

Appendix A

Cost-benefit details of three paddy cropping systems.

Item	DR			RR			RC		
	Early rice	Late rice	Annual	Main rice	Ratoon rice	Annual	Rice	crawfish	Annual
Costs									
1.Seed usage amount(kg)	112.50	30.00	142.50	22.50	0	22.50	20.25	—	20.25
Price(USD/kg)	0.33	7.55	—	9.06	—	—	9.06	—	9.06
Costs(USD)	37.13	226.50	263.63	203.85	0	203.85	183.47	—	183.47
2.Compound fertilizer(kg)	463.50	517.20	980.70	469.80	124.05	593.85	337.50	—	337.50
Price(USD/kg)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	—	0.48
Costs(USD)	222.48	248.26	470.74	225.50	59.54	285.05	162.00	—	162.00
3.Urea(kg)	195.15	208.05	403.20	162.90	155.40	318.15	135.00	—	135.00
Price(USD/kg)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	—	0.33
Costs(USD)	64.40	68.66	133.06	53.76	51.28	104.99	44.55	—	44.55
4.Pesticide usage amount(USD)	124.44	294.20	418.64	209.37	54.86	264.23	163.14	—	163.14
5.Plowing(USD)	226.59	226.59	453.18	226.59	0	226.59	203.93	—	203.93
6.Planting(USD)	181.27	181.27	362.54	181.27	0	181.27	163.14	—	163.14
7.Harvesting(USD)	181.27	181.27	362.54	181.27	181.27	362.54	163.14	—	163.14
8.Electricity(kWh)	369.25	910.85	1280.10	381.42	82.23	463.65	88.00	3512.00	3600.00
Price(USD/kWh)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Costs(USD)	29.54	72.87	102.41	30.51	6.58	37.09	7.04	280.96	288.00
9.Labor(Person d)	4	4	8	4	2	6	4	12	16.00
Price(USD/Person d)	45.32	45.32	45.32	45.32	45.32	45.32	45.32	45.32	45.32
Costs(USD)	181.28	181.28	362.56	181.28	90.64	271.92	181.28	543.84	725.12
10.Land rent(USD)	566.47	566.47	1132.94	566.47	566.47	1132.94	566.47	566.47	1132.94
11.Juvenile crawfish(kg)	—	—	—	—	—	—	—	450.00	450.00
Price(USD/kg)	—	—	—	—	—	—	—	1.51	1.51
Costs(USD)	—	—	—	—	—	—	—	679.50	679.50
12.Construction cost(USD)	—	—	—	—	—	—	—	120.85	120.85
13.Forage(kg)	—	—	—	—	—	—	—	4500.00	4500.00
Price(USD/kg)	—	—	—	—	—	—	—	0.15	0.15
Costs(USD)	—	—	—	—	—	—	—	675.00	675.00
14.Lime(kg)	—	—	—	—	—	—	—	187.50	187.50
Price(USD/kg)	—	—	—	—	—	—	—	0.30	0.30
Costs(USD)	—	—	—	—	—	—	—	56.25	56.25
Total	1814.86	2247.36	4062.23	2059.87	1010.64	3070.47	1838.16	2922.87	4761.03
Income									
1.Yield(kg)	6273.60	8284.35	14557.95	10551.15	3965.55	14516.70	6750.00	2250.00	—
Price(USD/kg)	0.26	0.33	—	0.26	0.33	—	0.39	3.93	—
Income(USD)	1611.05	2703.05	4314.1	2773.26	1305.88	4079.14	2651.06	8836.86	11487.92
2.Grain subsidy(USD)	79.31	79.31	158.61	79.31	79.31	158.61	79.31	79.31	158.61
Total	1690.36	2782.36	4472.71	2852.57	1385.19	4237.75	2730.37	8916.17	11646.53

Appendix B

Emergy calculation process and detailed inputs of three paddy cropping systems (a).

Solar radiation (DR):

Insolation=5.06E+09 J/m²/yr. Albedo=20%. Land area=10000m². Growth period=213d.

Energy (J)=(5.56E+09)×(1-20%)×10000×213/365=2.36E+13 J

Solar radiation (RR):

Insolation=5.06E+09 J/m²/yr. Albedo=20%. Land area=10000m². Growth period=220d.

Energy (J)=(5.56E+09)×(1-20%)×10000×220/365=2.44E+13 J

Solar radiation (RC):

Insolation=5.06E+09 J/m²/yr. Albedo=20%. Land area=9000m². Growth period=132d.

Energy (J)=(5.56E+09)×(1-20%)×9000×132/365=1.45E+13 J

Wind, kinetic energy (DR):

Land area=10000m². Air density=1.23kg/m³. Wind speed=1.6m/s. Drag coefficient=0.001. Time=213×24×3600s=11757600s.

Energy (J)=10000×11757600×0.001×1.22×(1.6)³=5.88E+08 J

Wind, kinetic energy (RR):

Land area=10000m². Air density=1.23kg/m³. Wind speed=1.6m/s. Drag coefficient=0.001. Time=220×24×3600s=12144000s.

Energy (J)=10000×12144000×0.001×1.22×(1.6)³=6.07E+08 J

Wind, kinetic energy (RC):

Land area=10000m². Air density=1.23kg/m³. Wind speed=1.6m/s. Drag coefficient=0.001. Time=132×24×3600s=7286400s.

Energy (J)=10000×7286400×0.001×1.22×(1.6)³=3.64E+08 J

Rain chemical energy:

Rainfall=1.26m/yr. Water density=1000kg/m³. Land area=10000m². Gibbs free energy=4940J/kg.

Energy=1.26×1000×10000×4940×365=6.22E+10 J

Irrigation water (DR):

Average quantity=4000m³. Water density=1000kg/m³. Gibbs free energy=4940J/kg. Energy=4000×1000×4940=1.98E+10 J

Irrigation water (RR):

Average quantity=2000m³. Water density=1000kg/m³. Gibbs free energy=4940J/kg. Energy=2000×1000×4940=9.88E+09 J

Irrigation water (RC):

Average quantity=19200m³. Water density=1000kg/m³. Gibbs free energy=4940J/kg. Energy=19200×1000×4940=9.48E+10 J

Net soil loss (DR):

Average soil loss=5250kg/ha/yr. Organic matter content=1.20%. Organic matter energy=5400kcal/kg. Conversion=4186J/kcal.

Energy=5250×1.20%×5400×4186=1.42E+09 J

Net soil loss (RR):

Average soil loss=5250kg/ha/yr. Organic matter content=1.20%. Organic matter energy=5400kcal/kg. Conversion=4186J/kcal.

Energy=5250×1.20%×5400×4186=1.42E+09 J

Net soil loss (RC):

Average soil loss=5250kg/ha/yr. Organic matter content=1.20%. Organic matter energy=5400kcal/kg. Conversion=4186J/kcal. Area factor=0.9.

Energy=5250×1.20%×5400×4186×0.9=1.28E+09 J

Appendix C

Emergy calculation process and detailed inputs of three paddy cropping systems (b).

Item	Original material			Unit	Conversion factors	Mass, Energy or US value			Unit
	DR	RR	RC			DR	RR	RC	
N fertilizer	403.2	318.15	135	kg	1000	403200	318150	135000	g
Compound fertilizer	980.7	593.85	337.5	kg	1000	980700	593850	337500	g
Pesticide	2.4	1.455	0.729	kg	1000	2400	1455	729	g
Seeds	142.5	22.5	20.25	kg	1000	142500	22500	20250	g
Deisel	136.08	93.24	61.24	kg	1000	136080	93240	61240	g
Electricity	1280.1	463.65	3600	kWh	1.25E+07	1.60E+10	5.80E+09	4.50E+10	J ¹⁾
Labor	8	6	16	d	1.26E+07	1.01E+08	7.56E+07	2.02E+08	J ¹⁾
Mechanical services	1178.26	770.4	530.21	USD	1	1178.26	770.4	530.21	USD
Construction investment	0	0	120.85	USD	1	0	0	120.85	USD
Juvenile crawfish	0	0	450	kg	5.45E+06	0	0	2.45E+09	J ¹⁾
Forage	0	0	4500	kg	1000	0	0	4.50E+06	g
Plastic film	0	0	36	kg	1000	0	0	36000	g
Wood sticks	0	0	120	kg	1000	0	0	120000	g
Lime	0	0	187.5	kg	1000	0	0	187500	g
Waterweed	0	0	300	kg	1000	0	0	300000	g

¹⁾ quoted from Chen (2011).

Appendix D

Normalization and weight factors of potential environmental impacts.

Impact category ¹⁾	Unit	Global benchmarks ²⁾	Weight factors ³⁾
CED	MJ a ⁻¹	2590457	0.15
GWP	kg CO ₂ -eq	6869	0.12
AP	kg SO ₂ -eq	52.26	0.14
EP	kg PO ₄ ³⁻ -eq	1.90	0.12
HT	kg 1,4-DCB-eq	197.21	0.14
AT	kg 1,4-DCB-eq	4.83	0.11
TT	kg 1,4-DCB-eq	6.11	0.09
WD	m ³ H ₂ O	2193.9	0.13

¹⁾ CED, cumulative energy demand; GWP, global warming potential; AP, acidification potential; EP, eutrophication potential; HT, human toxicity; AT, fresh water aquatic ecotoxicity; TT, terrestrial ecotoxicity; WD, water depletion;

²⁾ quoted from Sleeswijk et al. (2008);

³⁾ quoted from Wang et al. (2014).