Supplementary information

Restoration of Rice Ecosystem Services: 'Ecological Engineering for Pest Management' Incentives and Practices in the Mekong Delta Region of Vietnam

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Table S1. Profiles of farmers from southern Vietnam that practice conventional rice farming and that incorporate, or have incorporated in the past, ecological engineering for pest management

Responses	Conventional[1]	Current-EE[1]	Former-EE[1]	L-R χ^2-statistic [2]
Males (%)	91.6	97	92.3	3.741^{ns}
Age (years)	49.73±0.88	48.41±1.07	52.26±1.75	0.649^{ns}
Education attained (%)				
(i) Primary	25.2	27.8	28.2	6.376^{ns}
(ii) Secondary	52.4	49.6	35.9	
(iii) Secondary (high)	21.0	21.1	33.3	
(iv) College	0.7	1.5	2.6	
(v) University	0.7	0.0	0.0	
Mainly dedicated to rice (%)	90.9	94.0	97.4	2.324^{ns}
Rice-growing experience (years)	24.18±1.02	26.17±1.01	28.23±1.65	2.180^{ns}
Area of rice fields (ha)	1.53±0.12^{a}	1.84±0.17^{ab}	2.48±0.60^{b}	3.303*
Own land (%)	97.2	98.5	100	1.481^{ns}
Grow other crops on farm (%)	14.7	19.5	12.8	1.622^{ns}
Maintain livestock on farm (%)	34.3	42.1	38.5	1.798^{ns}
Diversified farm (%)	45.5	55.6	48.7	2.896^{ns}
Have other sources of income (%)	69.2	74.4	69.2	1.020^{ns}
Operate a business (%)	28.7	24.1	25.6	0.767^{ns}
N	143	133	39	

[1]: means with the same letters indicate homogenous groups based on Tukey pairwise comparisons; [2]: ns = $p > 0.05$, * = $p \leq 0.05$; χ^2 degrees of freedom = 2 (8 for education); for parametric analyses, F degrees of freedom = 2,312.

Table S2. Management of bund vegetation by farmers in south Vietnam and motivations for choosing bund plants

Responses	Conventional	Current-EE	Former-EE	L-R χ^2 -statistic [1]
Weeds removed (%)	55.9	67.7	66.7	4.404^{ns}
Herbicide used (%)	38.5	37.6	41.0	0.150^{ns}
Weeds as forage (%)	23.1	15.8	12.8	3.425^{ns}
Planted species richness		2.83+0.14	2.13+0.19	2.033^{ns}
Planted vegetable richness		0.72+0.09	0.46+0.12	2.192^{ns}
Planted flower richness		1.50+0.11	1.67+0.17	0.462^{ns}
Reason behind plant choice (%)				
(i) Easy or inexpensive		12.8 (64.7)	20.5 (62.9)	27.463***
(ii) Landscape related		42.9 (58.6)	35.9 (42.9)	
(iii) Profits and uses		40.6 (40.6)	12.8 (14.3)	
(iv) Recommended		3.8 (36.8)	30.8 (31.4)	
Coordination of activities (%)				
(i) Community coordination		51.0	18.2	10.068**
(ii) Based on rice sowing/planting		12.0	9.1	
(iii) Same time as rice sowing/planting		14.0	27.3	
(iv) Individual basis		23.0	45.5	

1: ns = $p > 0.05$, *** = $p \leq 0.001$; χ^2 degrees of freedom = 3

Table S3. Flowering plants used as part of ecological engineering for pest management in the Mekong Delta Region of southern Vietnam. Numbers are percentages of farmers who indicated that they planted corresponding species.

Plant species	Scientific names	Current-EE	Former-EE	Total	L-R χ^2 -statistic [1]
Vegetables					
Lady finger	*Abelmoschus esculentus* (L.) Moench	36.1	10.3	30.2	9.542^{ns}
Mung bean	*Vigna radiata* (L.) R. Wilczek	14.3	10.3	13.4	0.423^{ns}
Sesame	*Sesamum indicum* L.	10.5	15.4	11.6	0.693^{ns}
Chili	*Capsicum* spp.	6.8	0.0	5.2	2.785^{ns}
Squash	*Cucurbita* spp.	6.8	0.0	5.2	2.785^{ns}
Bitter melon	*Momordica* spp.	5.3	2.6	4.7	0.495^{ns}
Eggplant	*Solanum melongena* L.	5.3	0.0	4.1	2.140^{ns}
Cucumber	*Cucumis sativus* L.	4.5	2.6	4.1	0.293^{ns}
Gourd	*Lagenaria* spp.	4.5	2.6	4.1	0.293^{ns}
Watermelon	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	0.0	2.6	0.6	3.430^{ns}
Blackbean	*Phaseolus* spp.	0.8	0.0	0.6	0.295^{ns}
Ginger	*Zingiber officinale* Roscoe	0.8	0.0	0.6	0.295^{ns}
Stringbean	*Vigna unguicalata* (L.) Walp.	0.8	0.0	0.6	0.295^{ns}
Cinnamon	*Cinnamomum verum* J.Presi	0.8	0.0	0.6	0.295^{ns}
Flowers					
Cosmos	*Cosmos* spp.	78.9	71.8	77.3	0.880^{ns}
Butter daisy	*Melampodium* spp.	32.3	35.9	33.1	0.173^{ns}
Sunflower	*Helianthus annuus* L.	26.3	25.6	26.2	0.007^{ns}
Marigold	*Tagetes* spp.	14.3	20.5	15.7	0.884^{ns}
Lantana	*Lantana camara* L.	13.5	2.6	11.0	3.693*
Blackjack	*Bidens pilosa* L.	5.3	2.6	4.7	0.495^{ns}
Wild pea	*Macroptilium lathyroides* (L.) Urb.	1.5	2.6	1.7	0.198^{ns}
Zizanias	*Chrysogonum peruvianum* L.	2.3	0.0	1.7	0.895^{ns}
Dahlias	*Dahlia pinnata* Cav.	1.5	2.6	1.7	0.198^{ns}
Jasmine	*Jasminum* spp.	0.8	0.0	0.6	0.295^{ns}
Other plants					
Weeds		5.3	0.0	4.1	2.140^{ns}
Mango	*Mangifera indica* L.	0.8	0.0	0.6	0.295^{ns}
Eucalyptus	*Eucalyptus* spp.	0.8	0.0	0.6	0.295^{ns}
Cajaput	*Melaleuca* spp.	0.8	0.0	0.6	0.295^{ns}

[1]: ns = $p > 0.05$, * = $p \leq 0.05$

Table S4. Farmer responses to questions about their satisfaction with ecological engineering. Numbers are percentages of farmers associated with each response.

Responses	Current-EE	Former-EE	Total	L-R χ^2 - statistic [1]
Satisfied with results?				
(i) Yes	61.7	22.6		37.448***
(ii) Somewhat	32.5	22.6		
(iii) No	5.8	54.8		
Why satisfied?				
(i) Pest, disease or weed reduction	47.1	69.2	49.6	2.318^{ns}
(ii) Improved environment	49	38.5	47.8	0.520^{ns}
(iii) Reduced costs	47.1	15.4	43.5	5.250^{ns}
(iv) Increased profits	30.4	30.8	30.4	0.001^{ns}
(v) Improved wellbeing	24.5	15.4	23.5	0.581^{ns}
(vi) Technical support available	2.0	0.0	1.7	0.484^{ns}
Why dissatisfied?				
(i) Difficult to implement	47.8	41.7	45.7	0.242^{ns}
(ii) Increased costs	26.1	50.0	34.3	3.932*
(iii) Difficult to coordinate	17.4	16.7	17.1	0.006^{ns}
(iv) Increased rats	8.7	16.7	11.4	0.946^{ns}
(v) Herbicide burn	13.0	4.2	10.0	1.574^{ns}
(vi) Obstruction of drainage	8.7	0.0	5.7	3.484^{ns}
(vii) Theft of produce	0.0	8.3	2.9	4.396*

[1]: ns = $p > 0.05$, * = $p \leq 0.05$, *** = $p \leq 0.001$

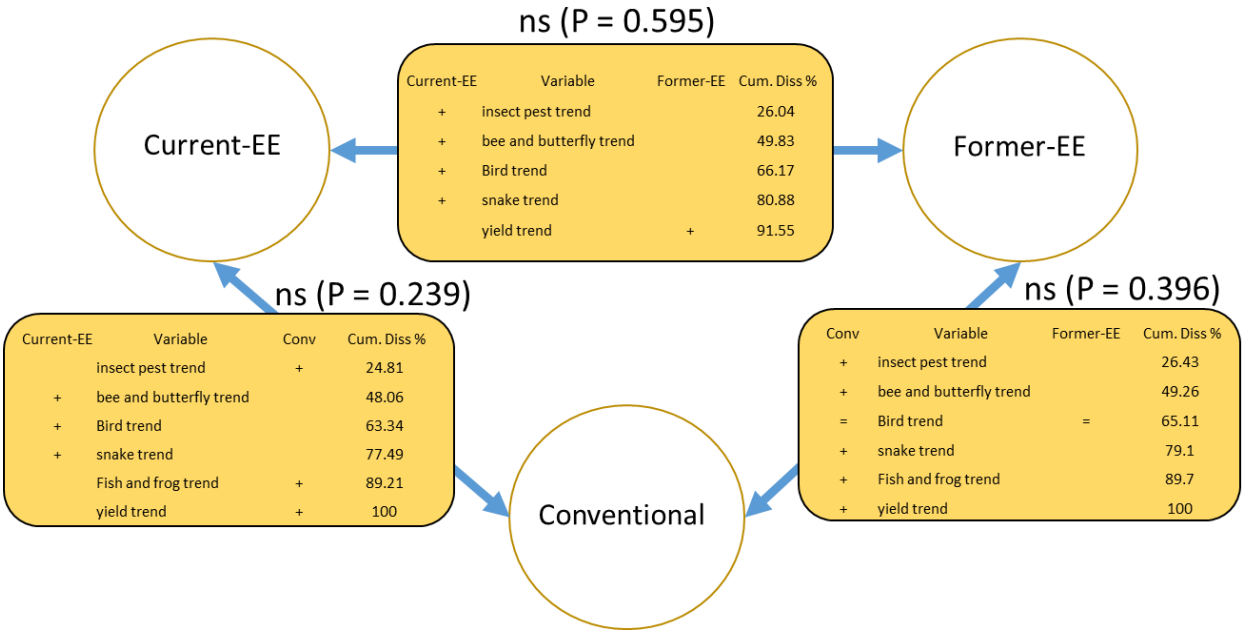

Figure S1. Differences between farmers' perception about the trends of biodiversity, rice pests and yields, based on rice management (in circles). PERMANOVA pair-wise analyses are shown. SIMPER analyses (in orange boxes) show the variables contributing most to the dissimilarity between each pair of groups. The '+' symbols indicate the group in which each variable is more prevalent. 'Cum. Diss %' = cumulative dissimilarity between pairs, expressed as a percentage.

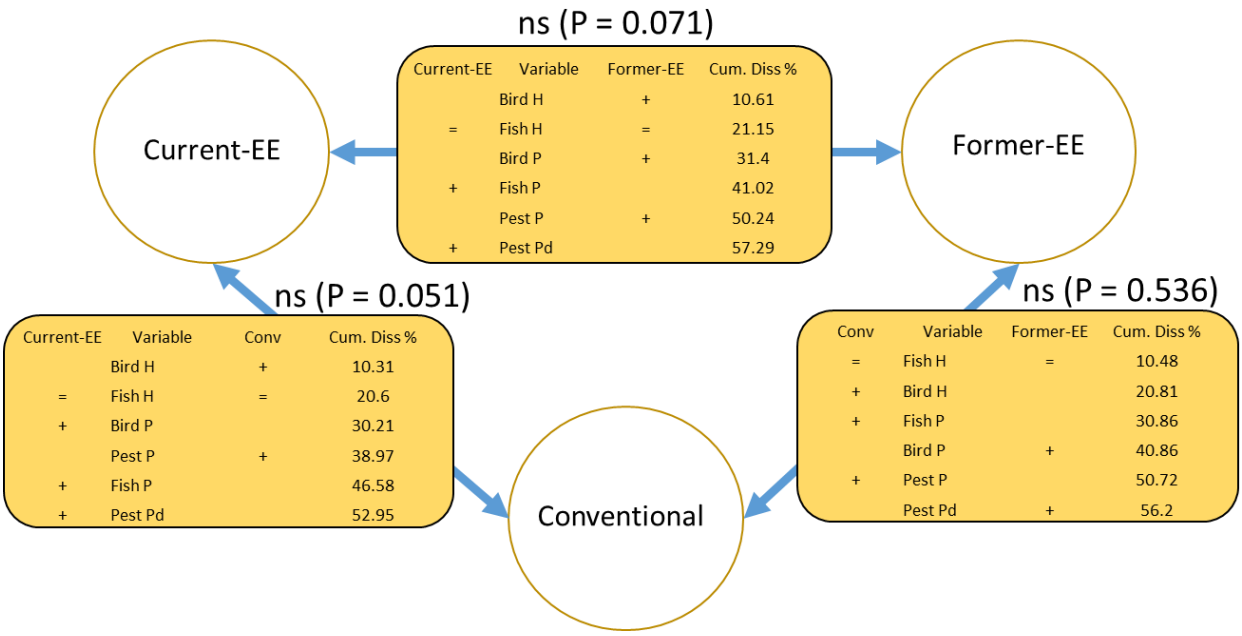

Figure S2. Differences between farmers' perception about the declining trends of biodiversity, based on rice management (in circles). PERMANOVA pair-wise analyses are shown. SIMPER analyses (in orange boxes) show the variables (an animal group followed by a letter indicating the reason behind the trend: 'H' = decline due to hunting; 'P' = decline due to pesticides; 'Pd' = increase due to pesticides) that contributed most to the dissimilarity between each pair of groups. The '+' symbols indicate the group in which each variable is more prevalent. 'Cum. Diss %' = cumulative dissimilarity between pairs, expressed as a percentage.