness value is low. Therefore the assumption that the two variables are normally distributed was met.

Checking the Equality of Variances

The Levene's Test of Homogeneity of Variance was used to check the equality of variences.

Table 5: Table of Test of Homogeneity of Variances

	P Value	
	Region 1	Region 2
Levene Statistic	0.017	0.036

Hupothesis:

H_0: Variances are equal of the considered variables

H_1:Variances are not equal of the considered variables

Here, the table 5 shows the significance values of Levene Statistic in two regions are less than 0.05. Therefore the Levene Statistic is significant at 5% level. So can be rejected H_0. That means the variances of the

yield of considered seed varieties were not equal. So the second assumption was met. Therefore now the theory of One-Way ANOVA can be apply by assuming the above considered two factors..

Table 6: Table of Results of One-Way ANOVA

		Region 1	Region 2
Between Seed varieties	F Value	22.603	9.027
	P Value	0	0

Hypotheses:

Null: There are no significant differences between the groups' mean scores.

Alternative: There is a significant difference between the groups' mean scores.

F values of Region 1 and Region 2 are 22.603 and 9.027. P value is 000 in both regions. Since the P value is less than 0.05 null hypotheses were rejected. Therefore there is significance different between average yields of seed varieties in both regions. That means the yield obtained from each seed varieties were different.

Comparison Analysis

Under the analysis of comparison the following areas were observed.

1. Annual average yields of selected areas
2. Average yields of selected two regions in application methods of varieties of fertilizer.

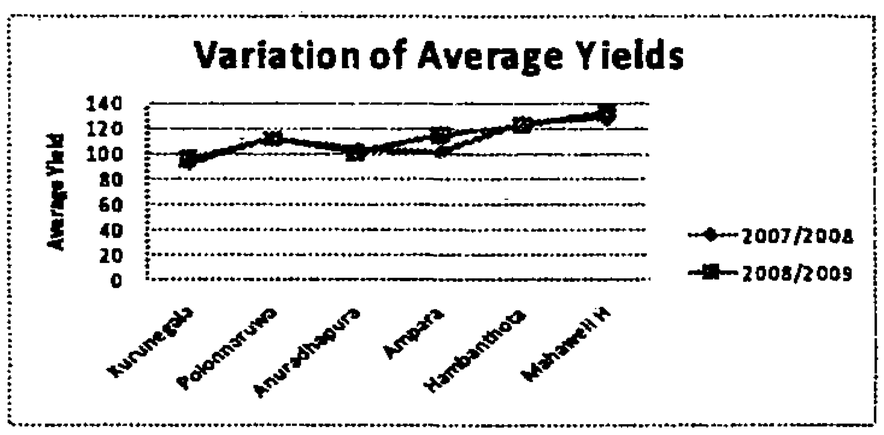

Figure 6: Figure of Variation of Average Yields

Table 7: Table of Average Yield

Application methods of Fertilizers	Region 1	Region 2
Method 1	81.54088	101.8649
Method 2	97.33863	117.519

According to the Figure 6, significant increment of average yield has visible only in Ampara district. In past two seasons highest yield has recorded from Mahaweli H area and the lowest was recorded from Kurunegala district.

According to the Table 7 the highest average yield recorded from the paddy parcels which have been treated with method 2 in both regions.

RESULTS AND DISCISSION

Descriptive statistics of two regions

When considering the mean value of average yield in both regions, the highest value has been obtained by the region 1. From this fact we can conclude that the agro- ecological factors of region 1 is familiar with the efficient production on paddy than region 2. But the standard deviation of both regions are in lower values with compare to the mean values. Therefore the deviation of average yields of each paddy parcels from its mean value is low. When consider the median value it is very close to the mean value and the skewness value is also very low. Therefore the mean value can be assumed as a good representing value for average yield.

Mean value of the chemicals fertilizer in region 2 is the lowest among two regions. Therefore utilization amount of chemicals fertilizer in region 1 is higher than the region 2. As the values of standard deviation and the variance are higher values mean is not a good representing factor of the usage of fertilizers. Therefore we can consider the median value as a representative value since the data series of both chemicals and organic fertilizers representing a skewed distribution.

Result Interpretation on One-Way ANOVA

The farmers of the selected regions have used number of seed varieties on paddy cultivation. There is a doubt whether the seed varieties in different categories provide the same yield or not. Therefore One-Way

ANOVA analysis was used to check whether the different seed varieties were obtain the same yield.

The result was significance, that leads there is significance different in mean values of average yield of seed varieties. The decision that can be taken is the different seed varieties give the different yields or the yield of the paddy parcels is depend on used seed varieties.

Since the yield was different among varieties the best variety that gives efficient yield can be identified from the highest mean value of the average yields in each category.

Selection of best application method of fertilizer and Rationale

There were three methods of application of fertilizers in both regions. The farmers of the selected two regions have used only method 1 and method 2.

As the result of descriptive analysis on average yield and the fertilizer application methods the method 2 was the best application method of fertilizer. Because the highest yield was recorded from the paddy parcels which have been treated with method 2 in both selected regions as shown in Table 7.

Selection of best Seed Variety and Rationale

There are several number of seed varieties which were available on paddy cultivation in Sri Lanka. These varieties can be categorized into groups by considering the time duration that has taken to grow. The following table represents the used varieties for cultivation in both regions and categories of each variety with the mean value of obtained average yield.

Table 8: Table of the Yields of Seed Varieties

		Average Yield	
Category	Variety	Region 1	Region 2
Four to Four and Half Month Age Group	BG379/2	111.725	
	BG450	102.655	
	BG94	84.9786	
	BG94/1	102.7009	
	BG94/2		92.3643
	H8	118.2617	
Three and Half Month Age Group	AT353	124.5238	104.9778
	AT362	138.6108	119.8756
	BG352	112.9765	91.1603
	BG357	107.885	
	BG358	114.1193	94.7402
	BG359		102.2385
	BG360	108.4786	83.0643
Three Month Age Group	AT307		96.1
	BG300	88.4349	83.5074
	BG300/1	118.6929	
	BG305		106.1711

When consider the four to four and half month age group in region 1 since it obtain the highest mean value, the best seed variety is H8. But in region 2 it is complicated to get a decision because only BG94/2 variety was used.

In three and half month age group in region 1 and region 2 the highest mean value of average yield was recorded from variety AT362. Therefore the best seed variety for both regions among three and half month age group is AT362.

The best seed variety among three months age group for region 1 is BG300/1 and for region 2 is BG305 as those varieties recorded the highest mean values of the average yield in respective areas.

CONCLUSION

As one of the objectives of study, efficient seed variety from each category has been identified for selected two regions. Furthermore efficient seed variety for each region from each category can be listed as follows.

- H8 variety is the most suitable one for the low country area of dry zone from the

category of four to four and half month age group.

- AT362 variety is the most suitable one for the low country area of dry zone and low country area of intermediate zone from the category of three and half month age group.
- BG300/1 variety is the most suitable one for the low country area of dry zone from the category of three month age group.
- BG305 variety is the most suitable one for the low country area of intermediate zone from the category of three month age group.

If the government focuses their attention for those details they will be able to specialize the regions according to the seed varieties for better production on paddy.

When considering the fertilizer application methods, the method of applying both chemical and organic fertilizer has been given the higher production in both regions.

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