Week-05-L-04

Agricultural Statistics in Practice

Stability & Sustainability Analysis

Measuring yield sustainability of different treatments

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Measuring Yield Sustainability of Different Treatments

- Let an experiment with t-treatments is conducted for j consecutive years on same crop.

A. Sustainability Index was proposed by Singh et al. (1990):

$$SI = \frac{\bar{y} - s}{y_{max}}$$

where $\bar{y}$, s, y_{max}, *are the average, standard deviation and maximum yield respectively for a particular crop/cropping sequence or nutrient treatment over a period of time.*

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B. Sustainability Index was proposed by ICARDA (1994):

$$y_{ij} = a + b_i \bar{y}_j \quad \rightarrow$$

where y_{ij} *is the yield corresponding to* i^{th} *treatment in the* j^{th} *time period. The sustainability index, according to this method is* $\left|\frac{1}{b_i}\right|$ *.Thus, as the value of* $|b_i|$ *increases, the sustainability decreases and vice-versa. This is one step forward because of the fact that it takes care of the average values at different time periods. However, this method is criticized because*

a. *While computing* $\bar{y}_j$ *(that is the average value for the jth time period combining all the treatments) the value of the ith treatment has also been included.*

b. *The measures of Singh, here also the sustainability index doesn't have any limit.*

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C. In an attempt to improve ICARDA (1994) Katyal et al. (2000) introduced a time coefficient in the above regression. Thus, the regression takes the shape of

$$y_{ij} = a + b_i t + c_i \bar{y}_j$$

The sustainability index, according to this method is $\left|\frac{1}{c_i}\right|$. *Thus, depending upon the value of the regression coefficient* c_i *, sustainability index is worked out. Though, this is again one step forward of the measure given by ICARDA (1994), the same two objection still remains.*

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D. To overcome the criticism of the measures two and three, Pal and Sahu (2007) proposed the following modification in the above two measures:

$$y_{ij} = a + b_i' \bar{y}_j'$$

$$and\ y_{ij} = a + b_i t c_i' \bar{y}_j'$$

Where, $\bar{y}_j'$ is the average yield for j^{th} year excluding the yield for the i^{th} treatment in the particular year and as usual $\left|\frac{1}{b_i}\right|$ and $\left|\frac{1}{c_i}\right|$ are the sustainability indices for the two measures respectively.

Though, these two measure incorporate improvement during the construction of sustainability indices, the demerits of not having limits for sustainability indices still remains.

Another serious objection to all these four measures is that the assumption of linearity of the regression is not valid, then the above measures will be put under question.

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E. Sahu et al (2005) proposed sustainability index based on average performance and the highest ever performance during the period of investigation with the help of the following formula:

$$\mathrm{SI} = \frac{Y_{max} - \bar{Y}}{\bar{Y}}$$

In this measure sustainability has been visualized as the minimum deviation of the average performance over highest ever achieved value during the period of investigation. As such, lower value of the index higher is the sustainability. Thus, from sustainability point of view a sustainability index value closer to zero the most desirable value.

$SI \propto \frac{1}{\text{acceptance (desirable)}}$

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F. In an attempt, Pal and Sahu (2007) proposed the following measures of sustainability which do not require any assumption like the above measures 2-5 which are based on regression technique:

$$SI = \frac{s_i}{\bar{y}_i \times s_{max}}$$

Where:

s_i *is the standard deviation of* i^{th} *treatment over the entire time period*

$\bar{y}_i$ *is the average of* i^{th} *treatment over the entire time period*

s_{max} *is the maximum value of the standard deviation of all the treatments*

$$SI = \frac{1}{n}\sum_{j}\left[\frac{y_{ij} - y_{max}}{\bar{y}_i}\right]$$

$\bar{y}_i$ *is the average of* i^{th} *treatment over the entire time period*

s_{max} *is the maximum value of the standard deviation of all the treatments*

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$$SI = \frac{1}{n}\sum_{j}\left[\frac{y_{ij} - y_{med}}{\bar{y}_i}\right]$$

$\bar{y}_i$ *is the average of* i^{th} *treatment over the entire time period*

y_{med} *is the median value of the* i^{th} *treatment over the time period*

$$SI = \frac{1}{n_{c_2}}\sum_{jj'}\sum_{,j<j'}\left[\frac{y_{ij} - y'_{ij}}{y_{imax}}\right]$$

Where,

N *is the number of time periods*

y_{ij} & y'_{ij} *are the value of the* i^{th} *treatment* j *and* j' *year respectively,* y_{imax} *is the maximum value of* i^{th} *treatment over the time period.*

Thank You