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ANALYSIS OF MIXED-UP PLOTS IN RANDOMIZED BLOCK DESIGN

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Abstract

Attempt has been made to find out the practical implication of some methods for tackling mixed-up plots in randomized block design. Two methods have been examined and other possible methods discussed in this paper. Infact, both methods used pseudo-variate for mixed-up plots and are equally efficient to tackle the mixed-up values. However, by John and Lewis's (1976) method it could be possible to tackle missing and mixed-up values simultaneously. Other methods also suggested to make a covariance adjustment on a pseudo-variate.

Keywords: Mixed-up plots, Analysis of covariance, Non-iteration, Residuals, Randomized block design.

In designed experiments it sometimes happens that one or more observations are lost or cannot be used, which may be unavoidable. Besides that in the hurry of data recording it is quite easy to mix-up two or three plots and also it is quite easy for a container to be lost and then, when it is found, no one can say which of plots it came from. In most of the cases the total for the plots is known, but it is not sure how to apportion it.

Nair (1939) proposed the use of dummy covariates in estimating observations which have been inadvertently mixed-up, that is whose total value is known but whose individual values are unknown.

John and Lewis (1976) also used pseudo-variate and showed that it could be possible to tackle missing and mixed-up values simultaneously. Smith (1981) showed that a covariance model also yields an exact analysis in the case of mixed-up plots.

Pearce (1983) suggested that the best procedure in case of genuine doubt is to assign the whole crop for the two plots, which is not in question, to one of the plots and zero to the other, to make a covariance adjustment on a pseudo-variate that has +1 for the plot that has been assigned every thing and –1 for the other, whith zero for the remainder. As a result a quantity b, being the regression co-efficient, will be transferred from the plot with everything to the one with nothing.

The following methods have been examined to analyze mixed-up and missing plots:

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1. Covariance technique for mixed-up plots (Niar, 1939).
2. Non-iterative method for estimating mixed-up and missing values (John and Lewis, 1976).

The data (Table– 1) have been taken from a randomized block experiment carried out by the North Carolina Agricultural Experiment Station at Rocky Mount, N. C. The experiment tested the effects of 5 levels of application of potash, supplying respectively 36, 54, 72, 108 and 144 lb K_2O per acre, on the yield and properties of cotton. The experiment was arranged in 3 randomized blocks of 5 plots each. In the first block the data from the first 3 plots, which contained treatment 36, 108, 144 lb, were mixed-up. The total of the mixed-up data was 22.25. In the observation vector V the mixed-up values took the values 7.4167, 7.4167, and 7.4167. Two dummy variables were introduced Z_1 and Z_2 for the mixed-up values as described by Niar (1939).

Applying covariance analysis we obtained $b_1 = -0.00667$ and $b_2 = -0.12667$. Setting these partial regression co-efficients we got the estimate for the mixed-up plots 7.55004, 7.53003 and 7.17003 with corresponding plot residuals- 0.18462, – 0.01129 and – 0.09129 respectively.

The data (Table – 2) have been taken from a randomized block experiment with five fertilizer treatments on Italian Ryegrass which was arranged in four blocks. In the first block the data from the first 3 plots, which contained treatment A, B and D, where mixed-up whilst in block 3 the value from the plot containing treatment C was missing. The total of the mixedup data was 39.30. The resulting yields were t/ha. In the observation vector y the mixed-up values took the values 39.30, 0, and 0 and the missing observation was replaced by 0. Three dummy variables were introduced, Z_1 and Z_2 for the mixed-up values as described by

Table – 1. Value assigned to the dummy variables and corresponding observation

Block	Teatments lbs. K_2O/ acre	Observation V	Dummy variables Z_1	Z_2
1	36	7.4167	1	1
	54	8.14	0	0
	72	7.76	0	0
	108	7.4167	–2	1
	144	7.4167	1	–2
2	36	8.00	0	0
	54	8.15	0	0
	72	7.73	0	0
	108	7.57	0	0
	144	7.68	0	0
3	36	7.93	0	0
	54	7.87	0	0
	72	7.74	0	0
	108	7.80	0	0
	144	7.21	0	0

John and Lewis (1976) and Z_3 for the missing value 1 as described by John and Prescott (1975). The residual from randomized block analyses of y_1, Z_1, Z_2 and Z_3 have been shown (Table – 2) in brackets for those positions corresponding to the mixed-up and missing values. The regression co-efficients were estimated by

$$\underline{b} = (\underline{Z}'\underline{R})^{-1}\, \underline{Z}'\underline{r}_y,$$

where $\underline{R} = (\underline{r}_1, \underline{r}_2 \ldots\ldots \underline{r}_{m-1})$, $\underline{r}_i$ denote the vector of residuals obtained from fitting the model $z_i = \underline{X}\underline{a}^* + \underline{e}$, where $\underline{a}^*$ is a parameter vector and z_i is the ith column of $\underline{Z}$ and $\underline{r}_y$ be the vector of residuals obtained from fitting the model $\underline{y} = \underline{X}\underline{a}^* + \underline{e}$.

So that the mixed-up values are estimated by 13.73 (39.30 – 14.60 – 10.97), 14.60 and 10.97 respectively and the missing value by 11.52. The residual mean square would, of course, be based on 12–3=9 degrees of freedom. By setting those estimated values, we got the new residuals for the mixed-up plots are all equal (to 0.20) and that the residual for the missing plot is almost zero.

It can be concluded that both methods are equally efficient to tackle the mixed-up values because in both cases the plot residuals are

Hence

$$\begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} 6/4 & 3/4 & 0 \\ 3/4 & 6/4 & 0 \\ 0 & 0 & 12/20 \end{bmatrix}^{-1} \begin{bmatrix} 30.125 \\ 27.110 \\ -6.919 \end{bmatrix} = \begin{bmatrix} 14.60 \\ 10.97 \\ -11.52 \end{bmatrix}$$

Table - 2 Value Assigned to Dummy Variables and Corresponding Observation

Block		Treatment	Observations	Dummy variables	
		y	Z_1	Z_2	Z_3
1	A	39.3(18.8)	1(3/4)	1(3/4)	0(1/20)
	B	00.0(-11.325)	–1(–3/4)	0(0)	0(1/20)
	C	11.8	0	0	0
	D	00.0(–8.60)	0(0)	–1(–3/4)	0(1/20)
	E	13.9	0	0	0
2	A	12.8	0	0	0
	B	13.4	0	0	0
	C	10.6	0	0	0
	D	11.4	0	0	0
	E	14.8	0	0	0
3	A	14.0	0	0	0
	B	14.2	0	0	0
	C	00.0(–6.915)	0(0)	0(0)	1(12/20)
	D	10.7	0	0	0
	E	15.8	0	0	0
4	A	13.1	0	0	0
	B	14.9	0	0	0
	C	10.7	0	0	0
	D	9.5	0	0	0

negligible. However, by John and Lewis's method it could be possible to tackle missing and mixed-up values simultaneously.

References

John, J. A. and Prescott, P. (1975). Estimating missing values in experiments. Appl. Statist. 24, 190-192.

John, J. A. and S. M. Lewis (1976). Mixed-up values in Experiments, Appl. Statist. 27, No. 1, pp 38–46.

Nair, K. R. (1939). The application of the technique of analysis of covariance to field experiments with several missing or mixed-up plots. Sankhya, 4, 581–588.

Pearce, S. C. (1983). The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. New York John Wiley & Sons.

Smith, P.L. (1981). The use of analysis of covariance to analyse data from designed experiments with missing or mixed-up values. Appl. Statist. 30. No. 1. pp 1-8.