

# Trend Free Partially Balanced Incomplete Block (TF-PBIB) Designs Useful in Agricultural Experiments

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## Introduction

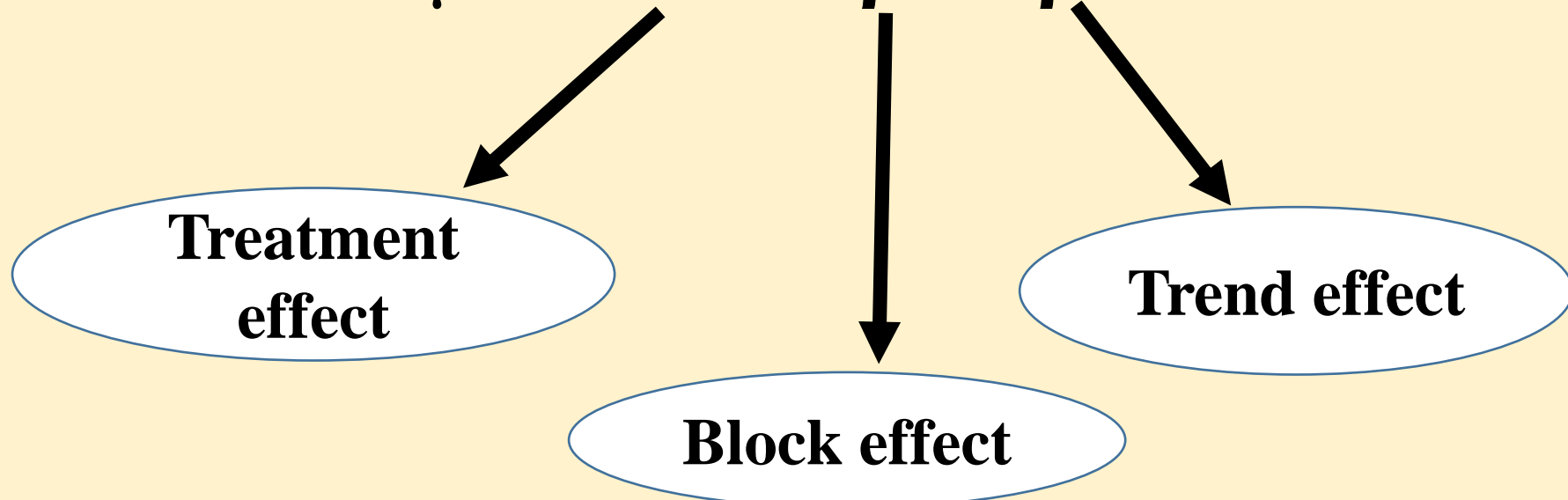
- Heterogeneity in the experimental material is the most important problem to be taken care while designing of scientific experiments
- Block designs are the most commonly used designs when heterogeneity is present only in one direction
- In agricultural experiments, apart from the known source of variations, the response may also depend on the spatial position of the experimental unit, i.e. on systematic trend effects
  - When plots occur in strips in a field, it is often the case that differing contiguous sets of plots within the same strip have different fertility gradient
  - Trend may occur in greenhouse experiments, where the source of heat is located on sides of the house and experimental units are kept in lines
  - In poultry experiments, where the source of heat is at the centre of the shed and chicks of early age are in cages
  - In orchard and vineyard experiments on undulating topography, where response variable is affected by slowly migrating insects entering the area from one side

## Objective

- To develop TF-PBIB design which will be useful for experiments involving systematic trend component

## Block Model with Trend Component

$$Y = \mu 1 + \Delta' \tau + D' \beta + Z \rho + e$$



## Necessary and Sufficient Condition for a Design to be Trend Free

A block design is said to be trend free iff  $\Delta Z = 0$

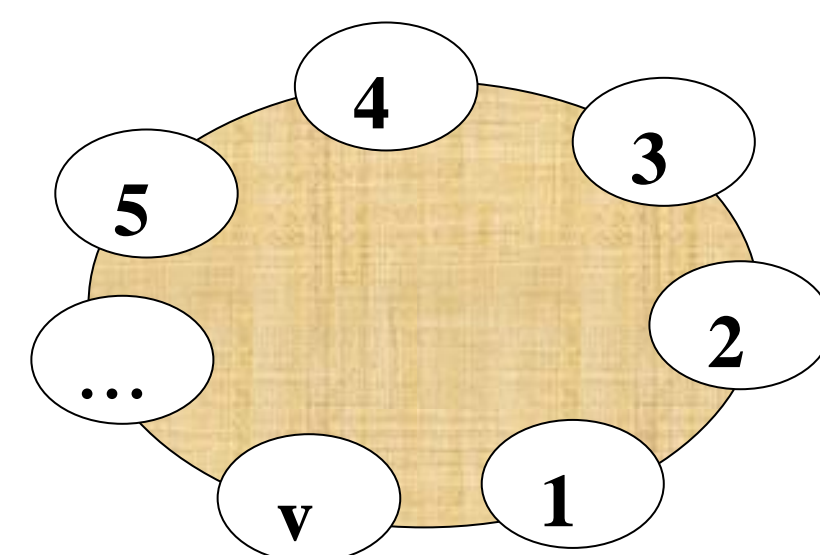
## TF-PBIB Design: Method of Construction

1	2	...	v-2
2	3	...	v-1
...	...	...	...
v	1	...	v-3

**Parameters**  
 $v = b, r = k = (v - 2)$

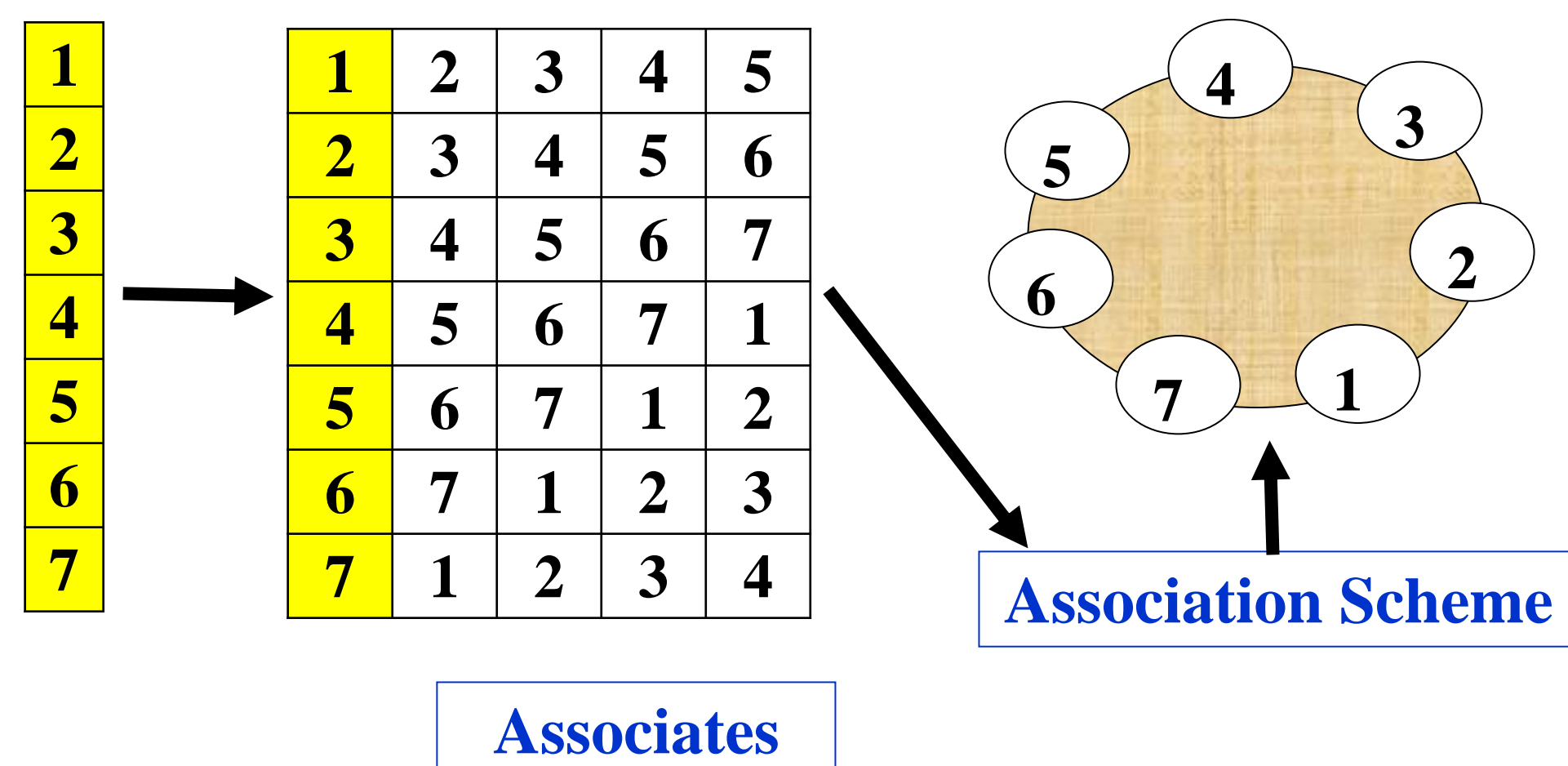
**Trend effects and Treatment effects are orthogonal for the developed design**

## Association Scheme



- The developed TF-PBIB design follows varying circular association scheme
  - For even  $v$  :  $v/2$  number of associates
  - For odd  $v$  :  $(v-1)/2$  associates
  - First Associates will appear together in the design  $(v - 3)$  number of times .
  - Associates other than first associates will appear together  $(v - 4)$  number of times

## Example ( $v = b = 7, r = k = v-2$ )



Treatments	1 <sup>st</sup> associates	2 <sup>nd</sup> associates	3 <sup>rd</sup> associates
1	2, 7	3, 6	4, 5
2	1, 3	4, 7	5, 6
3	2, 4	1, 5	6, 7
4	3, 5	2, 6	1, 7
5	4, 6	3, 7	1, 2
6	5, 7	1, 4	2, 3
7	1, 6	2, 5	3, 4

## Conclusion

- The developed construction method provides linearly TF-PBIB designs for any number of  $v$  and designs are equireplicated, proper, connected and easy to obtain
- In the experimental situations where there is presence of trend component, TF-PBIB designs can be used to make the trend effect as null

## Reference

- Bhowmik, A., Jaggi, S., Varghese, E., & Yadav, S. K. (2017). Trend free design under two-way elimination of Heterogeneity. *Rashi*, 2(1), 34-38
- Bradley, R. A. and Yeh, C. M. (1980). Trend-free block designs: theory. *Annals of Statistics*, 8, 883-893