Food and Agriculture Organization
of the United Nations

MEASURING FOOD LOSSES

Session 5:
Loss assessment through experimental design-field trial

2018

Objectives of the presentation

- Provide guidance on the measurement of grain losses through experimental design
- Present the different methods to assess losses at different stages of the supply chain using this approach

Outline

Introduction

1) Concepts and definitions

2) Statistical designs

3) Loss assessment at different stages

4) Example of Ghana

Introduction

- Used to compare the losses occurring with traditional and improved agronomic practices

- May be conducted for:
  - **Equipment testing**
  - **Storage simulation at research stations**
  - **Evaluation of post-production practices effects on the level of losses at the farm level**

- Is being used in biological sciences, social sciences, business and economics

Concepts and definitions

1.1. Concepts and definitions: introduction

- Very important to pay attention to **basic structure of an experiment**:
  - The treatments included in the study
  - The experimental units included in the study
  - The rules and procedures used to assign treatments to experimental units (or vice versa)
  - The measurements made on the experimental units after treatments have been administered

1.2. Concepts and definitions: Treatments

- Treatment = factor level in a single factor study or factor levels in a multifactor study

- Three issues to handle properly:
  - **The choice of treatments to be investigated**
  - **The definition of each treatment**
  - **The need for a control treatment**

- Control treatment:
  - **Applying the same procedures to experimental units that are used with the other treatments**
  - **Except for the effects under study**

1.3. Concepts and definitions: Experimental units

- The smallest subunit of the experimental material
  - ❖ *Such that any two different experimental units may receive different treatment*

- Pay attention to:
  - ➢ **Size of the experimental unit**
  - ➢ **Representativeness**

1.4. Concepts and definitions: measurements

- The measurements to be made on the experimental units represent the values of the dependent variables

- *The investigator decides what to measure and how to do it*
- *The measurement should be unbiased:*
  - **Crippling difficulties**

Statistical designs

2.1. Statistical designs: completely randomized designs (CRD)

- Most basic design for an experiment
- Treatments assigned to the experimental units are completely random
  - Every experimental unit has an equal chance to receive any one of the treatments
- Used generally when:
  - The experimental units are relatively homogenous
  - The experimental units are heterogeneous and no information is available for stratifying them
  - The experimental units are heterogeneous units, and the covariance analysis is used to diminish the variability of the experimental error

2.1. Statistical designs: completely randomized designs (CRD)

- $\mathbf{Y_{ij} = \mu_{.} + \tau_i + \varepsilon_{ij}}$ in the case of one factor
- $\mathbf{Y_{ijk} = \mu_{..} + \tau_i + \beta_j + (\tau\beta)_{ij} + \varepsilon_{ijk}}$ in the case of two factors with interaction

Where Y could be the losses in weight, τ the type of seed used and β the harvest method

- **ANOVA** could be applied to perform these kinds of models

2.2. Statistical designs: randomized block designs (RDB)

- Experimental units are first sorted out into homogeneous groups called blocks
  - **Achieve homogeneity within to block**
  - **Heterogeneity between blocks**

- Treatments are then assigned at random within the blocks

- Randomized complete block design (RCBD):
  - **Each design treatment is included in each block**
  - **Within each block, a random permutation is used to assign treatments to experimental units, the same as in a CRD**
  - **Independent permutations are then selected independently for a number of blocks**

2.2. Statistical designs: randomized block designs (RDB)

- Model (Neter and Wasserman, 1985)

$$Y_{ij} = \mu_{..} + \rho_i + \tau_j + \varepsilon_{ij}$$

where:

$\mu_{..}$ is a constant

ρ_i are constants for the block (row) effects, subject to the constraint $\sum \rho_i = 0$

τ_j are constants for the treatment effects, subject to the constraint $\sum \tau_j = 0$

ε_{ij} are independent $N(0, \sigma^2)$

$i = 1. . . n; j = 1, . . ., r$

- **ANOVA** could be applied to perform these kinds of models

Loss assessment at different stages

3.1. Loss assessments: harvesting losses

- Hire farmers from neighbouring areas as skilled harvesters
- Harvest the crops using a traditional approach
- Crops are harvested using the techniques that are being compared
  - **Example: harvest using panicle vs. harvest using sickle**
- Once the crops have been harvested, the crops remaining on the harvested experimental plots are then collected
- The losses are measured and compared for each technique

3.2. Loss assessments: threshing losses

- Comparing threshing methods
  - **Example: rice can be threshed by using bag-beating or a wooden box**
- Thresh using the different methods with different farmers
- Collect and weigh the grains that fall out, weigh the grains remaining on the stalks of cobs and calculate the losses
- Run the model

3.3. Loss assessments: drying losses

- Take a sizeable and manageable amount (10-15 kilos) of grains that was harvested to calculate moisture content
- Spread the grains on a drying floor in the same way farmers do it
- Let the grain dry and hire experienced farm labourers to collect the dried grains
- Weigh and record the moisture content
- Estimate the losses

3.4. Loss assessments: weight losses at storage

- Collect dried grains at a given moisture content
- Place the grains in bags or in a storage structure research station
- The farmers could be asked to build local storage containers
- At the end of the specified period, the grains is reweighed and the moisture content is measured
- Estimates losses **using the formulas described in session 3**

Example of Ghana

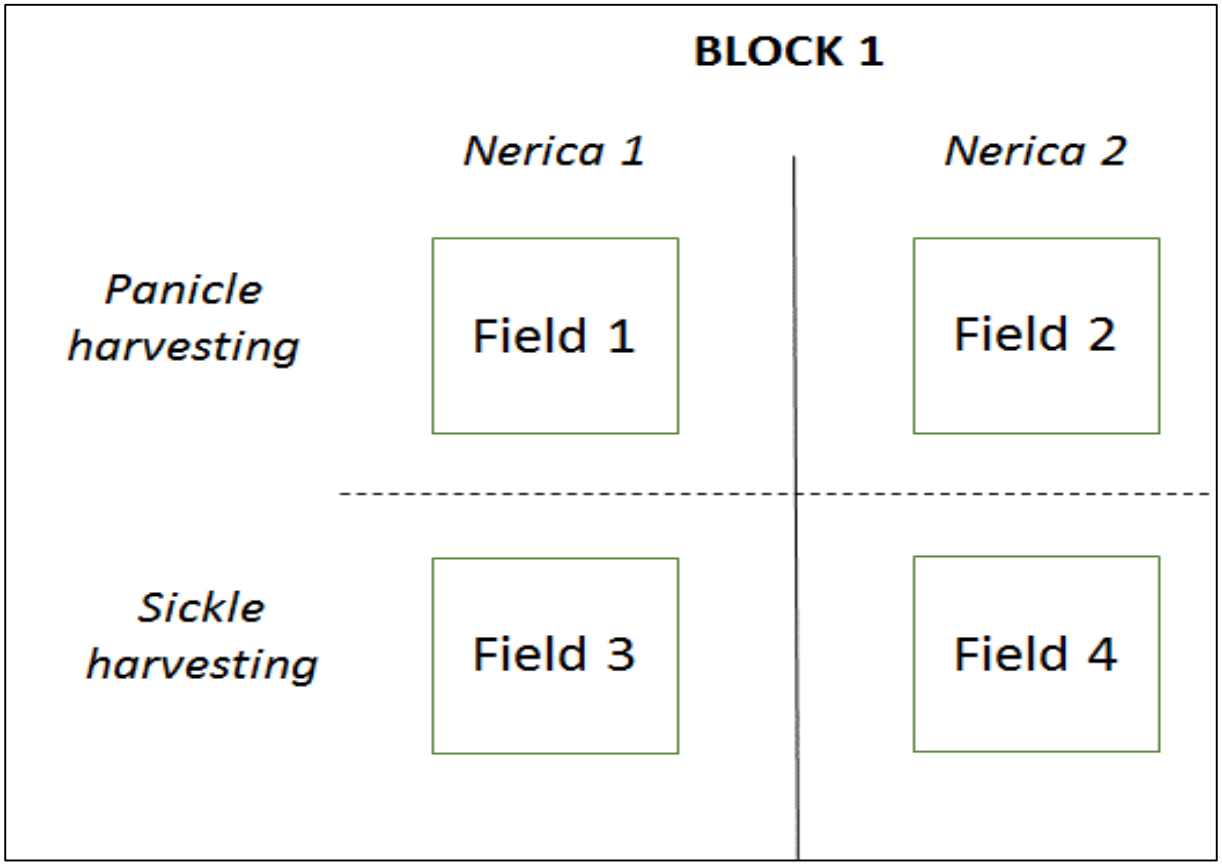
4. Example of Ghana

Appiah F, Guisse R and Dartey P.K.A

- Post-harvest losses of rice from harvesting to milling between 2009 and 2010
- Sites: Nobewam and Besease in Ejisu Juabeng District
- Two rice varieties: Nerica 1 and Nerica 2
- For each variety, an area of 4 x 5 m was demarcated for cultivation

4. Example of Ghana

Appiah F, Guisse R and Dartey P.K.A



4. Example of Ghana

Appiah F, Guisse R and Dartey P.K.A

- Three replications per variety
- Cultural practices: land clearing, ploughing, raising nursery for seeding and transplanting
- 2 x 2 RCBD comprised to two varieties
- Two harvesting and threshing methods (panicle and sickle) for determining harvesting losses and threshing losses
- For storage losses: the grains were stored for 60 days in a well-ventilated room

4. Example of Ghana

Treatments Variety	Total weight of harvested rice (g)	Harvesting losses (g)	Harvest weight loss (%)
Nerica 1	6 688	132	2.19
Nerica 2	6 926	148	2.13
Panicle	6 430	83	1.39
Sickle	7 184	196	2.93
Lsd	1 692.4	59.7	1.338
Nerica 1 x Panicle	6 450	66	1.13
Nerica 1 x Sickle	6 925	197	3.25
Nerica 2 x Panicle	6 409	100	1.64
Nerica 2 x Sickle	7 443	195	2.62
Lsd	2 393.4	84.4	1.89
CV (%)	21.8	11.4	32.3

Conclusion

- This presentation described standard methods and approaches to estimate losses **through experimental design**
- **The experimental units have to be well defined and the measurement method must be well known**
- It is very important to identify a good research station
- Farmers should be chosen based on the methods that are going to be compared

References

- **Appiah, F., Guisse, R. & Darty, P.** 2011. *Post-harvest losses of rice from harvesting to milling in Ghana***.** Journal of Stored Products and Post-Harvest Research, 2(4): 64–71.

- **Neter, J., Wasserman, W. & Kutner, M.H.** 1985. *Applied Linear Statistical Models Regression, Analysis of Variance, and Experimental Design*. 2nd edn. Richard D. Irwin, Inc.: Homewood, IL, USA.

26

Thank You