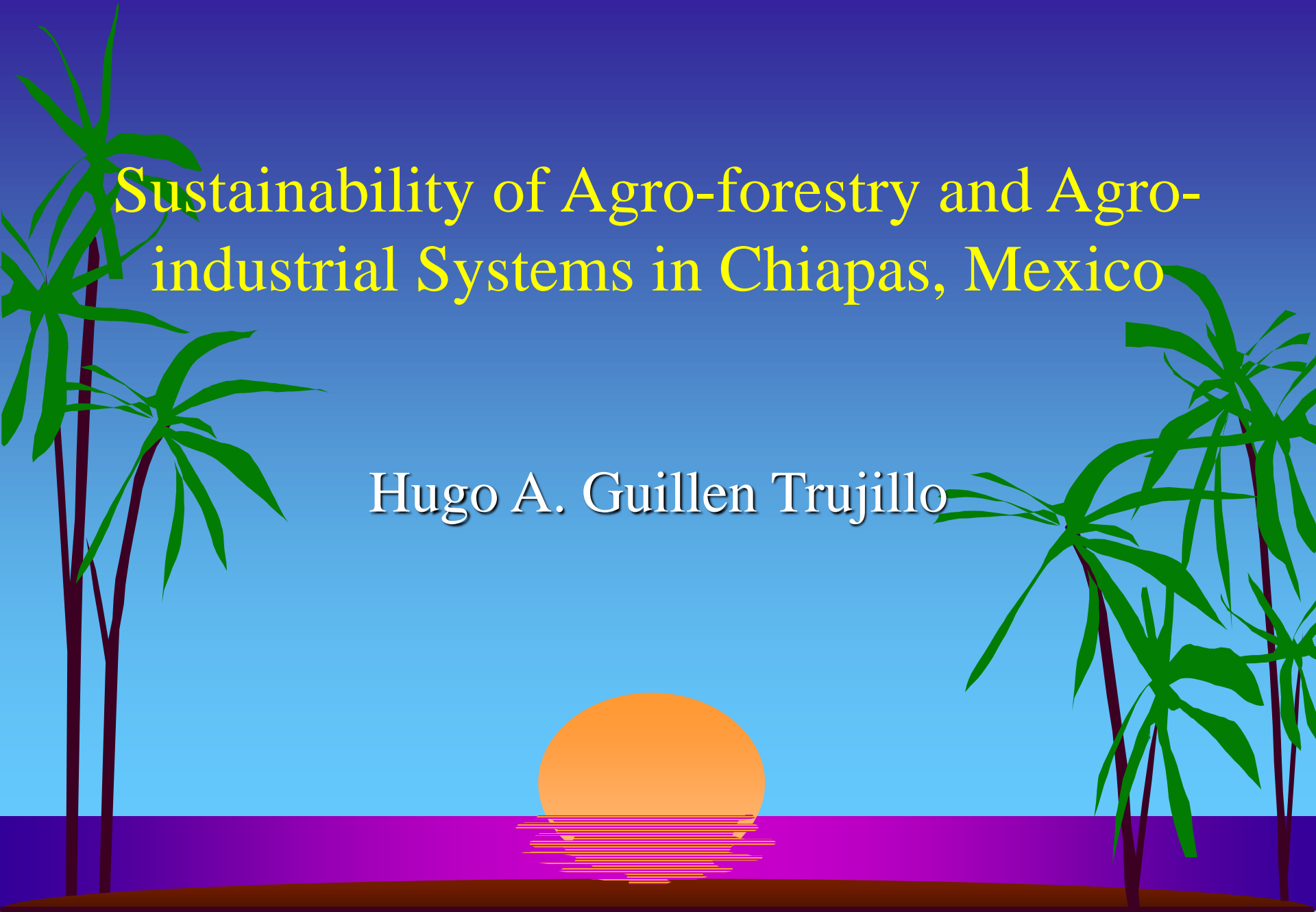


Sustainability of Agro-forestry and Agro-industrial Systems in Chiapas, Mexico

Hugo A. Guillen Trujillo



Objective

- Determine sustainability of agro-forestry and agro-industrial systems by using emergy and financial indicators

Methods

- Energy analysis
 - investment ratio
 - environmental loading ratio
- Financial analysis
 - net revenue cost ratio

A System Diagram Example

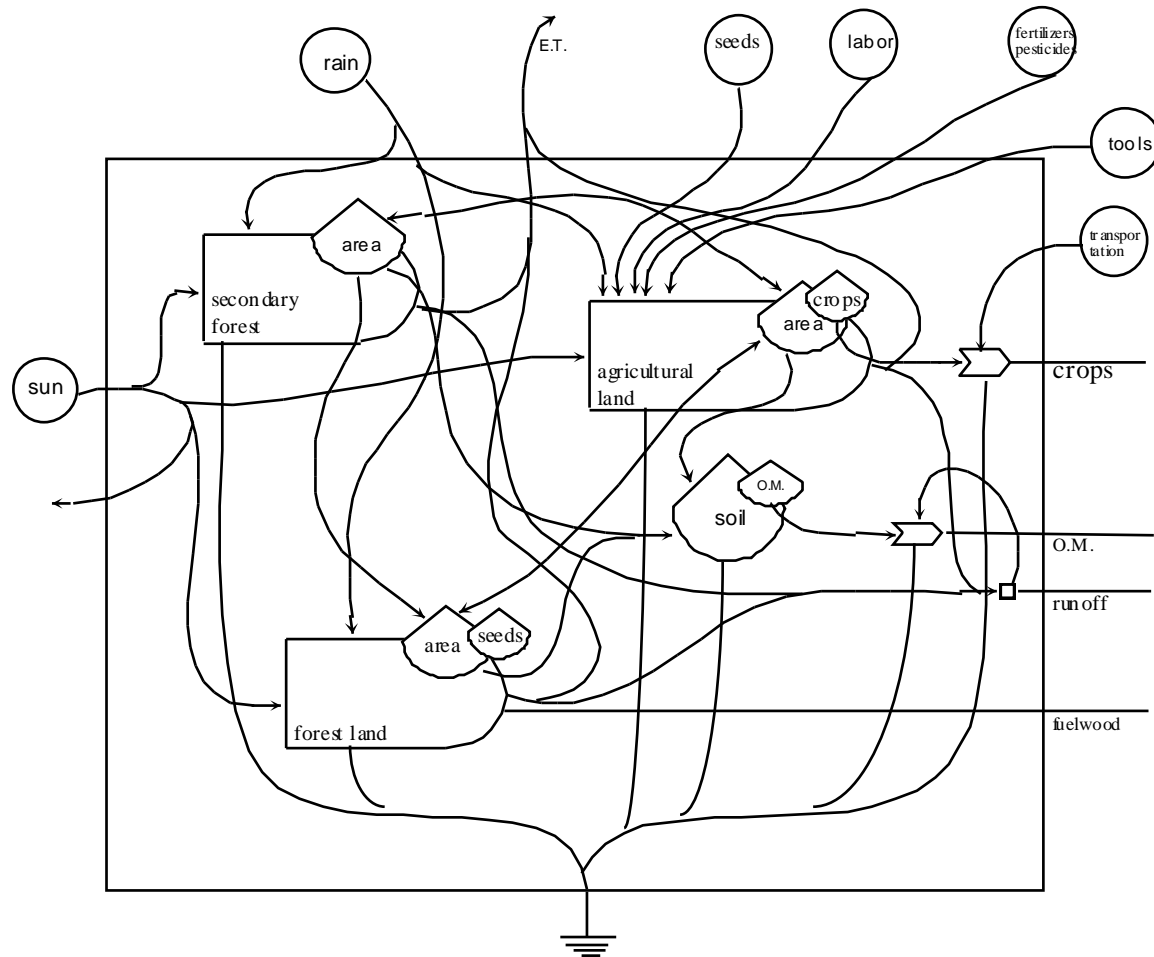


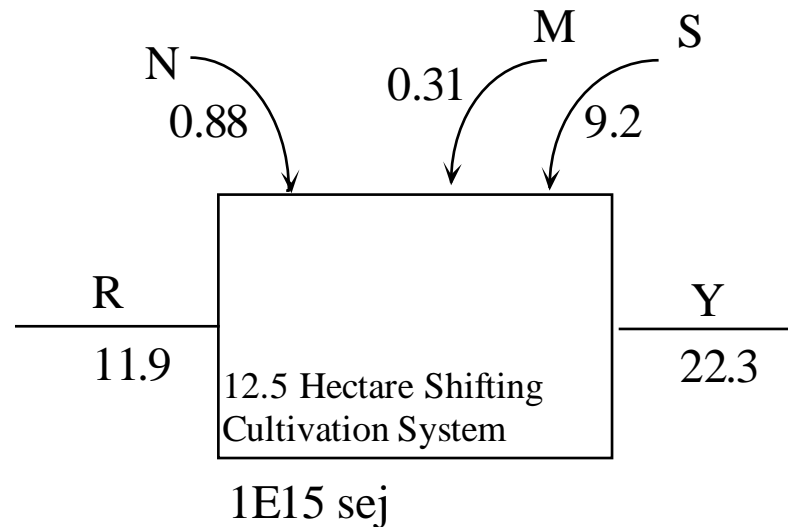
Figure 3-35. Shifting Cultivation System Diagram.

An Emergy Evaluation Table

Table 1. Emergy Evaluation of Shifting Cultivation System.

Note	Item	Raw Units (units/yr)	Trans- formity (sej/unit)	Solar Emergy 1E+15 (sej/yr)	Emdollar Value (US\$/yr)*
RENEWABLE RESOURCES:					
	1 Sunlight	1.97E+15 J	1E+00	1.97	1,045
	2 Rain, chemical	1.85E+12 J	2E+04	28.57	15,183
NONRENEWABLE RESOURCES:					
	3 Soil erosion	1.90E+10 J	7.37E+04	1.40	744
INPUTS:					
	4 Seeds	1.04E+09 J	3.57E+05	0.37	197
	5 ...				
YIELDS:					
	9 Crops	1.28E+11 J	3.57E+05	45.68	24,272

Emergy Ratios to Evaluate Resource Use



Investment Ratio

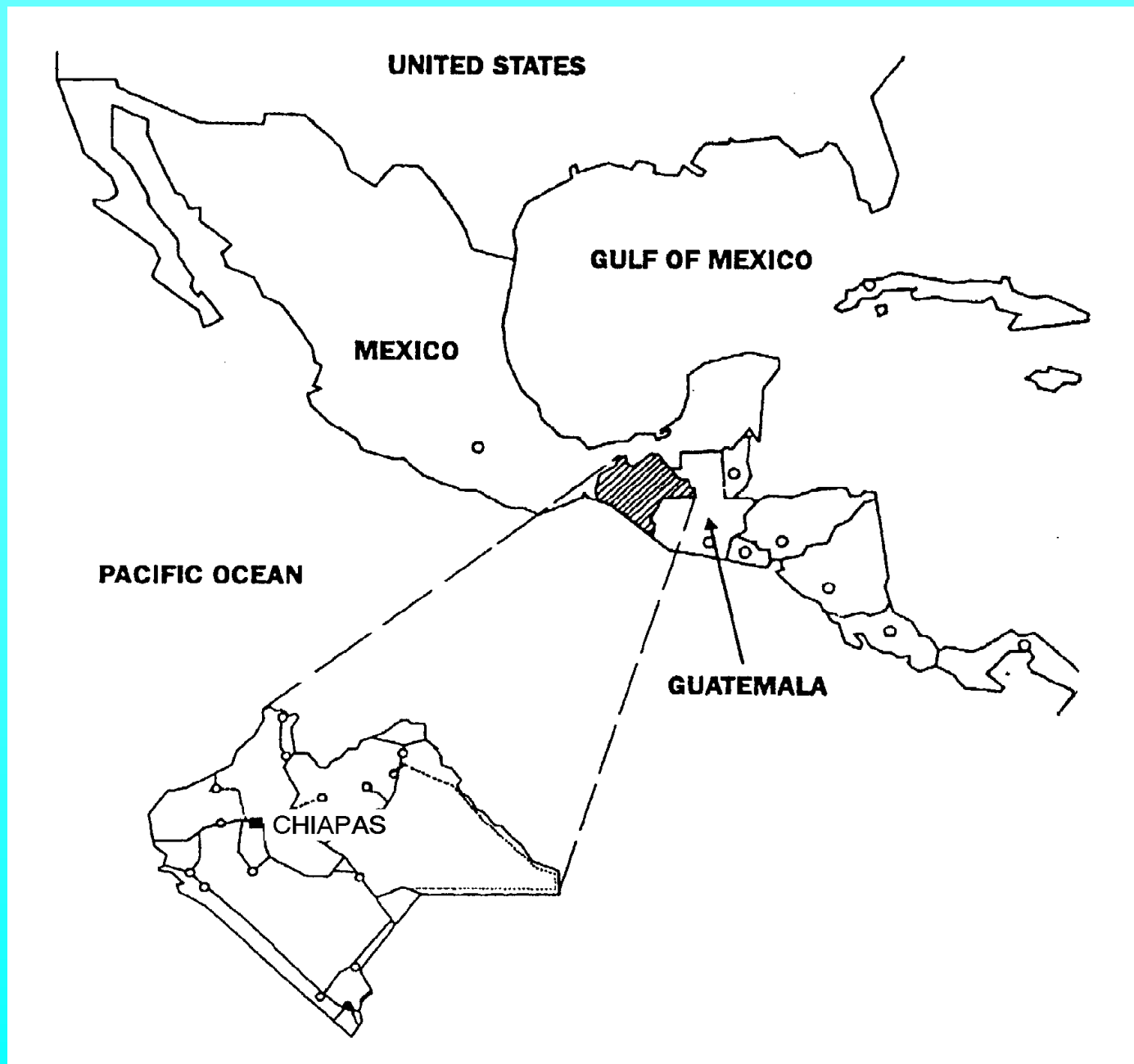
$$IR = (M + S) / (R + N)$$

Environmental Loading Ratio

$$ELR = (N + M + S) / R$$

Financial Analysis

- B (benefits) = Total financial benefits
- C (costs) = Total financial costs
- R (revenue) = $B - C$
- NET REVENUE / COST RATIO
 - $R/C = (\text{revenue}) / (\text{costs})$
- Government subsidies and loans



Systems Analyzed in this Study

- 400 Hectares Agro-forestry System
- One Hectare Shaded Coffee Cultivation System
- One Hectare Sugar Cane Industrialized Cultivation System

400 Hectares Agro-forestry System

- Wood extraction in tropical rain forest
- 12 stands of 33.3 hectares each
- 35% of trees with a diameter breast height (dbh) equal or greater than 45 cm can be cut

400 Hectares Agro-forestry System



400 Hectares Agro-forestry System



One Hectare Shaded Coffee Cultivation System

- Monoculture of *Arabic Coffea*
- 1,200 plants per hectare
- Two to three fertilizations per year
- Labor intensive (160 days/hectare/year)

One Hectare Shaded Coffee Cultivation System



One Hectare Shaded Coffee Cultivation System



One Hectare Sugar Cane Industrialized Cultivation System

- Irrigated systems
- Chemicals
- Mean values obtained from 3,686 hectares
- Eradication of forest

One Hectare Sugar Cane Industrialized Cultivation System



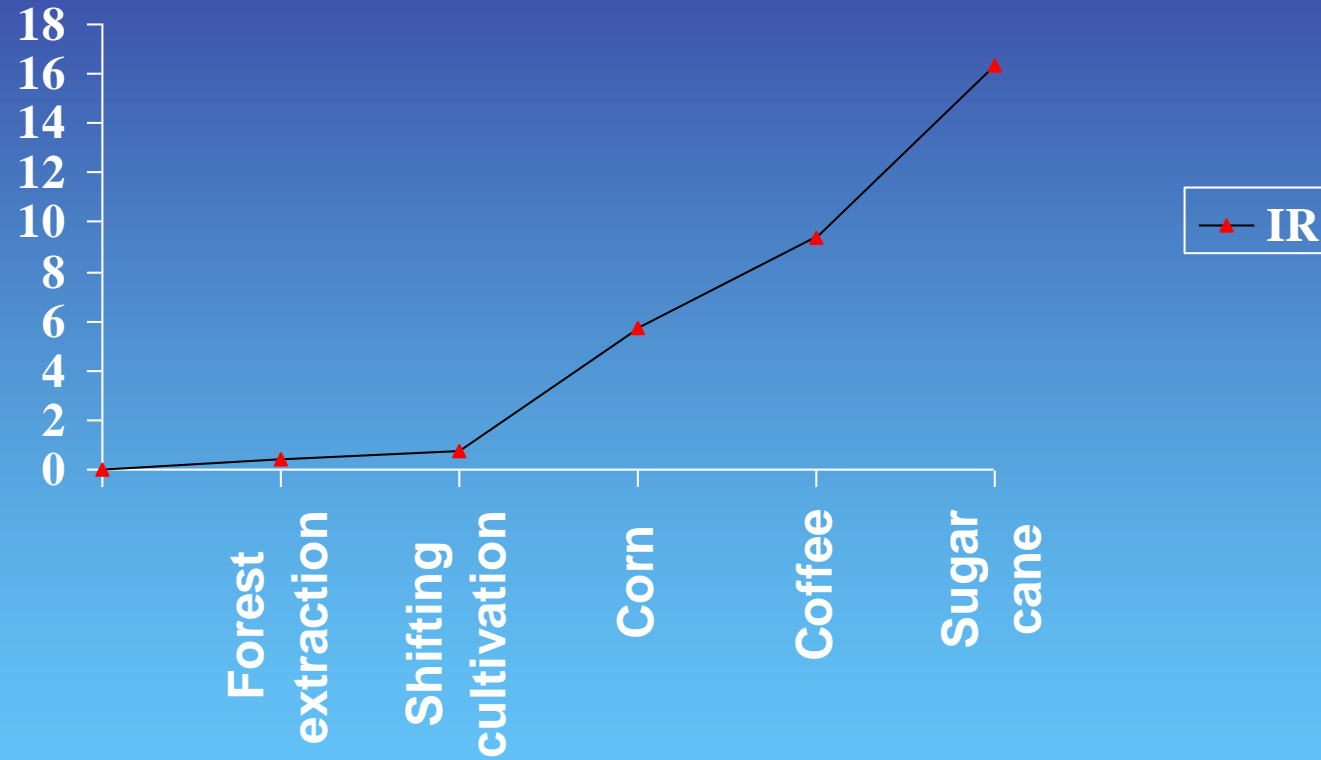
Other Systems for Comparison

- 12.5 Hectares Shifting Cultivation System
 - 2.5 hectares cultivated per year
 - 10.5 hectares left fallow
 - No chemicals
- One Hectare Corn Cultivation
 - With chemicals
 - Intensive (yearly) cultivation

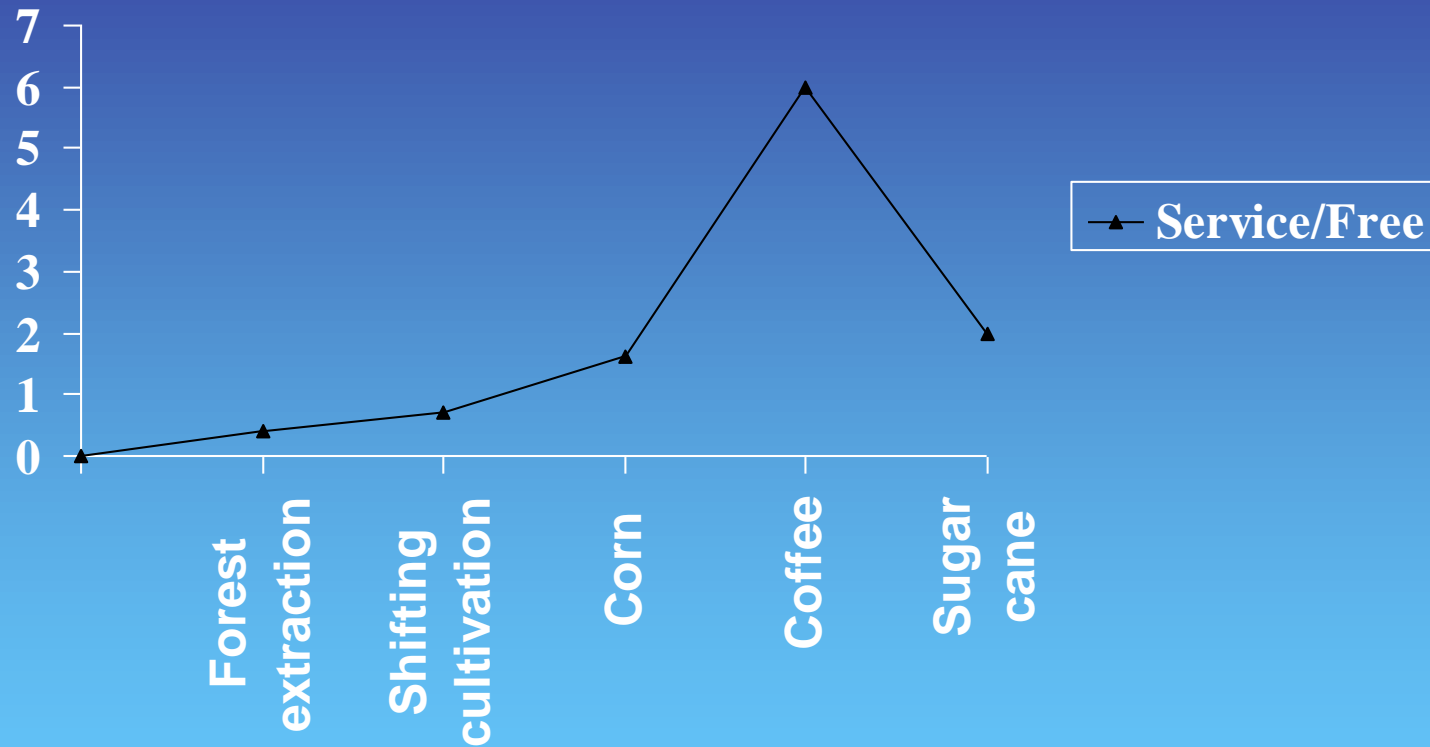
RESULTS AND DISCUSSION



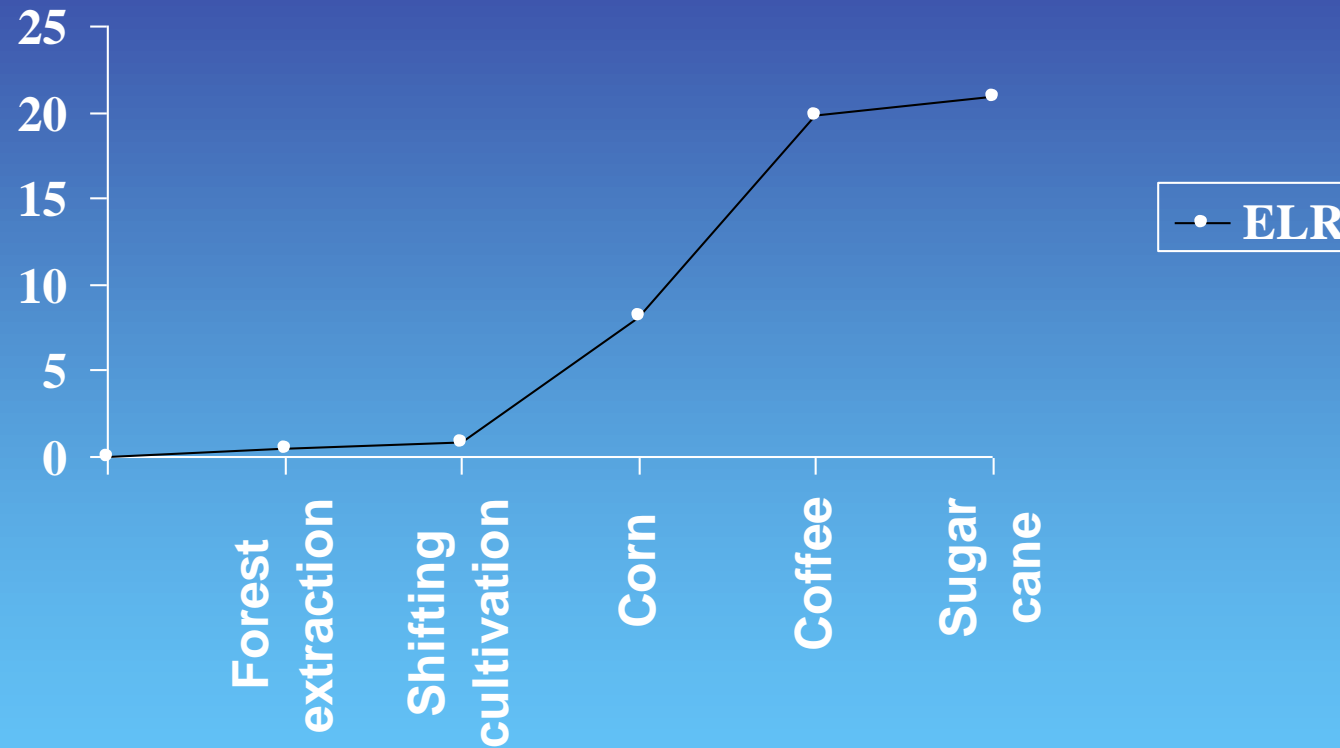
Investment Ratios



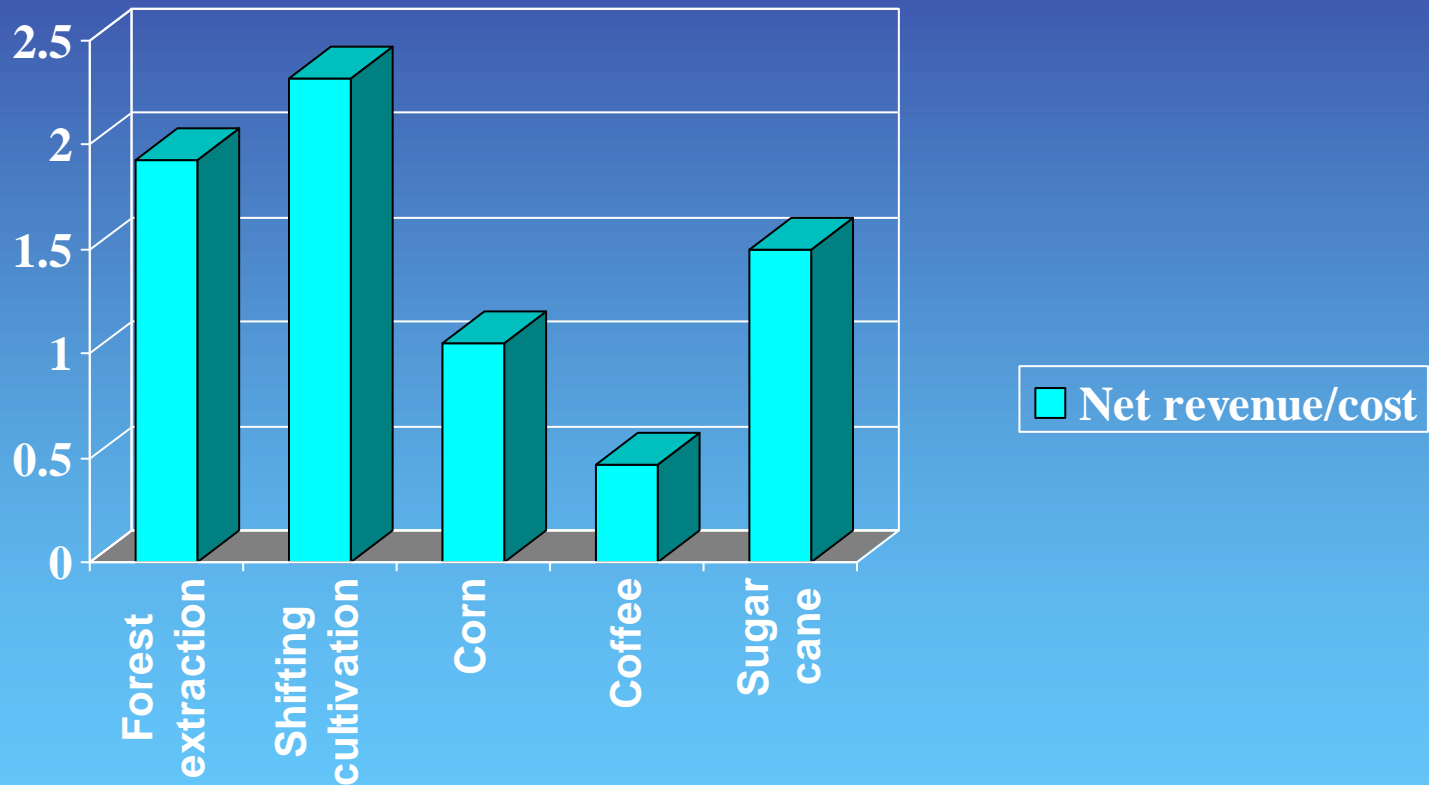
Service to Free Ratios



Environmental Loading Ratios



Net Revenue/Cost Ratio



400 Hectares Agro-forestry System

- ✓ Lowest investment ratio ($IR=0.41$)
 - ✓ Highly profitable ($NR/C=1.93$)
 - ✓ Forest conservation
-
- High requirement of land
 - Over quota extraction ($28.3 \text{ m}^3/\text{ha}/\text{yr}$)
 - Lack of law enforcement

One Hectare Shaded Coffee Cultivation System

- ✓ Maintenance of forest cover
- ✓ Adequate transition zone between protected areas and agricultural fields
- High investment ratio ($IR=9.4$)
- Low profitability ($NR/C=0.5$)
- Labor intensive (160 days/ha/yr)
- Chemical usage

One Hectare Sugar Cane Industrialized Cultivation System

- ✓ Highly profitable ($NR/C=1.5$)
- ✓ Not labor intensive (61 days/ha/yr)
- High external dependency ($IR=16.3$)
- Chemical usage (34 % of total emergy)
- 50 percent water loss
- Native ecosystems eradication

CONCLUSIONS



Sustainability of Agro-forestry and Agro-industrial Systems in Chiapas, Mexico

- Agro-forestry systems had lower investment and environmental loading ratios.
- Agro-forestry were more profitable than industrialized systems.

Sustainability of Agro-forestry and Agro-industrial Systems in Chiapas, Mexico

- Corn shifting cultivation was the most profitable ($NR/C=2.3$).
- Industrialized systems required less land but depended more on external resources.

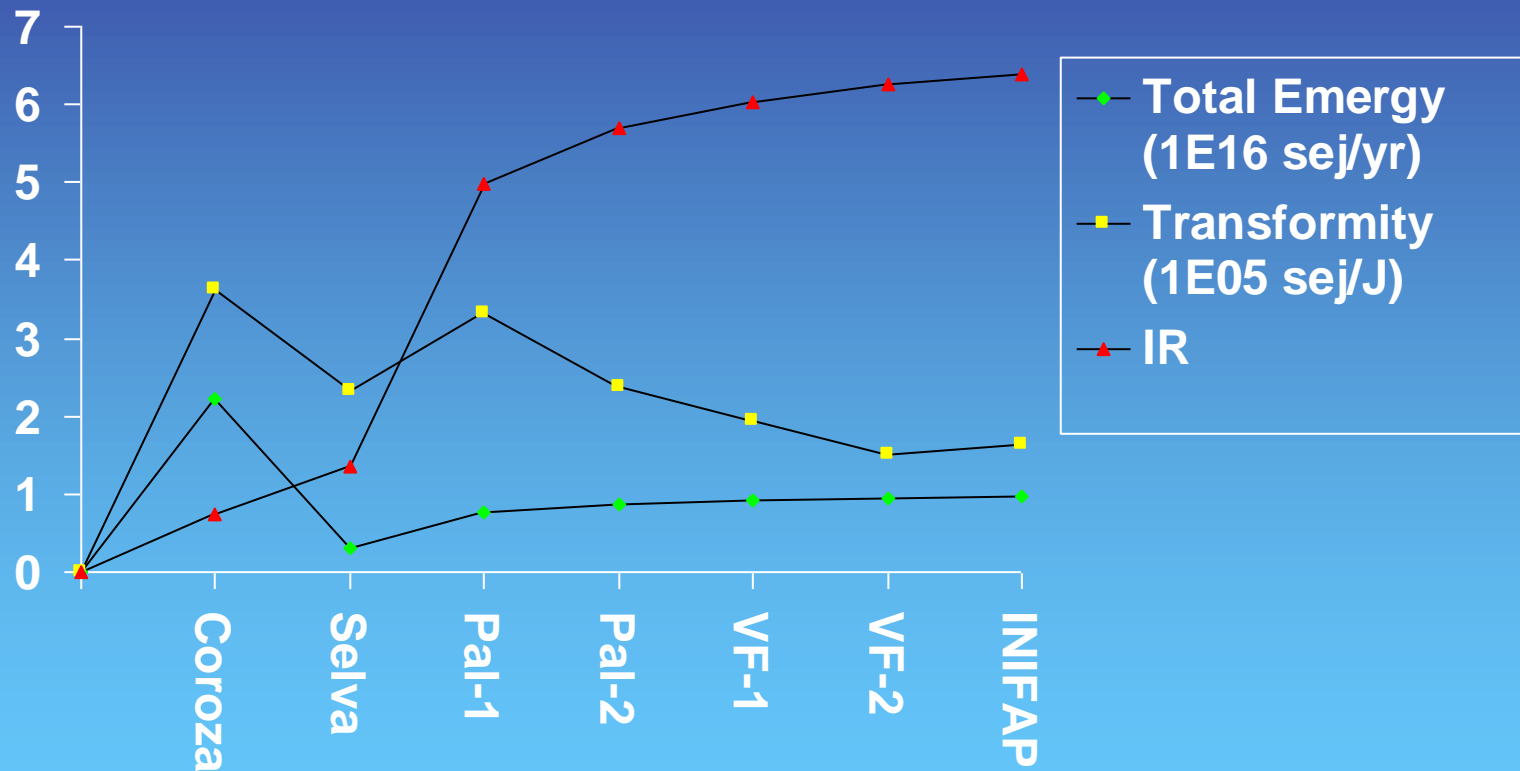
Sustainability of Agro-forestry and Agro-industrial Systems in Chiapas, Mexico

- Coffee grown under shade with chemicals was labor intensive with lower profitability.

Study Limitations

- ? Use of “circular” transformities
- ? Life cycle analysis (LCA): water pollution, soil pollution, forest cut, biodiversity, etc. should be included in the analysis

Total Emergy, Transformity and Investment Ratios for Corn Systems



Yield and Revenue Cost Ratios for Corn Systems

