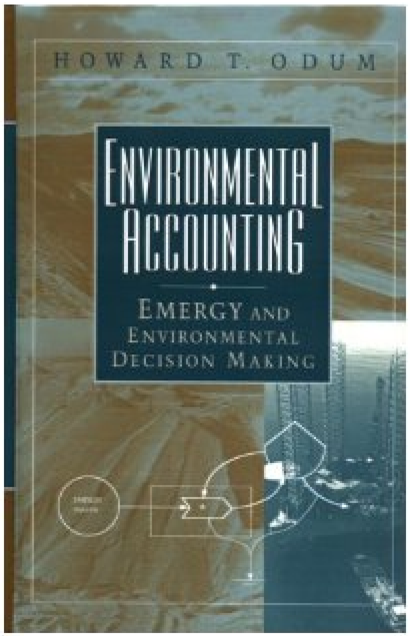
Emergy Analysis for Brazilian Cotton Agriculture

Academic Work

Cotton (*Gossypium hirsutum*)

Cotton Agriculture

EMERGY Environmental Accounting



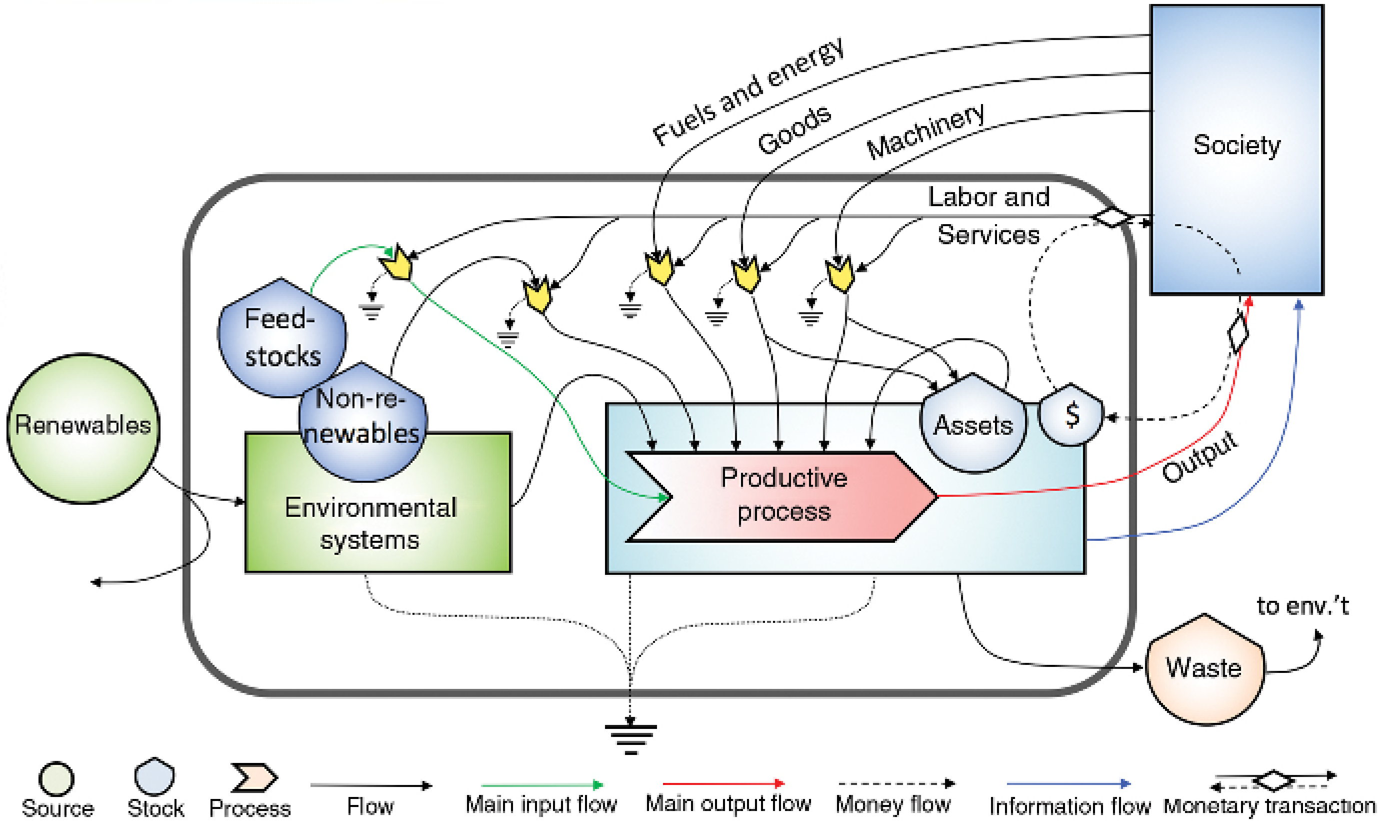


Table 1: Weighted Mean of Brazilian Cotton Harvest indicators - Season 2015/2016

Brazilian Cotton Harvest 15/16							
	YIELD	Production	Participation	Weighted Mean			
Region/FU	**3,924** (kg/ha)	**3,754.2** (mil ton)	**100** %	Elevation **525** meters	Solar Radiation **1.41E+13** J / ha.yr	Wind Power **5.06E+08** J / ha.yr	Rain Precipitation **755** mm^3 / mm^2
North	**3,848**	**30.4**					
TO	3,848	30.4	0.81%	639	1.48E+13	8.48E+08	685
Northeast	**3,832**	**1,059.2**					
MA	4,034	83.9	2.23%	551	1.48E+13	3.81E+08	685
PI	3,636	24.0	0.64%	406	1.47E+13	7.23E+08	507
CE	750	0.3	0.01%	439	1.73E+13	5.56E+08	581
RN	4,000	1.2	0.03%	129	1.86E+13	1.20E+09	282
PB	1,000	0.2	0.01%	302	2.15E+13	1.52E+09	387
PE	1,000	0.1	0.00%	380	2.69E+13	1.77E+09	455
AL	0	0.0	0.00%	378	1.36E+13	8.21E+08	464
BA	3,830	949.5	25.29%	628	2.13E+13	1.15E+09	1065
Midwest	**3,975**	**2,575.9**					
MT	3,943	2,314.1	61.64%	450	1.07E+13	1.71E+08	646
MS	4,502	137.3	3.66%	607	1.73E+13	8.67E+08	724
GO	4,069	124.5	3.32%	822	1.56E+13	8.72E+08	724
Southeast	**3,689**	**86.7**					
MG	3,726	70.8	1.89%	874	1.86E+13	8.57E+08	569
SP	3,533	15.9	0.42%	633	1.84E+13	2.42E+09	437
South	**2,222**	**2.0**					
PR	2,222	2.0	0.05%	276	1.93E+13	1.48E+09	488

Years
2007 - 2017

Table 2: Plantation and Harvest seasons per localization

Region/FU	22/09 to 21/12 Spring			21/12 to 20/03 Summer			20/03 to 21/06 Autumn			21/06 to 22/09 Winter		
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep
North												
TO			P	P	P				H	H		
Northeast												
MA			P	P	P				H	H	H	H
PI			P	P	P				H	H	H	H
CE				P	P	P			H	H	H	
RN	H			P	P	P			H	H	H	H
PB	H				P	P	P	P	H	H	H	H
PE	H	H			P	P	P	P	P	H	H	H
AL	H						P	P	P			H
BA		P	P	P	P			H	H	H	H	H
Midwest												
MT			P	P					H	H	H	H
MS		P	P	P			H	H	H	H	H	
GO		P	P	P					H	H	H	
Southeast												
MG		P	P	P			H	H	H	H	H	
SP	P	P	P		H	H	H	H	H	H		
South												
PR	P	P	P			H	H	H				

Source: (CRESESB 2016) - P = Plantation / H = Harvest

Figure 1: Energy system diagram of cotton production system

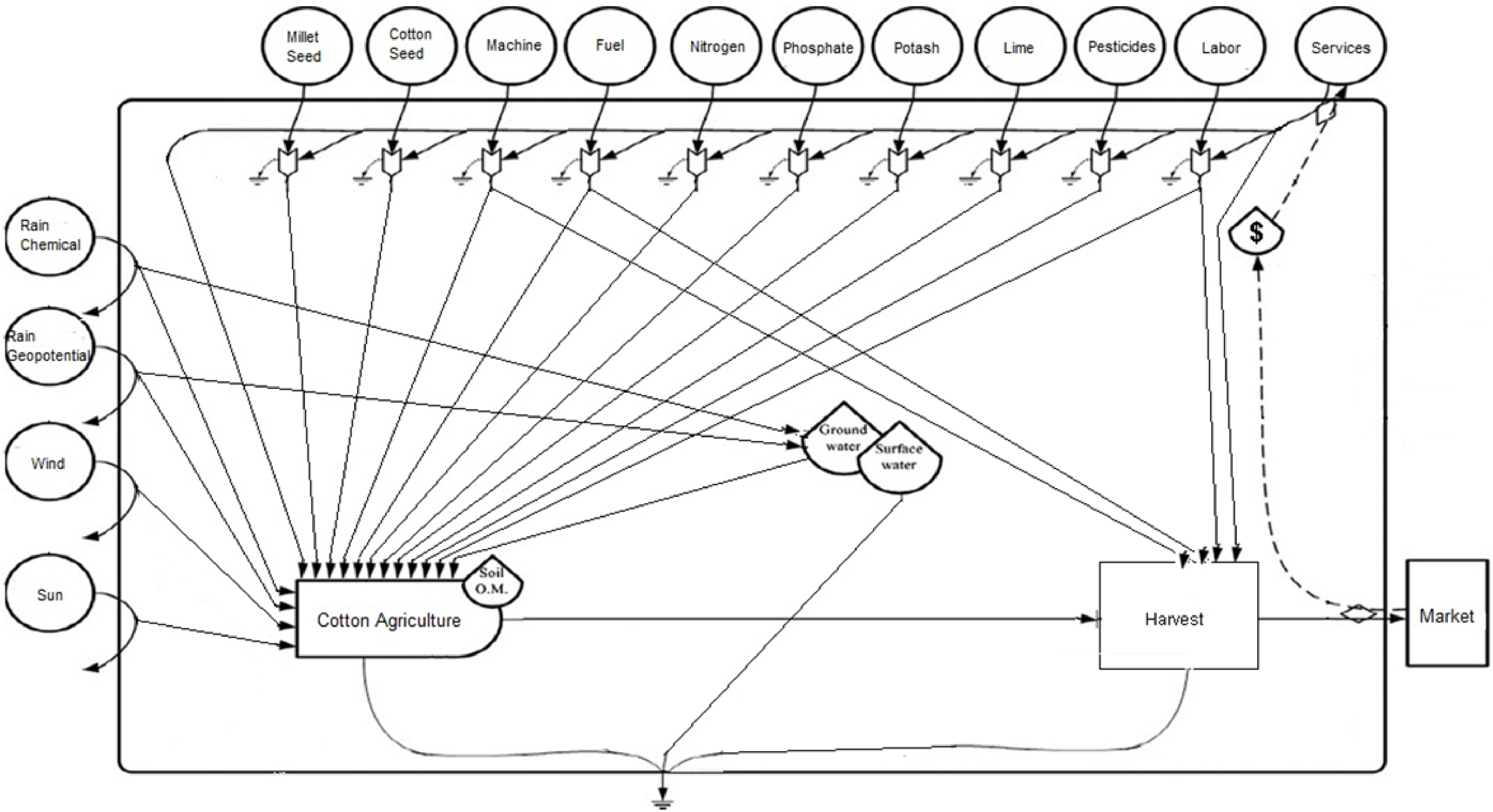


Table 3: Emergy evaluation of cotton crop in Brazil

Note	Item	Unit	Data (units / ha yr)	Unit Solar EMERGY (seJ/unit)	Solar EMERGY (E13 seJ/yr) 1E+13	Em$ Value US$ (2011)/yr	%
RENEWABLE RESOURCES							
01	Sun	J	1.10E+13	1.00E+00	1.10E+00	1.96E+00	0.19%
02	Wind	J	5.06E+08	4.23E+03	2.14E-01	3.82E-01	0.04%
03	Rain Geopotential	J	3.89E+08	2.96E+04	1.15E+00	2.05E+00	0.20%
04	Rain chemical	J	3.73E+10	5.14E+04	1.92E+02	3.42E+02	33.69%
NONRENEWABLE STORAGES							
05	Net Topsoil Loss	J	5.88E+08	1.24E+05	7.29E+00	1.30E+01	1.28%
	Sum of free inputs (sun, rain omitted)				1.99E+02	3.55E+02	
PURCHASED INPUTS							
Operational inputs							
06	Millet Seeds	J	2.14E+08	1.13E+05	2.42E+00	4.32E+00	0.43%
07	Cotton Seeds	J	2.64E+08	3.72E+05	9.81E+00	1.75E+01	1.72%
08	Machine	*	*	*	9.52E+00	1.70E+01	1.67%
09	Fuel	J	2.99E+09	1.11E+05	3.32E+01	5.93E+01	5.83%
10	Nitrogen	g	2.31E+05	6.62E+09	1.53E+02	2.73E+02	26.87%
11	Phosphate	g	6.72E+04	9.35E+09	6.28E+01	1.12E+02	11.04%
12	Potash	g	2.03E+05	9.32E+08	1.89E+01	3.38E+01	3.32%
13	Lime	g	1.39E+05	1.68E+09	2.34E+01	4.18E+01	4.11%
14	Pesticides	g	5.90E+03	2.49E+10	1.47E+01	2.62E+01	2.58%
15	Labor	Person	1.54E-02	2.75E+16	4.25E+01	7.58E+01	7.46%
	Sum of purchased inputs				3.70E+02	6.61E+02	
	Emergy without services				5.69E+02		100.00%
16	Services	US$(2011)	2.16E+03	5.60E+12	1.21E+03	2.16E+03	
	Total Emergy with services				1.78E+03		
TRANSFORMITIES, Calculated							
17	Total Yield without services	g	3.92E+06	1.45E+09	seJ/g		
		J	6.67E+10	8.53E+04	seJ/J		
18	Total Yield with services	g	3.92E+06	4.53E+09	seJ/g		
		J	6.67E+10	2.67E+05	seJ/J		

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INDICES, calculated

Note	Name of Index		Formula	Without Service	With Service
19	Emergy Yield Ratio (EYR)	EYR	U_{cotton} / F	1.54	1.13
20	Emergy Investment Ratio (EIR)	EIR	F / (N+R)	1.86	7.94
21	Environmental Loading Ratio (ELR)	ELR	(N+F) / R	1.97	8.28
22	Environmental Sustainability Index	ESI	EYR / ELR	0.7814	0.1361

Table 4: Compare the results with index results of the cited literatures.

	EYR	EIR	ELR	ESI	%R	%N	%F	Total Emergy	UEV (seJ/g)	UEV (seJ/J)
Blatt WS	1.126	7.936	8.275	0.1361	10.78	0.41	88.81	1.78E+16	4.53E+09	2.67E+05
Blatt WOS	1.538	1.859	1.968	0.7814	33.69	1.28	65.03	5.69E+15	1.45E+09	8.53E+04
Vendrametto WS	1.200	5.060	5.210	0.2300	16.10	0.40	83.50	1.82E+16		2.84E+08
Takahashi WS	1.580	1.710	4.900	0.3224	16.96	19.95	63.09	1.39E+16		1.56E+06
Folio 4 WS	1.950	1.052	15.007	0.1300	6.25	42.48	51.27	2.40E+16	2.31E+10	1.36E+06
Folio 4 WOS	2.056	0.947	14.187	0.1449	6.58	44.78	48.64	2.28E+16		

WS = with service; WOS = without service

Conclusions

Thank you!