

Determination of weights in multi-dimensional evaluation

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Abstract

The topic presented is a part of internal project „**Multicriterial evaluation of agricultural holdings performance**“ launched by FADN CZ within Institute of Agricultural Economics and Information (Czech Republic) in 2016

- Aim of the project is to propose a methodology for the compilation of a comprehensive multi-criteria evaluation of farm performance based on FADN database.
- The multi-criteria evaluation of agricultural holdings aims to use new approaches and views on farm performance in agriculture. The resulting bonity of the enterprise takes into account the wider concept of the farm's functions than the achievement of the best economic result, which is currently used as a basic indicator of successful business. Based on the possibilities offered by the FADN database, five dimensions have been identified, taking into account the production, position of the companies, efficiency, environmental and other (including social) functional areas that are important for the sustainable development of agriculture.
- Selected solution utilized potentials of FADN survey, which annually collects data on the structure, production and economic results of a representative sample of farms.
- Use of results is targeted at policy makers and researchers (evaluation of Czech agriculture), and individual farmers participating in FADN (benchmarking).
- The proposed methodology offers a flexible solution for the selection of indicators and for their scoring and weighting, which enable interaction on the future development in agriculture.
- Aim of the presentation was to underline the importance of the accurate determination of the weights used for evaluation. Among several methods listed two of them (Saaty method and Factor Analysis) were practically tested bringing different results for higher share of indicators and finding similar weighting factors for less then half of indicators.
- Presentations offers also simple example how results of multicriteria evaluation could be displayed to farmer.

Content

- **Aim of the research**
- **Methodology overview**
- **Methods examined**
- **Results and conclusions**



Aim of the research

- Synergy of various agricultural activities
- Capture diverse outputs of farming
- Impact of agriculture in its entire complexity

Sustainable
agriculture

- Production of food, feed, fiber
- Maintenance of countryside
- Designing of landscape
- Viability of rural areas
- Economic development
- Environmental protection
- Social aspects
- ...

Multi-criteria evaluation
of agriculture functions
and its assessment



Utilization of the method

Various beneficiaries of the results

- Surplus Information for **agricultural holdings** (all farms in the sample)
- **Evaluation** of agricultural policy (representative sample FADN CZ)
- Modelling based on scenarios for **future** policy designing
- **Researchers** working on specific topics



Methodology overview

Multi-criteria evaluation

FADN CZ sample (around 1400 farms)

5 dimensions, 34 variables

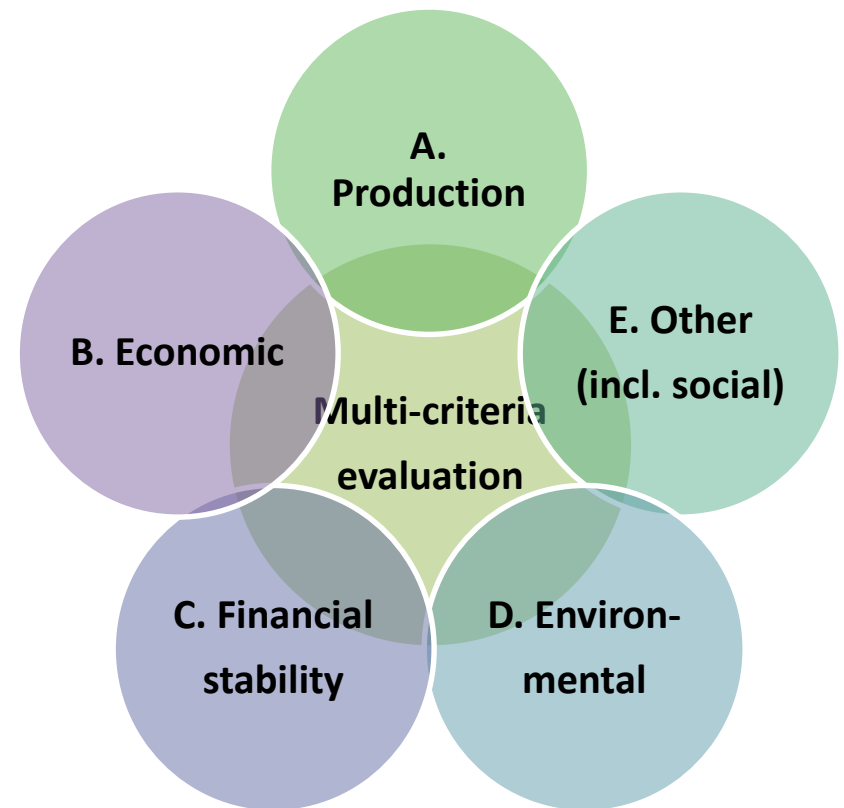
procedure

Farm MULTI-results calculation

Allocation of points (0-10)

Weighting of points

Final weighted evaluation



Determination of weights

List of methods ¹:

- Principal components analysis or **factor analysis**
- Data envelopment analysis
- Benefit of the doubt approach
- Unobserved components model
- Budget allocation process
- Public opinion
- Analytic hierarchy process
- Conjoint analysis
- Performance of the different weighting methods

List of methods ²:

- Rank ordering criteria
- Progressive weighting method
- Metfessel allocation
- Deviation scale method
- Pairwise comparison method
- **Saaty method**
- Compensation method
- ...



¹ Handbook on Constructing Composite Indicators: Methodology and User Guide, © OECD 2008

² Methods use for Multi-criteria decision analysis

Weights based on Saaty method

Comparison of the criteria pairs
determining the importance of the preferences
final comparison of the normalized weights.



!!! Subjective – based on expert opinion !!!
Average of 5 experts' weight settings was used.

Example of weight calculation by expert within one dimension

Variables	ME1	ME2	ME3	ME4	ME5	ME6	ME7	ME8	Geomean	Weight
ME1	1	1/2	1/3	1/3	1/2	1	1/4	1/4	0,451	0,046
ME2	2	1	1/3	1/3	1/2	1	1/4	1/4	0,537	0,055
ME3	3	3	1	1	4	4	1	1	1,861	0,191
ME4	3	3	1	1	4	4	1	1	1,861	0,191
ME5	2	2	1/4	1/4	1	1	1/4	1/3	0,616	0,063
ME6	1	1	1/4	1/4	1	1	1/4	1/4	0,5	0,051
ME7	4	4	1	1	4	4	1	1	2	0,205
ME8	4	4	1	1	3	4	1	1	1,929	0,198
								Sum	9,757	1

Weights based on factor analysis

Multivariate statistical method describing variability among correlated variables proposing latent variables (factors).

$$w_j = |r_{js}| \times var_s$$

r - absolute value of the correlation coefficient

var - proportion of explained variance

j - number of variables

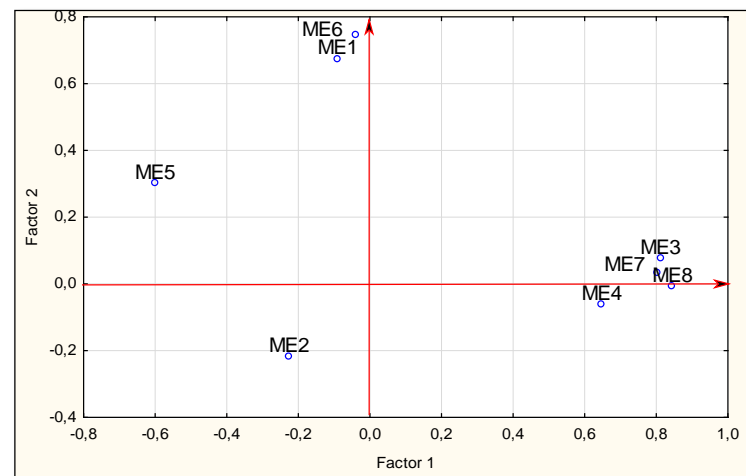
s - number of components

Example of weight calculation within one dimension

Variable	Factor (1)	Factor (2)	Normalized weight
ME1	-0,090	0,674	0,059
ME2	-0,226	-0,218	0,050
ME3	0,812	0,076	0,181
ME4	0,648	-0,063	0,144
ME5	-0,600	0,301	0,133
ME6	-0,038	0,747	0,066
ME7	0,803	0,032	0,179
ME8	0,845	-0,008	0,188
Var _s	35,973	14,268	1

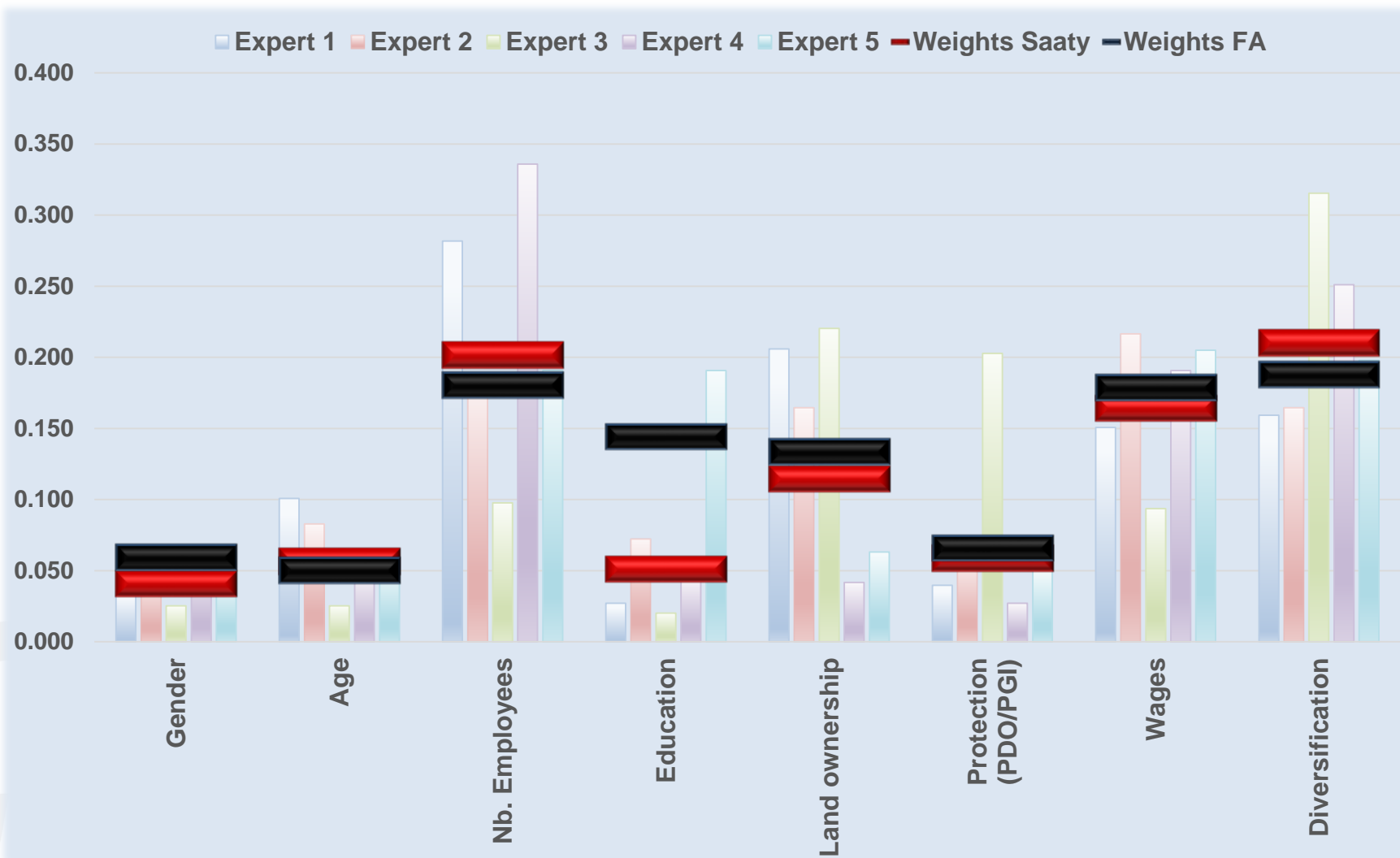
Factor Analysis over

- score (points):
 - dim. of production,
 - group of dimensions
- results of variables:
 - dim. B, C, D, E



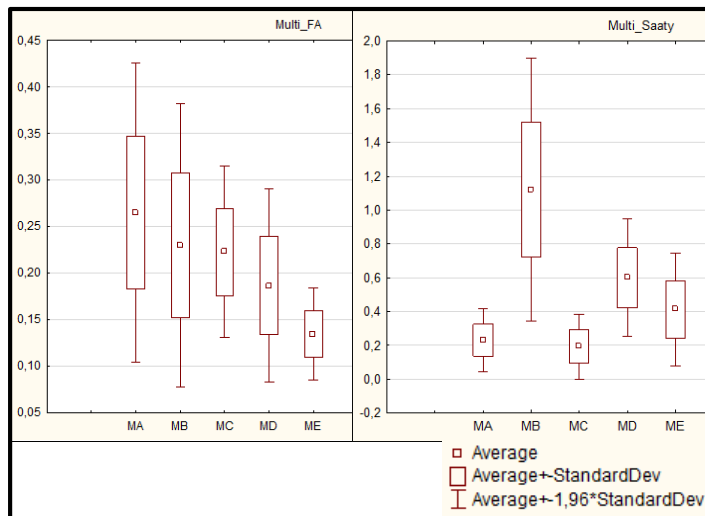
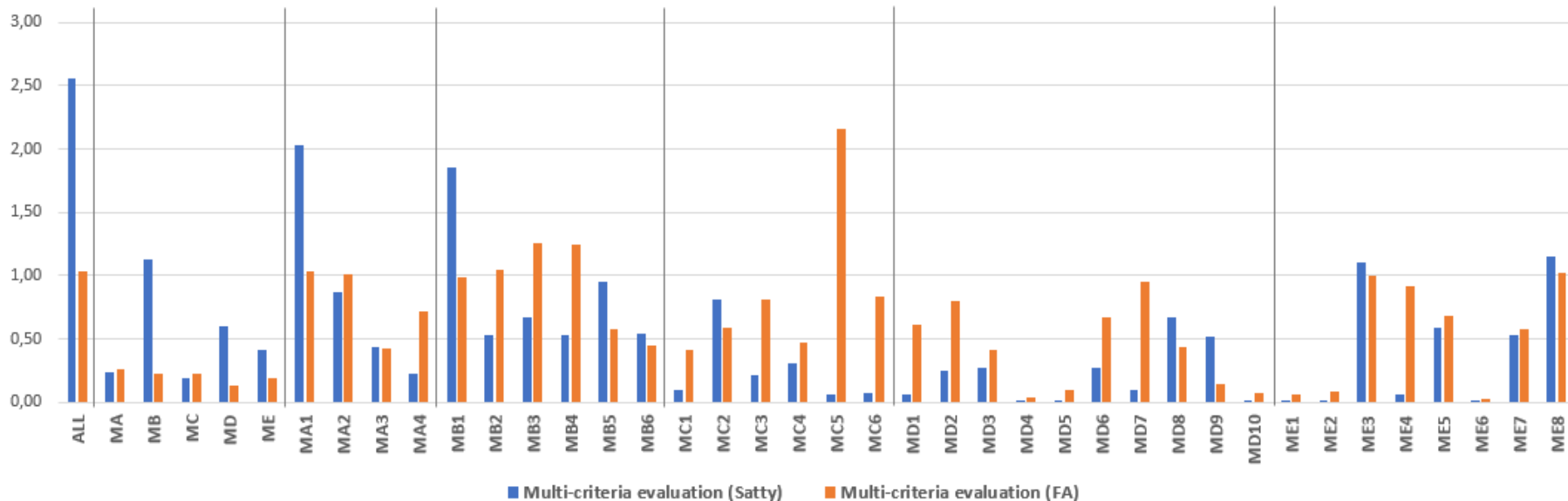
Comparison of weights

Example of dimension Other (incl. social)



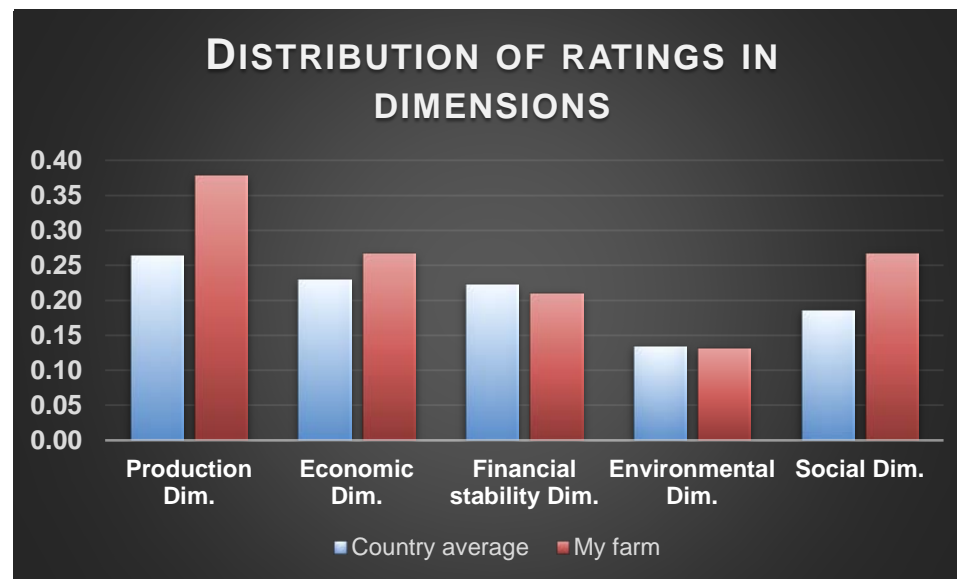
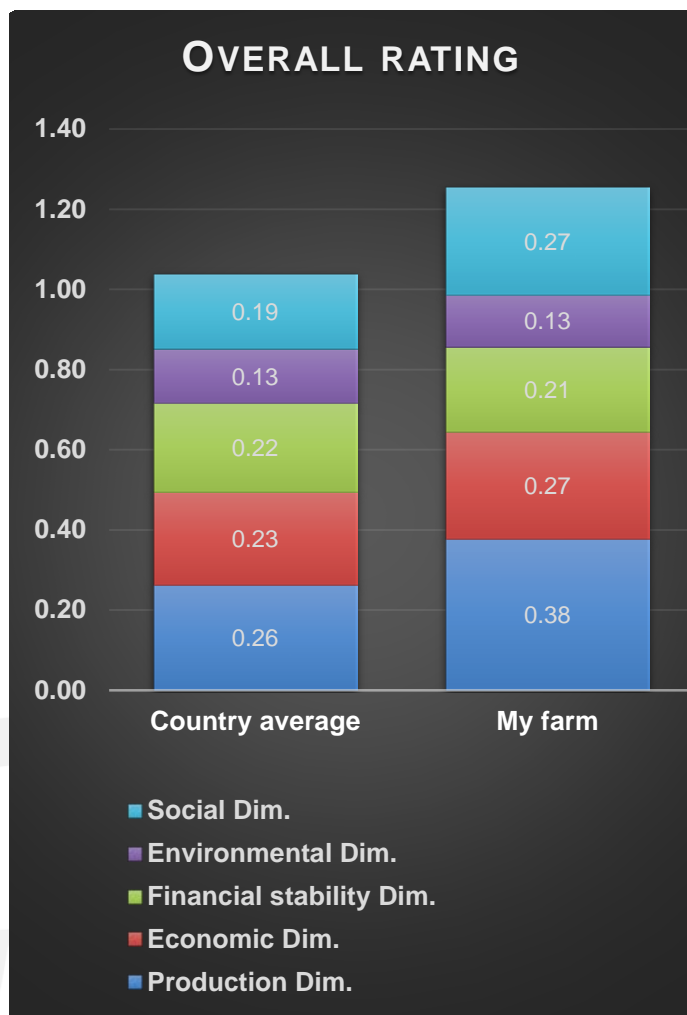
Comparison of results

Result of Multi-criteria evaluation done by 2 tested methods for 2015 FADN CZ sample



Results presentation – simple example

Result of Multi-criteria evaluation done by FA method in 2015

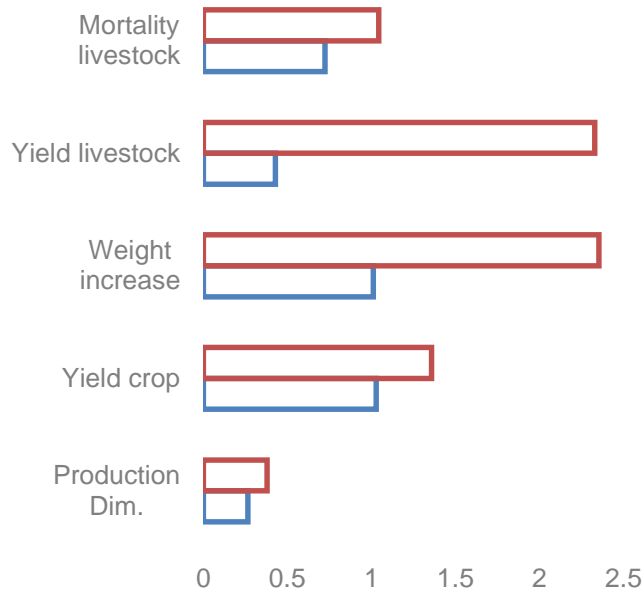


Results presentation – simple example

Result of Multi-criteria evaluation done by FA method in 2015

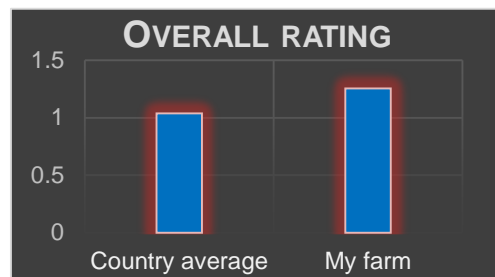
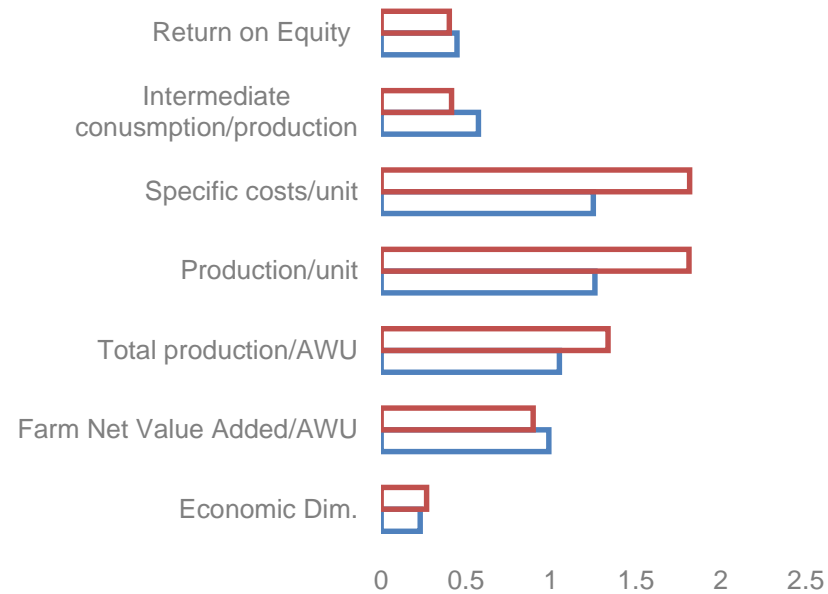
PRODUCTION DIM.

■ My farm ■ Country average



ECONOMIC DIM.

■ My farm ■ Country average

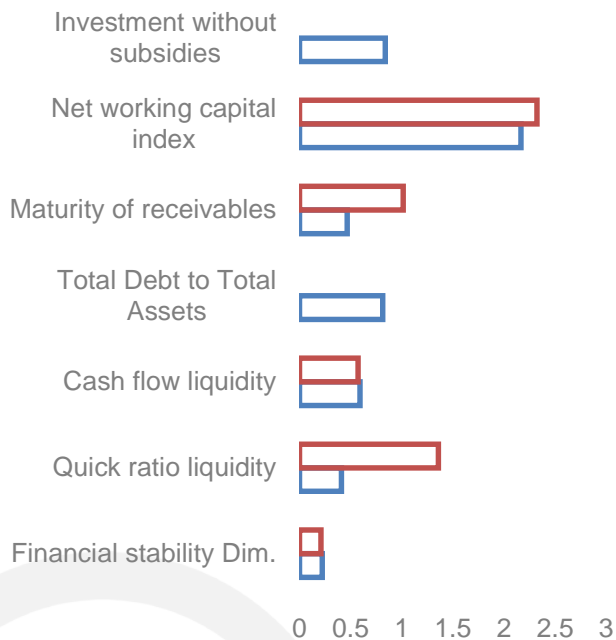


Results presentation – simple example

Result of Multi-criteria evaluation done by FA method in 2015

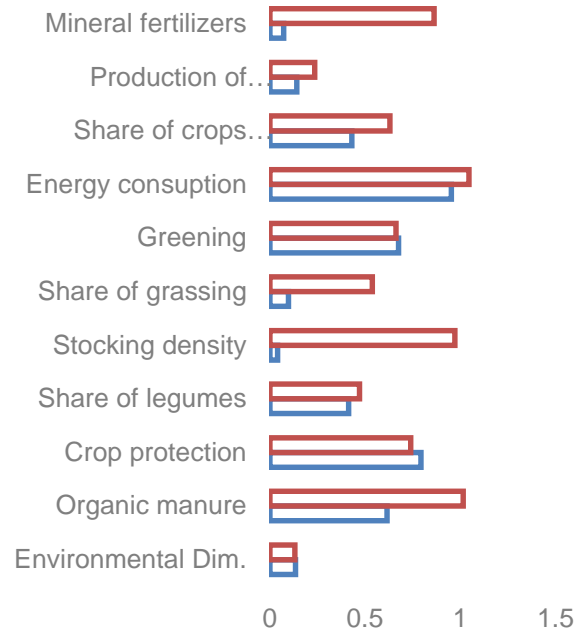
FINANCIAL STABILITY DIM.

■ My farm ■ Country average



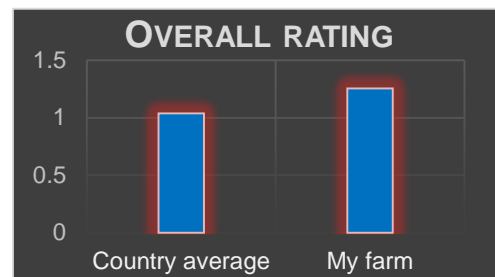
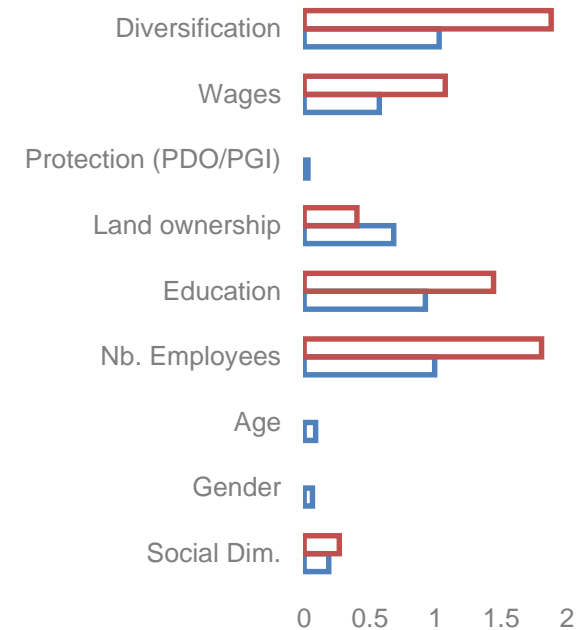
ENVIRONMENTAL DIM.

■ My farm ■ Country average



SOCIAL DIM.

■ My farm ■ Country average



Conclusion

- **Two tested methods gave different weightings factors**
- **Only less than half of indicators resulted in comparable weights**
- **Final results of evaluation are visibly different**
- **Statistical approach is preferred**
- **Next steps are:**
 - **to analyze results**
 - **to test combination of Factor Analysis method followed by expert tuning**

Thank you for you attention!



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