Sustainable Character of Agroproductive Nodes in Intermontane Arid Territories of Sonora, Mexico

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The sustainability of the agro-productive nodes of the Sonoran Desert is a function of environmental and water limitations, the degree of eco-technological inclusion and the strategic diversification of its production processes.

The objective of this work is to evaluate the inclusion of the ecotechnological approach of an Agroproductive Node with a Sustainable Trend (NATS) in Moctezuma, Sonora, Mexico.

The global evaluation of the activity is tending towards a decrease in sustainability and a value of the environmental compatibility trait of 25 BU.

The valuation of the same trait for the new productive approaches included in the node, result from collateral categories that contribute to production and sustainability, among which are distinguished a) Definition and practice of arid tourism with 47 BU, b) Buffer areas for protection of wildlife with 100 BU and c) the use of rescue grazing with 68 BU.
1. Introduction

2. Methods

3. Results

4. Conclusions

References
1. Introduction

Integrated and sustainable strategic management in agroproductive nodes

In the management of natural resources in arid Mexican territories, a complex and integrative approach cannot be postponed. There is a diversity of factors related to environmental and climatic risks or catastrophes, determining factors for effective development. The combination of nodes and their productive interconnection with the sustainable management of resources constitutes the Sustainable Ecotechnological Agrópolis [4,5,16].

General Objective & Specific research aims

Apply an ecotechnological adoption evaluation methodology to an agroproductive hay node in Moctezuma, Sonora, Mexico.

1) Assess the aptitude of new sustainable activities for the potential development of the study agro-productive node

2) Define the inclusion of the activity suggested to the node based on the capacity and sustainable and ecotechnological trend from the processes inserted in that activity
2. Methods

2.1. Study region and site

- The study was managed in the province of Moctezuma, Sonora, México, 658 above sea level (29°42´ 01´´ N; 109° 39´ 05´´W).
- The study area corresponds to a landscape of the Sonoran desert located in an intermontane valley. (Figure 1)
- Climate Dry semi-warm with rains in summer BS0hw (x’), with maximum and minimum temperatures in the range of -3 to 48 °C

2.2 Elements of the agroproductive node and its identification

The primordial activity is evaluated and compared with those activities of possible insertion to the node. It is necessary to identify:

a) The vulnerable points of the process
b) Establish the risks, respective indicators.

For both cases, a value from 0 to 1 is assigned, defined by the operator of the agroproductive node.

c) Identify the value of the threat (VT) using equation

2.3 Selection criteria of the elements or activities of the agroproductive node

To choose the activities or elements of the agroproductive node in transition, the following conditioning criteria were taken:

a) Vulnerable processes or with potential risks, that represent a threat to the existence of the node
b) The options for the use of natural resources generate a sustainable activity
c) Products or services with a sustainable category
d) Contributes to the development and food security of the community

2.4 Definition of the scale of ecotechnological and sustainable adoption

This scale is applicable in the agroproductive production process.

The pressure exerted must result in a change in the processes of the agroproductive node, thereby inducing an ecotechnological transition of the node.

The change moves from a conventional approach to an ecotechnological state, which reduces the vulnerability and risk of the agroproductive node.
Figure 1. Location of the arid territory of Moctezuma, Sonora, Mexico.
Establish the risks

Respective indicators

The node operator assigns a value from 0 to 1

Risk identification

Identify the value of the threat

VT = PVV x RV

Resulting threat

Low or tolerable: Between 0 – 5.

Medium or Latent: > 5 and < 10.

High or imminent: > 10

Figure 2: Elements of the agroproductive node and its identification
Figure 3: Selection criteria of the elements or activities of the agroproductive node (during the period 2021 – 2021)

- **Vulnerability**: Vulnerable processes or with potential risks, that represent a threat to the existence of the node.
- **Sustainable I**: The options for the use of natural resources generate a sustainable activity.
- **Sustainable II**: Results are products or services with a sustainable category.
- **Development**: Contributes to the development and food security.
Figure 4: Selection criteria of the elements or activities of the agroproductive node

- Food security
- Minimal environmental impact
- Local development
- Results are products or services
- Options for the use of Natural Resources
- Technical characteristics
- Financial characteristics
- Vulnerable processes
- Potential risks
- Vision or projection
- Biophysical characteristics

Selection criteria of the elements or activities
Table 1. Fundamentals of the Braden Scale adapted for the ecotechnological insertion in the elements of the agroproductive node

<table>
<thead>
<tr>
<th>Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process versatility</td>
<td>Completely rigid</td>
<td>Rigid in some parts</td>
<td>Rigid but open to change</td>
<td>Completely innovative and open to change</td>
</tr>
<tr>
<td>Water requirement</td>
<td>More than 24 hours</td>
<td>Between 12 and 24 hours</td>
<td>One hour a day</td>
<td>Rarely, once a month</td>
</tr>
<tr>
<td>Resilience in the natural resources involved</td>
<td>Nil</td>
<td>Low resilience in all</td>
<td>Partial resilience</td>
<td>Resilience in all</td>
</tr>
<tr>
<td>Consumption dynamism</td>
<td>Consumed more than twice per week</td>
<td>Consumed more than twice per season</td>
<td>Consumed twice per season of the year</td>
<td>In one season of the year</td>
</tr>
<tr>
<td>Contribution to the ecosystem, economy or food security</td>
<td>Does not offer immediate contribution</td>
<td>Only to the ecosystem</td>
<td>To the ecosystem and flow in the local economy</td>
<td>Total contribution</td>
</tr>
<tr>
<td>Environmental compatibility</td>
<td>Not compatible</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
</tr>
</tbody>
</table>

1 Each value represents a quartile of ecotechnological adoption in the agroproductive node process
3. Results

3.1 Analysis of the agroproductive process of the original activity in Moctezuma, Sonora, México

The original activity is oriented to the production of hay from Alfalfa and Sorghum, the vulnerable stages of the process and their respective score. Identification of vulnerable stages of the process were: Planting, Irrigation, Growth – Development, Cut – baled, Storage with importance values between medium and very high.

3.2 Identification of Risk Indicators

Those directly linked to the main activity of hay production were identified as main risks. The faults, shortcomings or deficiencies of the inputs in some part of the process stand out.

The assigned values ranged, according to the operator, from 0.23 for germination failure, to 0.97 for the necessary irrigation water for growth; 0.95 for hours of irrigation with electricity and 0.62 for low prevalence of plants in the meadow.

3.3. Alternatives for the transition of node of study

The main attributes identified according to the criteria defined in the methodology were: a) Biophysical characteristics, b) Projection of the node, c) Technical capacity, and d) Financial capacity.

The alternative activities identified for the ecotechnological conversion of the node, were: The practice of aridtourism (14 - 93 BU), Areas for the protection of wildlife (12 - 100 BU), and Rescue grazing use 36 - 86 BU).
Table 2. Identification of vulnerable stages of the process

<table>
<thead>
<tr>
<th>Process vulnerability</th>
<th>Vulnerability trait</th>
<th>Importance value</th>
<th>Assigned value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting</td>
<td>The seed loses its germinative capacity</td>
<td>High</td>
<td>0.85</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Water is not available due to lack of electricity</td>
<td>Very high</td>
<td>0.95</td>
</tr>
<tr>
<td>Growth - Development</td>
<td>Lack of water / nutrients</td>
<td>High</td>
<td>0.85</td>
</tr>
<tr>
<td>Cut – baled</td>
<td>Machinery in bad condition or lack of fuel</td>
<td>Middle</td>
<td>0.50</td>
</tr>
<tr>
<td>Storage</td>
<td>Putrefaction or combustion</td>
<td>Middle - high</td>
<td>0.5 – 0.85</td>
</tr>
</tbody>
</table>

*Assigned by the operator of the agroproductive node
Table 3. Identification of risks indicators of the process

<table>
<thead>
<tr>
<th>Risk</th>
<th>Indicator</th>
<th>Assigned value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack or failure of germination (LFG)</td>
<td>Number of lost or unviable seeds</td>
<td>0.23</td>
</tr>
<tr>
<td>Inefficient use of water (IUW)</td>
<td>Number of liters of water needed for growth</td>
<td>0.97</td>
</tr>
<tr>
<td>Inefficient use of energy (UIE)</td>
<td>Number of hours of irrigation applied with electricity</td>
<td>0.95</td>
</tr>
<tr>
<td>Infertile soil or soil with pathogens (ISP)</td>
<td>Number of hectares without vegetation or low plant density</td>
<td>0.62</td>
</tr>
</tbody>
</table>

*Assigned by the operator of the agroproductive node
Table 4. Quantifying the value of the threat in the nodeo of Moctezuma, Sonora, México

<table>
<thead>
<tr>
<th>VULNERABLE POINT OF THE PROCESS</th>
<th>VALUE</th>
<th>RISK</th>
<th>RISK VALUE</th>
<th>VALUE OF THE THREAT FOR EACH PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTING</td>
<td>0.85</td>
<td>LFG</td>
<td>0.23</td>
<td>0.1955</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>IUW</td>
<td>0.97</td>
<td>0.8245</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>UIE</td>
<td>0.95</td>
<td>0.8075</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>ISP</td>
<td>0.62</td>
<td>0.527</td>
</tr>
<tr>
<td>IRRIGATION</td>
<td>0.95</td>
<td>LFG</td>
<td>0.23</td>
<td>0.2185</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>IUW</td>
<td>0.97</td>
<td>0.9215</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>UIE</td>
<td>0.95</td>
<td>0.9025</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>ISP</td>
<td>0.62</td>
<td>0.589</td>
</tr>
<tr>
<td>GROWTH - DEVELOPMENT</td>
<td>0.85</td>
<td>LFG</td>
<td>0.23</td>
<td>0.1955</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>IUW</td>
<td>0.97</td>
<td>0.8245</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>UIE</td>
<td>0.95</td>
<td>0.8075</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>ISP</td>
<td>0.62</td>
<td>0.527</td>
</tr>
<tr>
<td>CUT – BALED</td>
<td>0.5</td>
<td>LFG</td>
<td>0.23</td>
<td>0.115</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>IUW</td>
<td>0.97</td>
<td>0.485</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>UIE</td>
<td>0.95</td>
<td>0.475</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>ISP</td>
<td>0.62</td>
<td>0.31</td>
</tr>
<tr>
<td>STORAGE</td>
<td>0.675</td>
<td>LFG</td>
<td>0.23</td>
<td>0.15525</td>
</tr>
<tr>
<td></td>
<td>0.675</td>
<td>IUW</td>
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<td>0.65475</td>
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<tr>
<td></td>
<td>0.675</td>
<td>UIE</td>
<td>0.95</td>
<td>0.64125</td>
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<td></td>
<td>0.675</td>
<td>ISP</td>
<td>0.62</td>
<td>0.4185</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.59525</td>
</tr>
</tbody>
</table>
Technical capacity
Sufficient to moderate, with necessary technical support for the development of low-energy eco-technologies

Biophysical characteristics
Soils with 73% fertility level, 46% erosion, 67% vegetation cover; existence of native vegetation - pristine in 95% of the area, 5% slope of the land. Presence of faunal diversity

Projection of the node
To be a diverse node in the activities aimed at fulfilling the SDGs. Presents innovative activities and ideas

Financial capacity
Sufficient for the development of ecological projects that require low investment

5. Conditioning criteria for the adoption of potential productive activities
6. Alternatives for the transition towards a sustainable ecotechnological management of the agroproductive node of Moctezuma, Sonora, Mexico

**Rg**

Rescue grazing use (36 - 86 BU)
Provides a healthy soil cover without pressure from trampling or soil erosion.

**PW**

Areas for the Protection of Wildlife (12 - 100 BU),
The purpose is to conserve undisturbed spaces on the site for the maintenance of migratory and local species.

**HP**

Hay production
Original activity

**At**

Aridtourism (14 - 93 BU),
Values spaces that are direct to the environment and focused on the appreciation of nature.
Figure 6. Comparison of the level of ecotechnological inclusion in the activities of the agro-productive node under study using the Braden scale.
Figure 6. Comparison between the main activity of the node and aridtourism.
Figure 7. Comparison between the main activity of the node and Buffer areas to protect wildlife in the node of Moctezuma, Sonora, México
Figure 7. Importance of agricultural production systems in arid Mexican territories & Level of ecotechnology adoption

01. Represent an alternative for food security and for local-regional self-consumption

02. The level of ecotechnology adoption is influenced by the physical-climatic conditions and the climatic emergency.

03. Severe conditions of a climatic nature occur in various ways during the seasons of the year in the arid territories of study.

04. It guarantees the existence of supplies and food for local users under an ecotechnological production approach.
4. Conclusions

In the node for hay production in Moctezuma, Sonora, Mexico, diversity traits were identified in the existence of resources, capacities and biophysical aptitudes.

The complex integration as well as the link in the optimal and sustainable use of the natural resources of the node derives from the implementation of the integrated strategic management.

Both the sustainable and ecotechnological capacity of the node, as well as its gradual changes in the processes over time, were determined in Braden Units.

The essential for the pragmatism of sustainability was valued with the various strategies applied in the activities included in the agroproductive node.


Very grateful for your attention!!

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Photo album

By Héctor T. Mojica
Grazing area & Alfalfa meadow for hay
Xeric orchards and establishment of organic vineyards (next slide) as potential activities in the agro-production node
Establishment of organic vineyards
Silage generation processing in the study node in the arid territory of Moctezuma, Sonora, Mexico
Buffer areas to protect the flora and fauna
Buffer areas to protect the flora and fauna (continuation)