Development of a SWAT-based decision support system to assist in selecting suitable agricultural projects in the tropical southeastern México

Jesus Uresti-Gil[1]
Diana Uresti-Durán[1]
Héctor D. Inurreta-Aguirre[1]
Roberto de J. López-Escudero[1]

[1]Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP)
e-mail: uresti.jesus@inifap.gob.mx

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Soil & Water Assessment Tool | SWAT

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TRÓPICO HÚMEDO
PROGRAMA ESTRATÉGICO PARA EL DESARROLLO RURAL
SUSTENTABLE DE LA REGIÓN SUR-SURESTE DE MÉXICO.

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BACKGROUND

The Mexican Ministry of Agriculture in 2007 implemented the

Humid Tropics Program (HTP)
(A Strategic Program for the Sustainable Rural Development of Southeastern México)

The program promotes the establishment of selected sixteen highly demanded perennial crops in the tropical southeastern México.
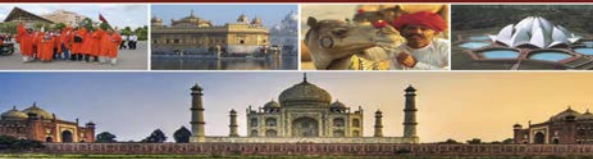
Promotion is done through subsidizing a fraction of the total establishment and maintenance costs of crop stands

Projects MUST BE located in highly productive areas.

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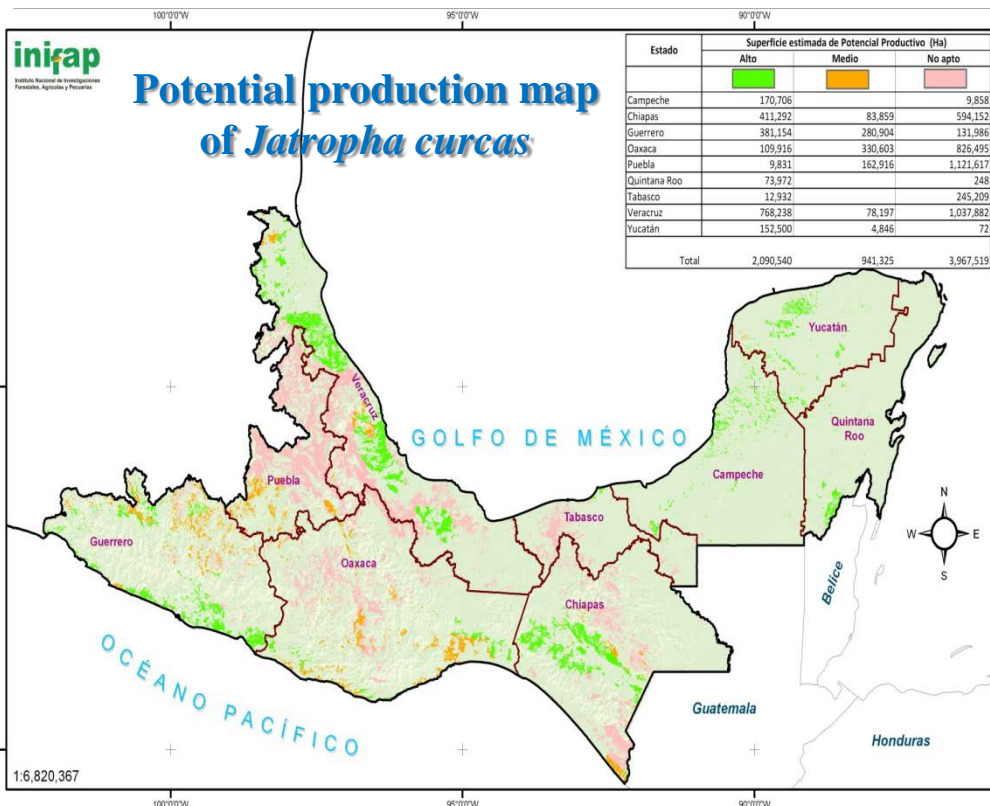www.sagarpa.gob.mx
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The HTP area:
Tropical Southeastern México
Nine political states
49.62 Mha

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Actually, decision is making based on Agro-Ecological Zoning Maps, after FAO's Methodology

Potential production map
of *Jatropha curcas*

Estado	Superficie estimada de Potencial Productivo (Ha)		
	Alto	Medio	No apto
Campeche	170,706		9,858
Chiapas	411,292	83,859	594,152
Guerrero	381,154	280,904	131,986
Oaxaca	109,916	330,603	826,495
Puebla	9,831	162,916	1,121,617
Quintana Roo	73,972		248
Tabasco	12,932		245,209
Veracruz	768,238	78,197	1,037,882
Yucatán	152,500	4,846	72
Total	2,090,540	941,325	3,967,519

The information offered by these maps is:
- **Rather General.**
- **Only Qualitative.**
- **Limited information for decision making.**
- **High Risk of Misplacing Projects .**

Jatropha curcas **fruit**

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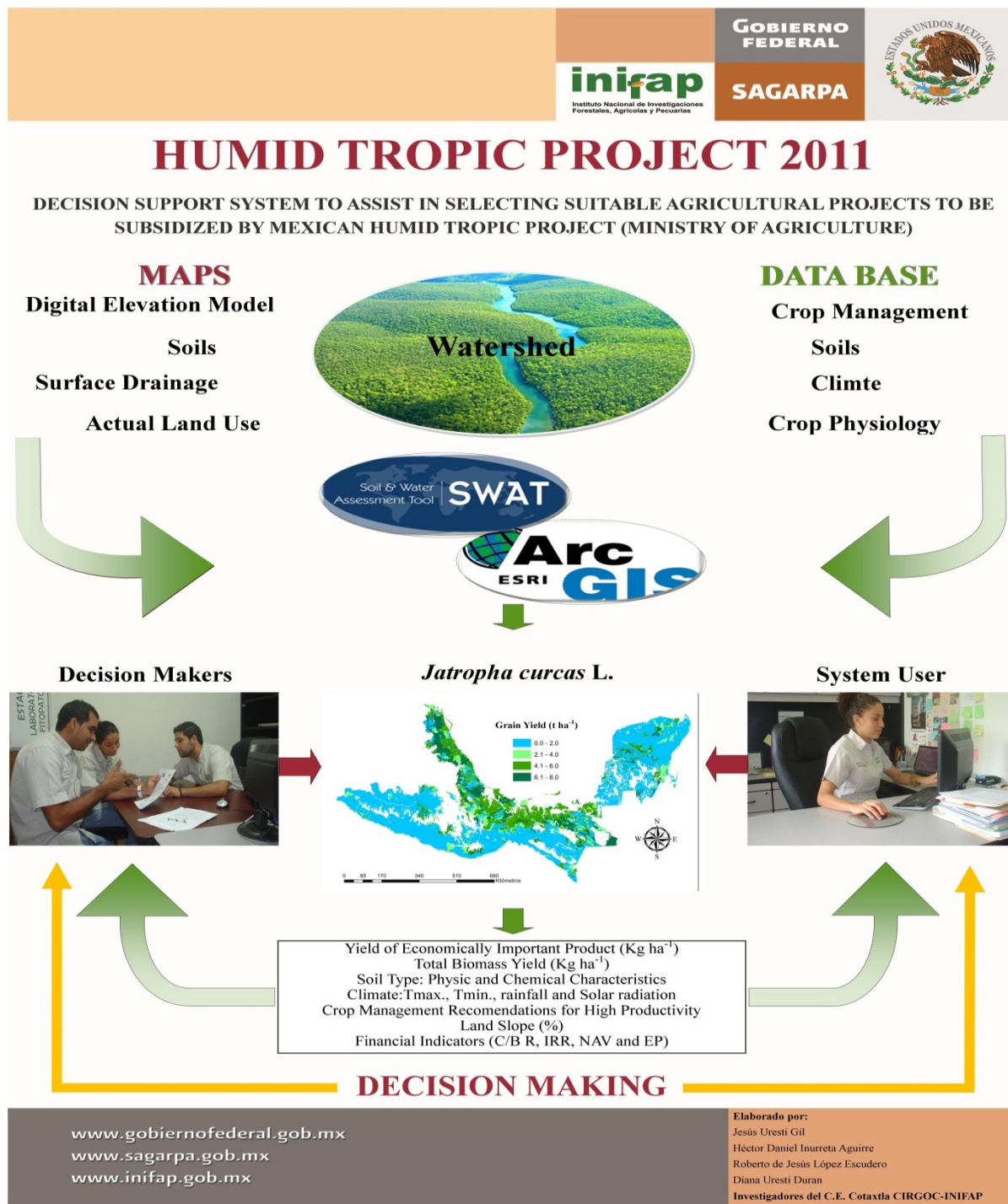
The HTP asked INIFAP to develop an internet, SWAT-based decision support system (DSS) to assist farmers and decision makers in selecting suitable projects.

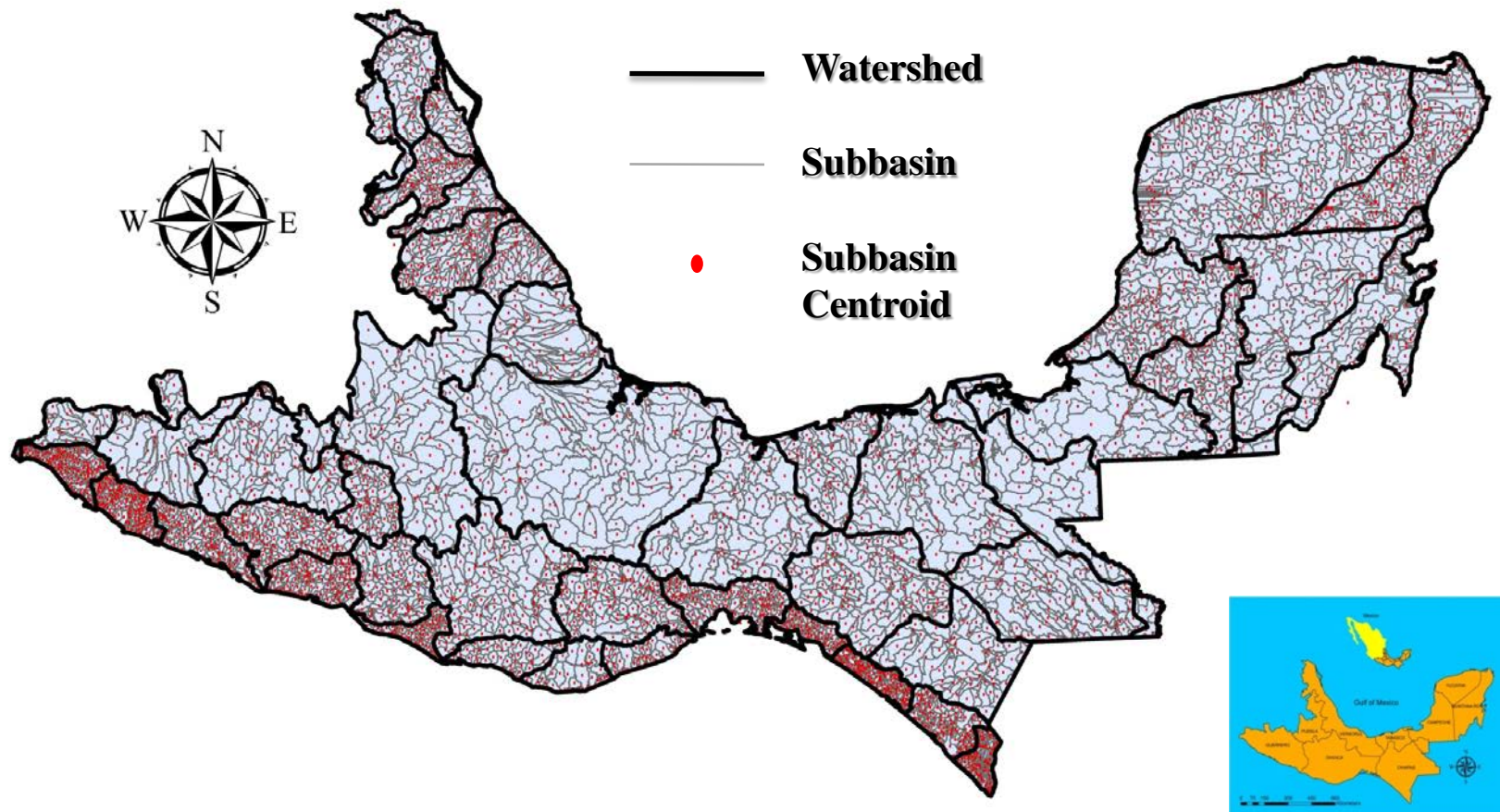The objective of these presentation is to describe the developed DSS.
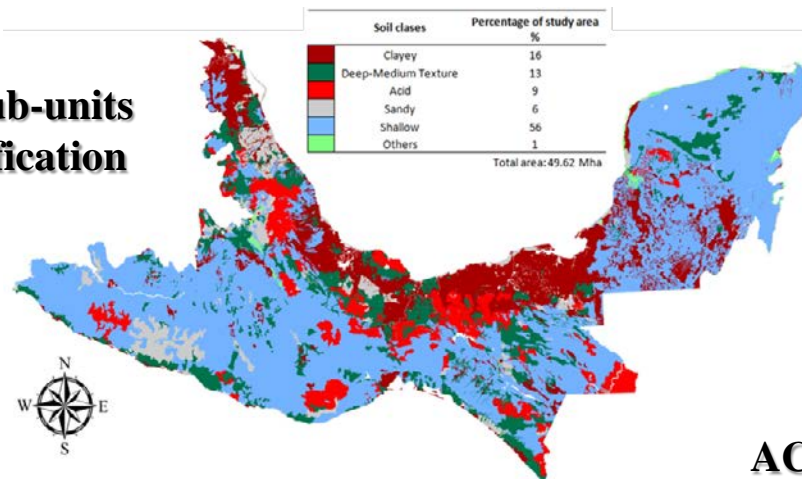
The studied area:

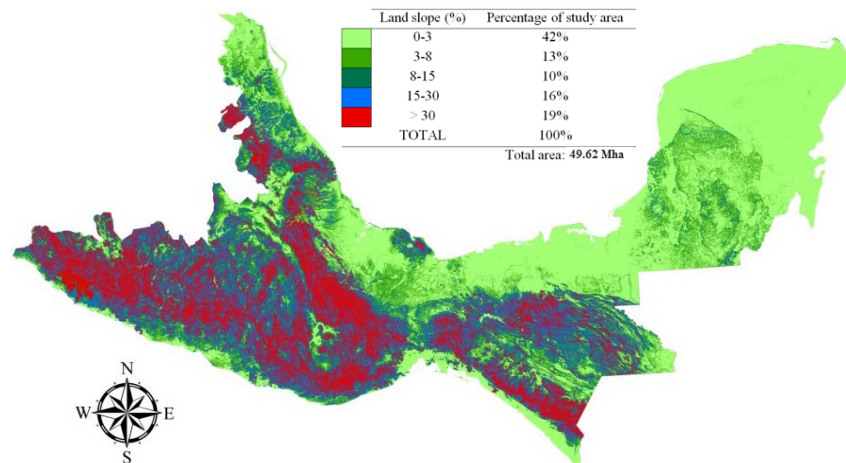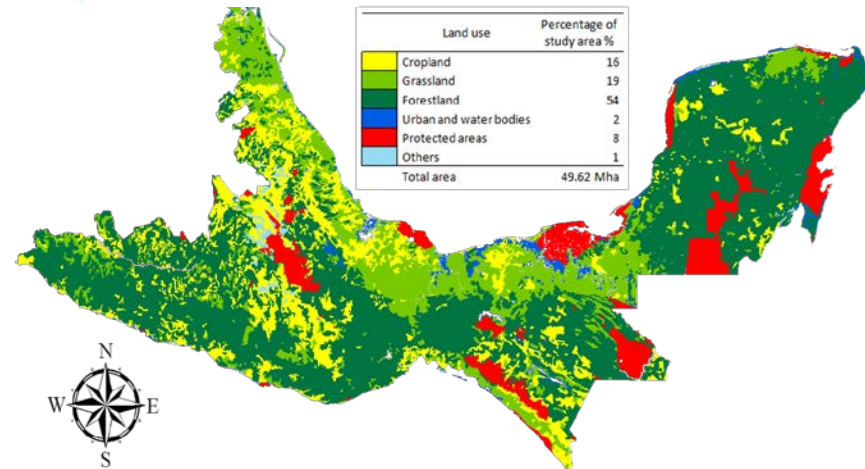49.62 Mha.   48 Watersheds   5,753 Subbasins

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110 SOIL Sub-units
FAO Classification

Soil clases	Percentage of study area %
Clayey	16
Deep-Medium Texture	13
Acid	9
Sandy	6
Shallow	56
Others	1
Total area: 49.62 Mha	

LAND SLOPE

Land slope (%)	Percentage of study area
0-3	42%
3-8	13%
8-15	10%
15-30	16%
> 30	19%
TOTAL	100%
Total area: 49.62 Mha	

ACTUAL LAND USE

Land use	Percentage of study area %
Cropland	16
Grassland	19
Forestland	54
Urban and water bodies	2
Protected areas	8
Others	1
Total area	49.62 Mha

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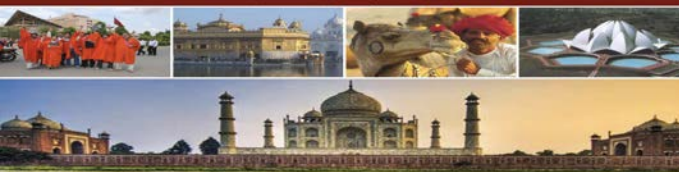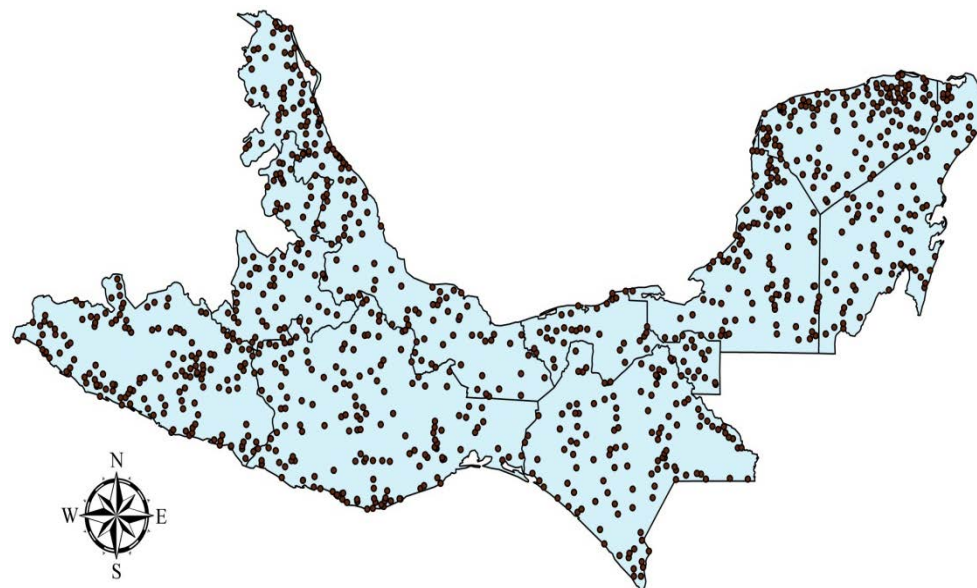
Soil Data base: 1,247 soil profile description pits

Typical soil profile of the Acrisol humico

Horizon	Depth (mm)	Clay (%)	Silt (%)	Sand (%)	pH	O.C. (%)	albedo	K (mmhr^{-1})	AWC	BD (g cm^{-3})
A	157	28	27	45	4.80	3.55	0.05	3.7	0.12	1.37
B1	202	39	24	37	4.75	1.58	0.11	2.0	0.12	1.30
B2t	856	44	22	34	4.79	0.66	0.18	1.7	0.12	1.28

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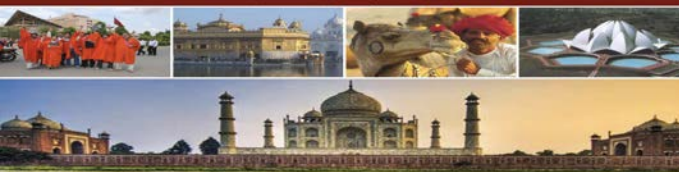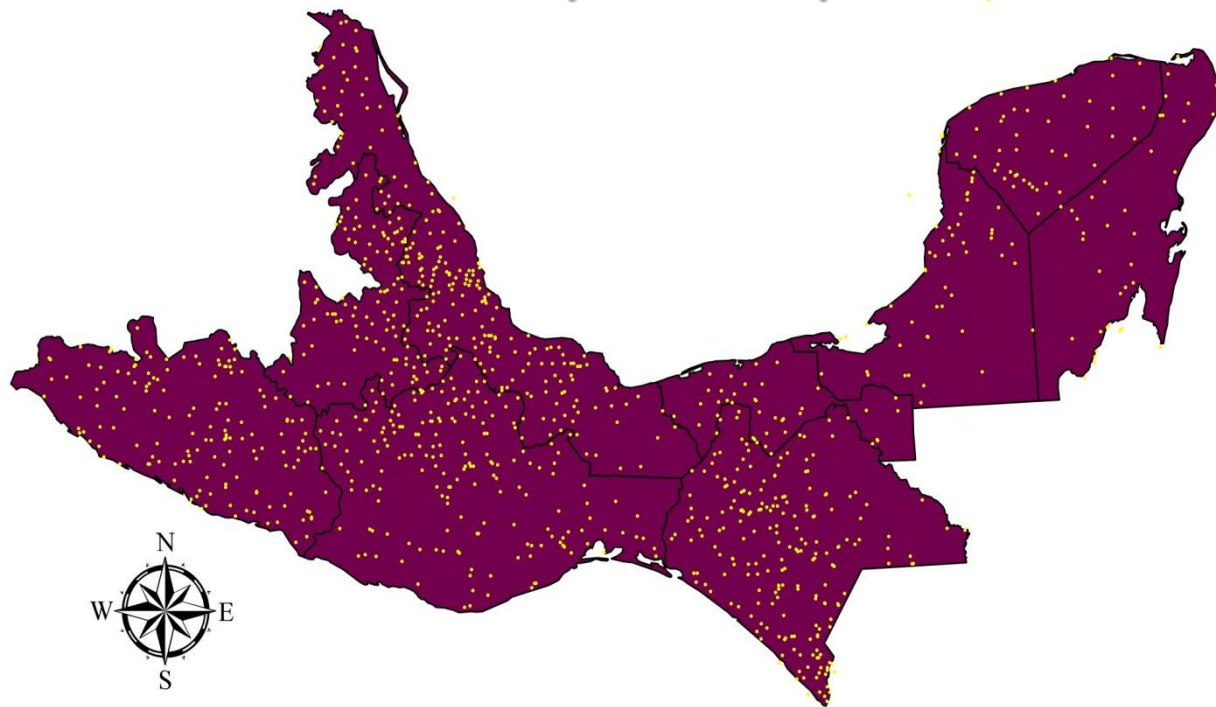
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Climate data base: 1060 Weather Stations

18 % with 10-20 years of daily records
67% with 20-40 years of daily records
15% with > 40 years of daily records

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Studied crops

Mangoes (*Mangifera indica*)	Cacao (*Theobroma cacao*)	Coconut Palm (*Cocos nucifera*)	King grass (*Pennisetum purpureum*).
Mexican nut (*Jatropha curcas*)	Coffee (*Coffea arabica*)	Oil Palm (*Elaeis guineensis*)	Stevia (*Stevia rebaudiana*)
Indian Nut (*Macadamia integrifolia*)	Black pepper (*Piper nigrum*)	Rubber tree (*Hevea brasilensis*)	Pineapple (*Ananas comosus*)
Lemon (*Citrus limon*)	Vanilla (*Vanilla planifolia*)	Tree (*Manilkara zapota*)	Sisal (*Agave fuorcroydes*)

Agronomic management of each crop was designed for high productivity.
**Physiological parameters** were obtained from local earlier research and peer reviewed literature.

Information and calibration of model was supported by crop researcher experts from INIFAP.
Before running the entire project, for each crop model was calibrated by simulating crop grow in selected watershed where crop yield was known and compared against simulated yield.

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Examples of resulted maps

Cacao (*Theobroma cacao*)
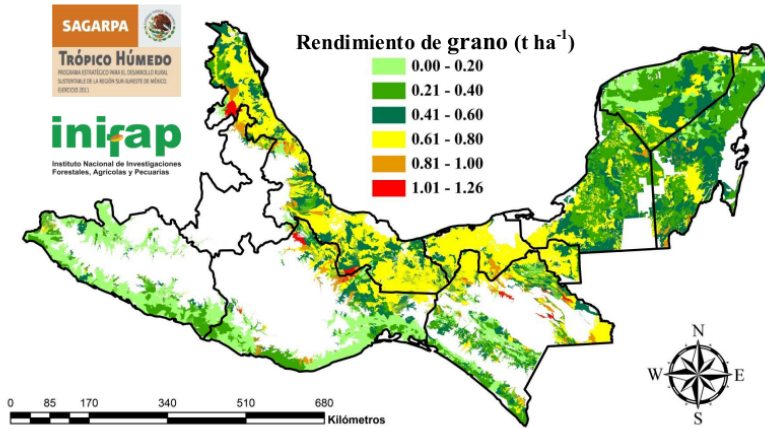
Rendimiento de grano (t ha⁻¹)
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.26

Elaborado por:
Jesús Uresti Gil, Héctor Daniel Inurreta Aguirre, Roberto de Jesús López Escudero, Diana Uresti Duran
Investigadores del C.E. Cotaxtla-CIRGOC-INIFAP

Café (*Coffea arabica*)
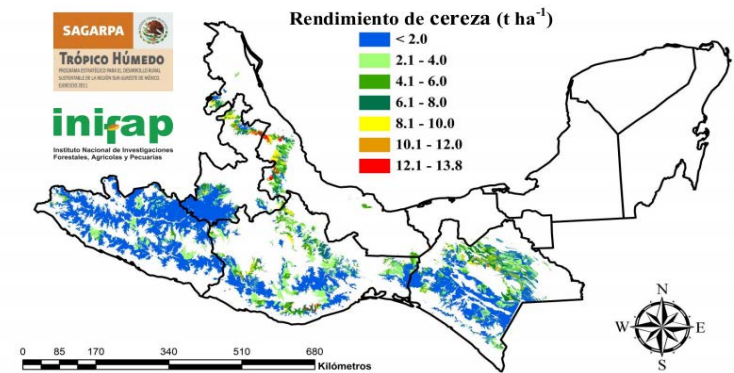
Rendimiento de cereza (t ha⁻¹)
- < 2.0
- 2.1 - 4.0
- 4.1 - 6.0
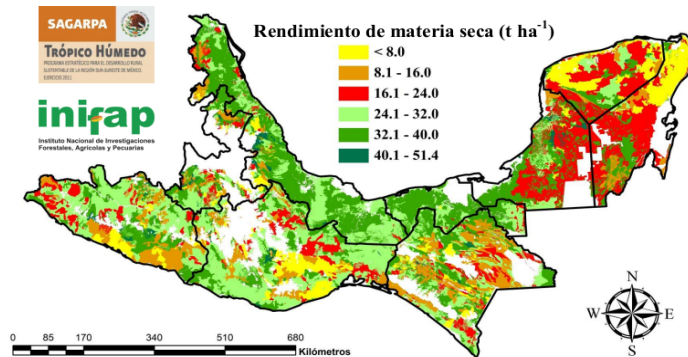- 6.1 - 8.0
- 8.1 - 10.0
- 10.1 - 12.0
- 12.1 - 13.8

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Pennisetum spp.

Rendimiento de materia seca (t ha⁻¹)
- < 8.0
- 8.1 - 16.0
- 16.1 - 24.0
- 24.1 - 32.0
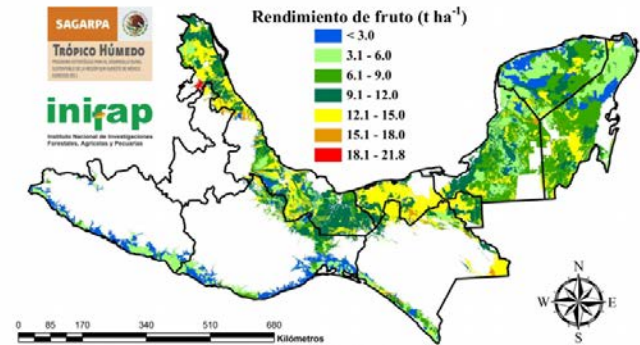- 32.1 - 40.0
- 40.1 - 51.4

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Palma de aceite (*Elaeis guineensis*)

Rendimiento de fruto (t ha⁻¹)
- < 3.0
- 3.1 - 6.0
- 6.1 - 9.0
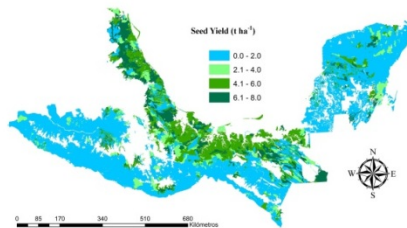- 9.1 - 12.0
- 12.1 - 15.0
- 15.1 - 18.0
- 18.1 - 21.8

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Jatropha curcas Attribute Table

SUBBASIN	HRU	Area_ha	SOIL_CODE	SLOPE_CODE	WEATHER STATION	CPMN	BIOMth	YLDth
2	44	42.93	Re	0-3	Ver30056	Jatr	9.88	1.976
2	42	98.01	Re	3-8	Ver30056	Jatr	9.82	1.964
2	43	23.49	Re	8-15	Ver30056	Jatr	9.74	1.948
3	16	313.308847	Bf	3-8	Ver30214	Jatr	20.37	4.074
3	12	670.965035	Bf	0-3	Ver30214	Jatr	20.14	4.028
3	13	48.199078	Bf	8-15	Ver30214	Jatr	20.86	4.172
3	15	0.81	Bf	15-30	Ver30214	Jatr	21.67	4.334
3	24	0.030113	Re	30-9999	Ver30214	Jatr	28.52	5.704
3	25	2.29644	Re	8-15	Ver30214	Jatr	28.79	5.758
3	23	39.20593	Re	3-8	Ver30214	Jatr	28.8	5.76
3	26	114.476894	Re	0-3	Ver30214	Jatr	28.65	5.73
4	49	3.24	Vc	15-30	Ver30043	Jatr	31.18	6.236
4	43	2.613544	Re	30-9999	Ver30043	Jatr	12.24	2.448
4	42	285.278117	Re	0-3	Ver30043	Jatr	14.41	2.882
4	45	145.555973	Re	3-8	Ver30043	Jatr	14.28	2.856
4	41	82.055703	Re	8-15	Ver30043	Jatr	14	2.8
4	44	7.266245	Re	15-30	Ver30043	Jatr	13.31	2.662
4	39	1.562852	Lf	30-9999	Ver30043	Jatr	35.46	7.092
4	38	369.560359	Lf	0-3	Ver30043	Jatr	35.56	7.112
4	46	51.03	Vc	8-15	Ver30043	Jatr	31.36	6.272
4	47	283.5	Vc	0-3	Ver30043	Jatr	31.82	6.364
4	48	257.58	Vc	3-8	Ver30043	Jatr	31.62	6.324
4	40	51.241415	Lf	15-30	Ver30043	Jatr	35.51	7.102
4	37	541.714543	Lf	3-8	Ver30043	Jatr	35.56	7.112
4	36	190.44127	Lf	8-15	Ver30043	Jatr	35.53	7.106
5	9	922.810264	E	3-8	Cam04005	Jatr	2.3	0.46
5	12	650.684369	E	0-3	Cam04005	Jatr	2.3	0.46
5	11	634.246455	E	8-15	Cam04005	Jatr	2.18	0.436
5	10	120.186781	E	15-30	Cam04005	Jatr	2.25	0.45
6	75	4.118133	Lf	0-3	Ver30033	Jatr	30.47	6.094

Decision Making Process

Decision Makers

System User

Jatropha curcas L.

Seed Yield (t ha⁻¹)
- 0.0 - 2.0
- 2.1 - 4.0
- 4.1 - 6.0
- 6.1 - 8.0

Yield of Economically Important Product (Kg ha⁻¹)
Total Biomass Yield (Kg ha⁻¹)
Soil Type: Physic and Chemical Characteristics
Climate:Tmax., Tmin., rainfall and Solar radiation
Crop Management Recomendations for High Productivity
Land Slope (%)
Financial Indicators (C/B R, IRR, NAV and EP)

DECISION MAKING

Go To XY   (Decimal Degrees)

Long: _____   Lat: _____

EXAMPLE OF DATA FOR THE DECISION MAKING

Decision makers

System user

Subbasin	4
HRU	38
Land slope	0 - 3 %
Characteristics of Soil	Lf
Monthly and daily Weather	Ver30043
Crop Management	Technology for high productivity
Biomass yield	35.56 tha-1
Seed yield	7.112 tha-1
Cost, Income and Financial indicators	C/BR, IRR, NPV, EP

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CONCLUSIONS

The SWAT-based decision support system to assist in selecting suitable agricultural projects in the tropical southeastern México was developed.

The SWAT model linked to a GIS is a useful tool for efficiently planning and operating agricultural programs.

Model results must be validated against observed data (Activity in process).

Acknowledgements

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