What Motivates Indonesian Smallholders' to Adopt Non-Conventional Farming Systems? An Application of Best-Worst Scaling Methods

Wahida[1,2], Wendy Umberger[1], Nicholas Minot[3] and Randy Stringer[1]

[1] Global Food Studies, University of Adelaide

[2] Indonesian Center for Agricultural Socio Economics and Policy Studies

[3] International Food Policy Research Institute

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Introduction

Indonesia is rapidly advancing middle income country with:

- Demand for high value agricultural products with credence attributes (e.g. organic, pesticides free) is growing
- An increasing concern towards food safety (pesticides residue)
- A strong need to shift producers' objectives to be more responsive to consumers' needs (e.g. food safety, quality)
- Non-conventional farming systems (such as IPM, pesticide-free, and organic) have been introduced since the early 1990s.
- Policies and extension programs have aimed to encourage Indonesian farmers to adopt these technologies.
- However, the adoption rates for these technologies have been generally low.

Objective

- To explore farmers' relative preferences for attributes of technology
- To determine the shallot producer characteristics in explaining their preferences for technology attributes

Best Worst Scaling

- A method to measure relative importance attributes.
- Developed based on random utility theory for paired comparisons (Finn and Louviere, 1992)
- Frequency of selection for each technology attribute as best or worst shows the strength of preference (Balcombe, Rigby and Azapagic, 2014).

Best Worst Scaling

- This method avoids “middling” of responses which often occurs when respondent’s rate level of importance using Likert scales.
- Relatively easy for respondent to perform and allows an efficient elicitation of importance attributes (Mueller and Rungie, 2009; Mueller et al., 2010)
- Heavily used in health care and marketing research (Auger, Devinney and Louviere, 2007)
- Recent studies explore the heterogeneous of farmer preferences to determine marketing channel choice or buyer attributes (Umberger et al., 2010 and Sahara, 2012) and the adoption of horticulture crops (Suprehatin et al., 2015).

Data

- 2011 Shallot Producers Survey
- 687 households (531 traditionals; 157 adopters) completed the survey which was located in Brebes, Central Java
- A stratified random sampling was used to identify traditional shallot growers (control) while the adopter was randomly selected from the list of farmers who purchase organic fertilizer from local supplier (NASA).
- The shallot producers were scattered across 47 villages from 13 sub-districts

BWS set-up

- The BWS experiment consisted of 11 technology attributes that were selected from a set of 24.
- During the pre-survey, this set was delivered to shallot farmers to rank the five most important attributes.
- The 11 attributes were assigned to sub-sets which using a balanced incomplete block design (BIBD).
- BIBD is designed to obtain a full ranking of all attributes in a relatively small number of subsets (Cohen, 2009).

Best Worst Scaling Set

"I am going to show you 11 cards with characteristics that may be important when adopting a new crop or new farming system. In each case there will be 5 characteristics shown, these will be different from one card to the next (total 11 cards). Please select one attribute that is MOST important to you when considering why you decided to adopt, and then select one characteristic that is LEAST important to you. Please select only one of each. I will guide you through the 11 cards."

Most Important (tick one box)	**Of these technology or farming practice attributes, which are the Most and Least important to you…**	**Least important (tick one box)**
☐	Stable price and market demand	☐
☐	Expected high yield	☐
☐	Disease resistant crop	☐
☐	Use less water	☐
☐	High expected profit /return	☐

Analysis and Results

- Relative Importance of Technology Attributes (n=658)

Attributes	Best	Worst	Sqrt B/W	Sqrt stand	Rank	Mean-BW	Std. Dev BW
Higher expected price	1080	326	1.82	74.68	3	1.15	1.84
Stable price and market demand	826	423	1.40	57.33	4	0.61	1.80
Growing market demand	521	456	1.07	43.86	6	0.10	1.59
High expected profit/return	1396	235	2.44	100.00	1	1.76	1.89
Time from planting to harvest is short	291	1086	0.52	21.24	9	-1.21	1.90
Expected high yield	1072	204	2.29	94.05	2	1.32	1.57
Less labour required to produce	224	970	0.48	19.72	10	-1.13	1.64
Use less water	133	1454	0.30	12.41	11	-2.01	1.84
Disease resistant crop	738	385	1.38	56.81	5	0.54	1.81
Crop adapts easily to production	510	762	0.82	33.57	7	-0.38	1.81
Low initial investment cost	447	937	0.69	28.34	8	-0.74	1.84

Analysis and Results

- Modelling Heterogeneity using a Latent Class cluster analysis

Crop Attributes	Cluster 1	Cluster 2	Cluster 3	Wald	p-value	R^2
Higher expected price	0.816	-0.503	-0.312	40.216	0.000	0.413
Stable price and market demand	-0.027	0.038	-0.010	0.991	0.610	0.002
Growing market demand	0.081	-0.180	0.098	12.324	0.002	0.031
High expected profit/return	0.630	-0.421	-0.209	71.387	0.000	0.347
Time from planting to harvest is short	-0.214	0.182	0.032	35.422	0.000	0.088
Expected high yield	0.139	-0.582	0.443	27.442	0.000	0.194
Less labour required to produce	-0.199	0.392	-0.192	32.980	0.000	0.124
Use less water	-0.079	0.358	-0.279	23.056	0.000	0.135
Disease resistant crop	-0.228	-0.123	0.351	29.890	0.000	0.109
Crop adapts easily to production	-0.363	0.053	0.309	41.769	0.000	0.178
Low initial investment cost	-0.099	0.328	-0.230	32.158	0.000	0.118
Active Covariates						
Intercept	3.286	-1.059	-2.227	19.290	0.000	
Age of respondent	-0.016	0.014	0.002	7.959	0.019	
Level of education of respondent	-0.038	-0.036	0.073	8.473	0.014	
Awareness	-0.120	-0.125	0.245	3.070	0.220	
Concerned about soil fertility	-0.138	0.109	0.029	2.035	0.360	
Concerned about health risk	-0.090	0.094	-0.005	1.580	0.450	
Low cost investment	-0.032	0.009	0.023	0.138	0.930	
Yield risks	0.010	0.050	-0.061	0.388	0.820	
Training	-0.124	-0.373	0.497	6.147	0.046	

Analysis and Results

- BW score means for 11 technology attributes for 3 – cluster solution

Technology Attributes	Cluster 1 (59%) **“general farmer”**	Cluster 2 (23%) **“risk-averse”**	Cluster 3 (18%) **”adopter”**	Anova F- value	Anova p
Higher expected price	2.19[a,b]	-0.51[b,c]	-0.13[a,c]	282.51	0.000
Stable price and market demand	0.58	0.74	0.55	0.53	0.587
Growing market demand	0.24[a]	-0.47[a,b]	0.38[b]	13.76	0.000
High expected profit/return	2.74[a,b]	0.17[a,c]	0.64[b,c]	206.06	0.000
Time from planting to harvest is short	-1.68[a,b]	-0.36[a]	-0.76[b]	33.5	0.000
Expected high yield	1.48[a,b]	0.13[a,c]	2.29[b,c]	85.97	0.000
Less labour required to produce	-1.49[a]	0.03[a,b]	-1.47[b]	58.38	0.000
Use less water	-2.21[a,b]	-0.87[a,c]	-2.81[b,c]	48.67	0.000
Disease resistant crop	0.15[a]	0.52[b]	1.81[a,b]	42.88	0.000
Crop adapts easily to production	-1.05[a,b]	0.16[a,c]	1.08[b,c]	92.05	0.000
Low initial investment cost	-0.96[a,b]	0.45[a,c]	-1.58[b,c]	54.89	0.000

Note: Means with the same superscript letters are significantly different at $p < 0.05$, post-hoc Tukey HSD (Honest Significant Difference) test.

Heterogeneity in Characteristics
Farmer and farm household characteristics and assets

	Cluster 1 Most Important Attributes **58.8% (n = 387)**	**Cluster 2** Most Important Attributes **23.1% (n=152)**	**Cluster 3** Most Important Attributes **18.1% (n=119)**
Most	High expected profit /return	Stable price and market demand	Expected high yield
2nd	Higher expected price	Disease resistant crop	Disease resistant crop
3rd	Expected high yield	Low initial investment cost	Crop adapts easily to production
4th	Stable price and market demand	High expected profit /return	High expected profit /return
5th	Growing market demand	Expected high yield	Growing market demand
Age of respondent (years)	46.72[a]	50.36[a,b]	46.45[b]
Educational level of respondent (years)	5.61[a]	5.36[b]	8.19[a,b]
Educational level of spouse (years)	5.19[a]	4.35[b]	6.50[a,b]
Respondent with high school degree and above (percentage)	14.21[a]	13.82[b]	30.25[a,b]
Spouse with high school degree and above (percentage)	6.98[a]	5.92[b]	17.65[a,b]
Respondent literacy (ability to read - percentage)	82.69[a]	79.61[b]	96.64[a,b]
Spouse literacy (ability to read - percentage)	79.33	72.37[a]	84.87[a]
Agricultural labourer as secondary profession (percentage)	31.27[a]	29.61[b]	13.45[a,b]
Motorbike ownership (percentage)	75.45[a]	76.32[b]	87.39[a,b]
Agricultural pump ownership (percentage)	55.21[a]	57.89	69.75[a]

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5th	Growing market demand	Expected high yield	Growing market demand
Irrigated- farm assets (in ha)	0.30	0.37	0.41
Share of farms without irrigation during dry season (percentage)	7.66	17.22[a]	3.14[a]
Share of land owned and farmed by respondents (percentage)	56.33	53.95	64.71
Share of land sharecropped-land by respondents (percentage)	30.49	28.29	25.21
Share of land rented-land by respondents (percentage)	38.76	36.84	34.45
Shallots yield (ton per ha)	8.58	8.65	8.64

Note: Means with the same superscript are significantly different at $p < 0.05$, post-hoc Tukey HSD (Honest Significant Difference test.

Heterogeneity in Characteristics
Non-conventional technology adoption

Size	**Cluster 1**	**Cluster 2**	**Cluster 3**
	Most Important Attributes	Most Important Attributes	Most Important Attributes
	58.8% (n = 387)	**23.1% (n=152)**	**18.1% (n=119)**
Most	High expected profit /return	Stable price and market demand	Expected high yield
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4th	Stable price and market demand	High expected profit /return	High expected profit /return
5th	Growing market demand	Expected high yield	Growing market demand
Awareness of non-conventional farming systems (percentage)	73.83[a]	65.56[b]	97.48[a,b]
Received training on non-conventional farming methods, conditional on awareness (percentage)	35.66[a]	32.89[b]	61.34[a,b]
Adopted a non-conventional farming method, conditional on training (percentage)	22.74[a]	23.03[b]	43.70[a,b]
Adopted a non-conventional farming method, without training (percentage)	6.2	7.24	10.92
Continue to adopt non-conventional farming method, conditional on training (percentage)	17.83[a]	21.05[b]	38.66[a,b]
Continue to adopt non-conventional farming method, without training (percentage)	2.58	6.58	6.72
Number of years adopting (years)	1.59	1.50	2.16
First person to implement non-conventional farming in village (percentage)	17.14[a]	20.55	41.67[a]

Note: Means with the same superscript are significantly different at $p < 0.05$, post-hoc Tukey HSD (Honest Significant Difference) test.

Heterogeneity in Characteristics

Access to and changes in use fertilizers and pesticides

Size	Cluster 1	Cluster 2	Cluster 3
	Most Important Attributes	Most Important Attributes	Most Important Attributes
	58.8% (n = 387)	**23.1% (n=152)**	**18.1% (n=119)**
Most	High expected profit /return	Stable price and market demand	Expected high yield
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3rd	Expected high yield	Low initial investment cost	Crop adapts easily to production
4th	Stable price and market demand	High expected profit /return	High expected profit /return
5th	Growing market demand	Expected high yield	Growing market demand
Increased use of organic fertilizer per m2 (percentage)	18.09[a]	24.34[b]	38.66[a,b]
Decreased use of chemical pesticides per m2 (percentage)	9.56[a]	13.82[b]	22.69[a,b]
Increased use of bio-pesticides per m2 (percentage)	7.75[a]	8.55[b]	18.49[a,b]
Reason to use organic fertilizer is to increase land fertility (percentage)	9.56[a]	17.11[b]	26.05[a,b]
Reason to use organic fertilizer is to increase quality (percentage)	2.84	1.97[a]	6.74[a]
Reason to use bio-pesticides is to increase quality (percentage)	2.07	0.00[a]	5.04[a]
Keep records of pesticide use (percentage)	13.70	6.58[a]	15.97[a]
Member of farmer group (FG) (1/0 in percentages)	54.01[a]	51.32[b]	71.43[a,b]
Learning from other members is benefit of being a member of FG	16.02	9.87[a]	19.33[a]
Farmer groups are main source of information for production methods (percentage)	8.53	5.92[a]	14.29[a]
Other farmers are the main source of information for production methods (percentage)	70.03[a]	73.03[b]	53.78[a,b]

Note: Means with the same superscript are statistically different at $p < 0.05$, post-hoc Tukey HSD (Honest Significant Difference) test.

Conclusion

- Shallot farmers' preferences toward technology adoption attributes are heterogeneous
- Unique clusters or segments exist
- There are significance difference in the characteristics that may influence the determinant of adoption of non-conventional farming practices
- To increase the adoption rates, investment in human resources (via education and training) is a must.

Limitation

- Endogeneity issues in technology attributes and characteristics (potential determinant variables)
- Next stages – for further analysis need to implement a treatment (selection) model such as endogenous treatment model (Suprehatin et al., 2015)

Thank you!

wahida@adelaide.edu.au

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Questions? and Inputs, please…

Thank you

Wahida

wahida@adelaide.edu.au