TABLE-7 : Relative precisions (RP) ± s.e. of the worst and the beast observers, and under perfect ranking, also the between and the within set variances while estimating herbage mass (grass and mixture) and clover contents

Experiments	Relative Precisions (R P)			Variances	
	Worst	Best	Perfect	Between	Within
1 (Grass)	1.11±0.09	1.23±0.14	1.31±0.17	0.24	0.31
2 (Mixture)	1.11±0.09	1.27±0.10	1.40±0.16	0.07	0.09
3 (Grass)	-	-	1.66±0.17	0.00	1.58
4 (Mixture)	1.36±0.14	1.51±0.15	1.55±0.16	0.11	0.66
2 (Clover)	1.15±0.12	1.34±0.15	1.44±0.16	16.3	34.4
4 (Clover)	1.36±0.19	1.62±0.18	1.72±0.20	16.2	71.6

[Source: Martin *et al.* (1985)]

6. 5. Estimation of Multiple Characteristics

Many times we need to estimate several correlated characteristics economically. For example, one could be interested to investigate not only the characteristics of immediate interest, but also the soil quality under the plantations. See Figure 5. Using the experience and expertise of the field personnel the RSS methods could be employed for estimating multiple characteristics cost-effectively in a single investigation. Of course, the level of cost-effectiveness depends on the magnitude of the correlation between the main variable of interest and other associated variables. Patil, Sinha and Taillie (1994) initiated the work in this direction considering a sampling situation referred to by Sengupta et al. (1951), and discussed by Stokes (1980). For the Government of India Sengupta et al. (1951) conducted a survey of cinchona plants to estimate the yield of dry bark and quinine content, which is used in the treatment of malaria. The yield of dry bark from these plants is obtained after passing through a number of stages like uprooting the plants, stripping the bark and then drying it until its weight gets stabilized. Further, they had observed that the dry bark yield was highly correlated (0.9) with the volume of bark, which could be approximately determined using the height, the girth and thickness of the bark at some specific heights of the plants. As the required data were not available, Stokes generated a bivariate data set (X, Y) of size 150 (and assuming bivariate normality. Finally, she could find a ranked set sample of dry bark weight (X) of size 30 (m = 5 and r = 6). The author obtained the relative precision RP(X:Y) of the RSS estimate of the dry bark weight compared to that of the SRS estimate as 2.07. In real life scenario one might be interested to estimate the average volume of bark as well as its dry weight per plant. This situation could arise for various comparative studies dealing with impact of fertilizers, insecticides, environmental setting, etc.

Figure 5. A tree with several characteristics of interest

Patil, Sinha and Taillie (1994) obtained the Relative Precision (Y) = 2.76. A higher value for RP(Y) than RP(X:Y) occurs because in the former case the ranking of the plants was assumed to be accomplished on the basis of bark volume of the plant, which was used as a concomitant variable for estimating dry bark yield. Obviously, one could obtain the RSS estimate of the characteristic on which the ranking of the units is based with the maximum RP, and thereafter the RPs of the estimates of other characteristics depend upon the correlation between the characteristic on which the ranking is based, and the characteristic that is being estimated.

Patil, Sinha and Taillie (1994) applied the RSS procedures to estimate the means of more than one characteristics of interest using an observed bivariate data set referred to by Prodan (1968). The paper has shown that the efficiency of the estimation for the other characteristics depends on their correlations with the characteristic on which ranking is based, but is at least as good as SRS with the same number of measurements.

Using the data set of of 399 trees provided by Platt, Evans and Rathbun (1988) the means of diameter, height and age were estimated employing the RSS methods. With the equal allocation of RSS the estimates of the RPs were obtained as

3.40, 2.36 and 1.76 for height, diameter and age respectively. The corresponding values in the case the unequal allocation are 4.21, 3.05 and 2.60 respectively. The TNPS's method gave the estimates of the RP's for height, diameter and age as 3.17, 2.95 and 1.86 respectively. The results appear better than the McIntyre's method based on equal allocation. The results were obtained considering the set size 6 and the number of cycles 10. These results suggest that the unequal allocation is overall the most efficient method of RSS. See Norris, Patil and Sinha (1995) for more details.

6.6. Estimation of Underground Farm Produce

Kumar and Sinha (2012, 2013) have shown that RSS could be employed for estimating potato more efficiently than SRS with the same sample size. This investigation could help minimize the exploitation of farmers because a farmer could estimate the total yield of his underground farm produce more accurately than traditional SRS method.

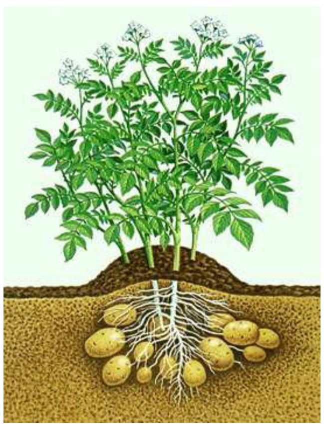

Figure 6. A potato plant

The main results are summarized in Table 8.

TABLE 8 : Relative precision and relative savings under equal and unequal allocation for the set size 4 and the sample size 12 for potato yields

Allocation	Relative Precision	Relative Cost	Relative Savings
Equal Allocation (m=4, r=3, n=12)	1.81	0.55	0.45
Unequal Allocation (m=4, n=12)	1.93	0.52	0.48

The findings show that RSS with unequal allocation performs better than SRS and RSS with equal allocation. But the unequal allocation requires the knowledge of standard deviations of various rank orders for estimating the number of quantifications for each rank order. If this information is not available, then equal allocation needs to be preferred. The illustration recommends that the RSS methods instead of SRS method could be used for estimating farm produces that are grown under the land surface such as potato, ginger, turmeric, garlic, onion, beetroot, peanut, etc.

6.7. Some Briefly Reported Applications

(i) Yangawa and Chen (1980) mentioned that the RSS method was regularly used at the Pastoral Research Laboratory, CSIRO at Armidale, N S W , Australia. Following the RSS procedure a plate with four holes is randomly thrown on a field, the pasture in the four holes is ranked by eye, and a hole is selected for quantification of pasture.

(ii) They also mentioned that the method had been used to estimate rice crops in Okinawa, Japan. They attributed this information to H. Mizuno at the "Mathematical Method in Sampling" symposium held at Chiba University, Japan in 1974.

(iii) Evans (1967) pointed out that the method could save time while determining the cell wall thickness of different species of wood. In the same area of application Dell (1969) mentioned that the RSS procedure could be efficient for estimating average for various properties of cells in a cross section of wood chips.

(iv) The method of sampling could be useful in determining the average length of various kinds of bacterial cells. Also, it could be used to obtain the average number of bacterial cells per unit volume. This is possible because it is convenient to order the tubes containing the cell suspension on the basis of concentration with the help of an optical instrument without knowing the exact number of the bacterial cells. Takahasi and Wakimoto (1968) have suggested these applications. Also, Patil, Gore and Sinha (1992 and 1994) may be consulted for applications in these and some related areas.

(v) The technique may also be used for determining the average height of trees because it is easy to rank the heights of several nearby located trees by a visual perception. The application has been suggesed by Takahasi and Wakimoto (1968).

(vi) For carrying out more rapid assessments of natural resource damage after the occurrence of catastrophic events, Jonson and Myers (1993) proposed ranked set sampling by using the information of remote sensing media for ranking of randomly drawn samples.

(vii) Johnson, Patil and Sinha (1993) presented a review of applications of the RSS method in the area of vegetation as well as they proposed to use indices like greenness, brightness and texture derived from satellite images as concomitant variables for carrying out ranking of vegetation samples.

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OBITUARY

DR. ABDUL RAQUIB

(Treasurer of Mendelian Society of India passes away)

Every story has a beginning and an end. The story of human life, though manifesting in different forms and degrees, has also a similar kind of textual extremes as marked by birth and death. The story of arrival of every human being in this world of ours is nearly identical, but the subsequent growth, development and build-up of human traits varies from person to person. And this embodiment of human traits expressed as personality and life time achievements makes a man lovable and memorable. The end of life again reminds us of the uniformity of providential laws. We are reminded of this philosophy and truth of human life by the sudden demise of Dr. Abdul Raquib, the unopposed Treasurer of Mendelian Society of India for over three decades, on 26th April, 2014 at Jamshedpur (Jharkhand). He is survived by his wife Mrs. Momina Raquib, four daughters and a son, and their spouse and descendants.

Born on 17th October, 1943 at Barh as the eldest son of his parents Mr. Masood Kabir and Mrs. Sakina Khatoon, Abdul Raquib had the privilege of being the heir of an affluent Zamindar family (Ramzanpur Estate) of the then Patna District (now Sheikhpura district) of Bihar. His upbringing in a rich noble family engrained esteemed qualities of culture and civilization into the growing child in him.

He got his elementary and primary education at Chakdi School, Sarae and secondary education (Matriculation) at Patna. Having prosecuted his Intermediate (Science) education from Presidency College, Calcutta (Kolkata), he received a sound foundation in science. After doing his B.Sc. (Hons.) in Botany from Gaya College, Gaya, he joined as a Demonstrator in the Department of Botany at the College of Commerce, Patna on 19th September, 1963. However, after doing his Masters in Botany from Magadh University, Bodh Gaya his rank was upgraded to that of a Lecturer. He was highly conscious of his progression in professional career and obtained his Ph.D. in 1995 under the supervision of Prof. R. N. Trivedi, after which he got his promotion to the rank of Reader. Finally he superannuated from active service on 31st October, 2003.

Dr. Raquib was an able teacher and a competent counsellor of his students, who had high respect for him. He was equally popular amongst his colleagues. He had an attractive personality and ever wore a pleasant smile on his face. Anxiety and worries had no place in his psyche. He had inherited an elitist mental make-up and this was evident in his thoughts an actions. He had always a choice for a comfortable and lavish living, and usually spent extravagantly in his personal and social life.

He was a man of strong commitment and exemplary religious cohesion and tolerance, and was gifted with charming and lovable qualities of heart and mind.

His contributions to the founding and early patronage of Mendelian Society of India made him the Treasurer of the Society for over three decades with no contender to replace him from this position. His sustained efforts to nourish the society to grow into a widely acclaimed body of serving the community of scientific researchers will be ever remembered By Dr. Raquib's death, Mendelian Society of India is deprived of a true benefactor and a selfless service provider.

Mendelian Society of India mourns the sad demise of Dr. Abdul Raquib and prays to the Almighty for providing courage and strength to the bereaved family to bear with this irrepairable loss.

Dr. Arvind Kumar Sinha
Secretary
Mendelian Society of India

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