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THE AVOCADO INDUSTRY IN MICHOACAN, MEXICO

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ABSTRACT

Avocado is grown in a narrow geographical belt that crosses Michoacan state from west to east. This belt is located at 1 300 to 2 300 m above sea level. The surface area planted to avocado is about 80 000 ha, the largest avocado producing region in the world. Seventy per cent of the avocado acreage is grown under irrigation. The harvesting season is from September to February and the average yield is seven ton/ha.

*Three counties — Uruapan, Peribán and Tacámbaro — contribute 86,5% of fruit produced in the state. Four climatic types can be identified throughout this belt. Ando type soils comprise more than 70% of the region. Planting densities in the avocado groves cover a wide range from 69 to 204 trees/ha, which brings out overcrowding of trees. Irrigation is carried out by filling basins with levees around the trees from November to May. Pest and disease control require 15% to 38% of the investment for grove management. The main pests are red spider mite (*Olygonychus *spp) and thrips* (Heliothrips *spp). Among the main diseases affecting this crop are anthracnose* (Colletotrichum gloeosporioides) *and scab* (Sphaceloma Persea). *Nutrition of trees depend on manure and fertiliser application which represents between 22% to 38% of the investment. Most of the fruit is directed to the national market. Less than 5% is exported, mainly to Canada, Europe and Japan.*

INTRODUCTION

México is the largest avocado producer in the world. The surface area planted to this fruit crop was 83 000 ha (205 000 acres) with a production of 625 000 metric tons for the 1986—1987 crop cycle (Sanchez, 1987). Four states are leaders in avocado production: Michoacán, Sinaloa, Puebla and México.

Avocado is the main fruit crop grown in Michoacán state. This crop was planted to 79 186 ha with an annual growth rate of 4—5%; this allows an estimated surface area of 90 000 ha planted to avocado for 1989.

GENERAL FEATURES OF AVOCADO PRODUCTION

For 1987, almost 70% of the avocados planted in Michoacán were in production. Irrigation is available for about 70% of the surface area, whereas 30% depends on rainfall. Hass is planted in 98% of the area; other cultivars are: Fuerte, Bacon, Zutano, San Miguel, Choquette, Booth 7, Booth 8, Lula, Rincón, and Hall. A great number of local selections (creole type) are also under cultivation.

The main harvest season occurs from September to February, although in different regions the harvest season may start before or after the period mentioned depending on the climate. Average yield is about 7 ton/ha.

GEOGRAPHICAL LOCATION OF THE AVOCADO BELT

The main surface area and production of avocado is located along the Neo-volcanic Michoacán axis which crosses this state from west to east and is known nowadays as the "avocado belt". This belt is between 100° 15' and 102° 45' West longitude and between 19° and 20° North latitude. The altitude above sea level varies between 1 300 m and 2 300 m. The belt comprises 25 counties, even though the largest number of groves and amount of fruit produced are concentrated at Uruapan, Tacámbaro, and Peribán. The avocado belt is divided into six producing areas according to county location and vicinity (Table 1). Uruapan and Tacámbaro contribute 86,5% of the total avocado produce.

CLIMATE

The characteristics of the main climatic types in the avocado belt are given in Table 2.

On average hail storms vary from 0 to 4 events in the same location, and is more frequent higher than 2 000 m above sea level. At semi-warm and temperate sites, the numbers of days with frost or temperatures under 4°C vary from 0 to 4 per year. At Peribán, Tingambato, S Escalante and Zitacuro, such days occur 20 to 40 times per year, thereby increasing frost hazard.

This diversity in climatic conditions results in a great variation of tree phenology. With Hass, this allows harvesting for eight to nine months per year.

TABLE 1 Zones and counties where avocado is produced in Michoaćan state, México

Zones	Counties	Surface area (Ha)*	Production (ton)
I — Zitácuaro	Zitácuaro	2 874	19 278
	Jungapeo	638	4 389
	Tuxpan	670	4 515
	Hidalgo	691	4 473
	Maravatío	686	4 739
II — Tacámbaro	Tacámbaro	8 015	51 128
	Arío de Rosales	6 512	15 792
	S Escalante	1 871	10 227
III — Uruapan	Uruapan	16 842	92 446
	Tingambato	3 425	16 779
	Ziracuaretiro	2 518	14 882
	San Juan Parangaricutiro	2 513	11 928
	Tancítaro	14 845	41 419
IV — Peribán	Peribán	12 043	61 992
	Los Reyes	958	4 151
	Tingüindín	1 425	9 758
	Tocumbo	376	2 471
	Cotija	135	875
V — Chilchota	Chilchota	774	5 152
	Jacona	208	1 379
	Tangamandapío	341	2 170
	Villamar	210	1 414
VI — Others	Jiquilpan	241	1 652
	Shuayo	185	1 239
	N Réglues	200	1 379
Total		**79 196**	**386 127**

Fuente: Comisión Nacional de Fruticultura, Delegación Estatal Michoacán 1987.
*Includes trees which have not come into production.

TABLE 2 *Some climatic characteristics of Michoacán avocado belt*

Classification	Winter rainfall (%)	Annual rainfall (mm)	Mean temperature		Countries
			Coldest month	Warmest month	
Semi-warm, humid, high rainfall in summer	< 5	1 522 to 1 622	15,5	18,8	Uruapan, San Juan P, Zira-cuaretiro, and Tingambato
Semi-warm, semi-humid, rainfall in summer	< 5	1 186 to 1 365	16,2	21,9	Tacámbaro, Arío de Rosales, S Escalante, Peribán Los Reyes, and Chilchota
Temperate, humid, high summer rainfall	> 5	1 692	15,1	20,8	San Juan P, Uruapan, and Tingambato.
Temperate, sub-humid, summer rainfall	< 5	991 to 1 315	12,9	19,7	Tancítaro, Tingambato, S. Escalante, Arío de Rosales and Tacámbaro

SOILS

There are eight soil units in the avocado belt (FAO classification system). The more important units are (Inegi, 1985):

Andosol

Its regional native name is "Tupure". It has a sandy texture. The organic matter content is high (4 to 6%) which is a typical feature of humic andosols. Both structure and texture allow excellent drainage with good moisture and nutrient holding capacity (Etchevers, 1985). Because of its physical, chemical and biological properties, this soil type is considered as an optimum substrate for avocado production. It covers more than 70% of the Michoacán avocado belt.

Regosol

It is known locally as "volcano sands". It is a loose material, mainly sandy or volcano cinders. The texture is a coarse sand, with a low content of organic matter and nutrients, as well as a low moisture holding capacity. It is accepted, however, that underlying this soil, andosols are prevalent because of parental material. Avocado growing in regosols are located at San Juan P, Uruapan and Peribán counties with good results.

Litosol

This is known locally as "Malpais". Just like in the case of regosols this type of soil is being planted into avocados because of the fast planting rate. Litosols are very thin soils that vary in depth from 0 to 0,5 m. The texture is either loamy or sandy; organic matter content is high with intermediate content of nutrients.

Luvisol

This type is called "Charanda". The soils have a red colour with a clay texture; medium organic matter and nutrient content with a very high water holding capacity which make a good substrate for pathogenic fungus growth which cause root rot. These soils are not appropriate for avocado growing.

The main chemical characteristics of soils planted to avocados are: pH 5,5 to 6,9; organic matter content 1 to 6%; 0,5 to 6,0 ppm P; 0,5 to 1,5 meq/100g, K; 3,0to 7,0 meq/100 g, Ca and Mg 1,0 to 4,0 meq/100 g. These levels are considered low and very low.

The best groves for production combine semi-warm humid climate with andosols. Medium production orchards are located at temperate humid climates combined with either andosols, regosols or litosols, in that order. Either one of the abovementioned climates associated with luvisol constitute the less productive orchards. Climate-soil association in this last case may be improved with better management practices which will not, however, achieve the production formerly indicated.

NURSERY MANAGEMENT

Avocado nurseries for plant production are owned individually and management practices differ widely. Mexican race avocados predominate as rootstocks. They are seedlings and there is not any strict method for selecting mother trees. Once germination has occurred and seedlings start growing, there is only a visual selection to eliminate albine, diseased, malformed or weak avocado seedlings. Young seedlings are grafted during February to May and get ready to be sold for transplanting 60 to 90 days after grafting.

ORCHARD MANAGEMENT

Orchard management practices are very similar throughout the avocado belt from the time of planting to the harvesting season. Their application, however, vary in intensity and frequency.

Planting systems

Fifty two per cent of the groves follow a hexagonal pattern and 48% a square pattern system. Spacing between trees varies from 7 to 12 m, which provide tree densities of 69 to 204 trees/ha. The vigorous, open and tall (up to 20 m) growth of cv Hass at Michoacán state, resulted in overcrowding of approx 29% of the groves. This led to shading and slow air movement amongst the trees, which caused several management problems.

Irrigation

Water quality is excellent for irrigation purposes, but insufficient because of inefficient systems used in this region. Irrigation is generally done using PVC pipe lines to flood wide basins with levees built surrounding each tree. Tests were recently started, however, to introduce sprinkler, fixed jet-sprinkler and drip irrigation systems.

During the irrigation season (from November to May), the number of water applications vary from 2 to 10 at regional level, with the highest frequency at 6—7. The amount of water application varies from 300 to 600 f/tree.

Weed control

This is dependent on land topography and is done either manually or mechanically. Frequently one or two herbicides (Paraquat or Glyphosate) are sprayed annually.

Pests

Avocado growers in Michoacán spray pesticides six to seven times a year mainly to control avocado pests such as red spider mite *(Olygoncychus* spp), and thrips *(Heliothrips* spp). Economically, less important pests are: *Amorbia cunearía, A*

emigratella, Sabulodes spp, white fly *(Tetraleurodes* spp), leafhopper *(Idona* spp), green fly *(Aethalion guadratum),* and leaf miner *(Gracilaría persea).* The branch weevil *(Copturus aguacatae)* and the seed weevil *(Conotrachelus aguacatae) are* only found in neglected orchards and/or those where "creole" type trees are planted. Because these trees are quite tall, phytosanitary control is difficult.

Diseases

Avocado diseases in the region have increased together with the avocado surface area. About 21 diseases have been identified, but the ones economically more important are:

Anthracnose *(Colletotrichum gloeosporioides)*

This is an endemic disease which affects fruit quality and reduces production. Its damage to fruits is a constraint in export. Fruit damage varies from 40 to 64% on trees planted in groves with insufficient air movement (Lázaro, 1985).

Scab *(Sphaceloma persea)*

This is also an endemic disease, even though its damage to fruit is not as severe as that caused by anthracnose. Disease incidence usually varies from 30 to 40% but in extremely severe cases it reaches 70% (Campos, 1984).

Peduncle ringing

Premature fruit abscission occurs, but a causal agent has not been identified. Martinez (1977) has found pathogenic organisms like *Xanthomonas, Alternaría* and *Helminthosporium* associated with the disease. Colinas (1987) suspects a physiological disorder to be the cause of this problem. In some orchards where the problem is severe, more than 200 fruit per tree fall each season (Campos, 1984).

Avocado root rot *(Phytophthora cinnamomi)*

The incidence of this disease is low in the avocado belt, since it only affects 0,27% of the trees planted there (Gallegos, 1983). However, the disease is increasing and spreading in some orchards located at Uruapan (Campos, 1984).

Limbs and trunk canker *(Nectria galligena* and *Fusarium ephisphaeria)*

They cause tree weakness and death. Their frequency is higher in orchards irrigated by a spraying system. The incidence has reached 18% of sampled trees at Uruapan and Ario de Rosales (Coria, 1985).

Tip wilt *(Glomerella cingulata).*

This disease is prevalent at Uruapan, where the incidence reaches 20 to 56% (Escobar, 1985).

Tree nutrition and fertilisation

The use of organic and inorganic fertilisers, as well as the amounts applied, greatly varies. Organic manures come from cattle, hogs and poultry using 20 to 150 kg/tree/year. More than 86% of the avocado growers apply organic fertilisers from using 0,2 to 10 kg/tree/year of nitrogen and phosphorus. Potash is used in about half the amounts mentioned above.

Minor elements included are mainly Fe, Cu and Zn. They are applied as chelates either to the soil or as foliar sprays. Four to five applications are used in irrigated orchards (every two or three months), whereas only one or two are used in orchards dependent on rainfall. In both cases, either tree phenology or nutritional requirements are taken into account when deciding which element or what amount should be used.

Apparently the amounts applied of both organic manures and inorganic fertilisers, are in excess of what is needed, although some systematic information is available. Standard values for leaf analysis found for cv Hass, highly productive within the belt, are situated among the levels proposed for Fuerte by Embleton and Jones (1966) with the exception of nitrogen (Table 3).

Nitrogen concentration varied from 2,04% to 2,9% which is considered adequate for Hass by Robinson (1986).

TABLE 3 Standard values of leaf analysis and coefficients of variation to diagnose nutrient status of avocado cv Hass*

Nutrient (i)	Standard value (ii)	cv (%)
N	2,35	10,9
P	0,14	11,1
K	0,80	15,9
Ca	1,86	17,6
Mg	0,58	15,7
Mn	240	38,9
Fe	91	38,9
Zn	27	32,8
Na	296	13,1

* After Palacios (1986).
(i) Expressed as percentage for N, P, K, Ca and Mg; and as ppm for Fe, Zn, Mn and Na in dry matter.
(ii) Determined from 54 trees sampled with yields above 85 kg/tree.

ECONOMIC FEATURES

Avocado production amounted to 62% of the total fruit crop production at Michoacán state during 1987 (Conafrut, 1987). The avocado industry provides permanent employment to about 37 000 field labourers and also generates several crop-related activities.

The economic investment varies. This is dependent on the amount and quality of inputs used, the amount of hand labour and the specific decision taken by the grower. More resources are required in fertilisers, phytosanitary control and irrigation (Table 4).

Avocado growers in Michoacán are organised into 16 local associations, nine cooperative societies and a group of independent growers all belonging to the Regional Agricultural Union of Michoacán State's Avocado Growers. There are also many avocado growers that do not belong to this organisation.

The marketing of the fruit is carried out through store house and packing plants, located mainly at Uruapan. During 1987 the amount of fruit sold was about 110 000 metric tons.

TABLE 4 Relative proportion of investment during the first eight years of avocado cultivation at Michoacán, México

Input or Labour	Relative value (%)
Land tillage	0,66 — 1,30
Transplanting	2,19 — 3,82
Replanting	0,25 — 0,93
Weed control	0,48 — 6,99
Levee building	6,20 — 12,70
Fertilisation and manuring	22,73 — 37,78
Irrigation	11,57 — 13,92
Phytosanitary control	14,75 — 38,14
Other cultural practices	5,19 — 13,34
Harvest	3,71 — 10,78

At national level the main avocado consumption centres are: Mexico city, Nuevo León and Mexico states. Fruit export has fluctuated, with no definite trend. Less than 5% of total production is exported mainly to France, Japan, Great Britain, Federal Republic of Germany and Canada (Jiménez, 1984).

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REFERENCES

CAMPOS AVILA, J, 1984. Principales plagas del aguacatero en Uruapan, Mich. Simposium sobre el cultivo, producción y comercialización del aguacate. IV Congreso Nacional de la Asociación de Egresados de la Facultad de Agrobiología, Uruapan, Mich, p 69 - 77.

COLINAS LEON, M T, 1987. Efecto de reguladores de crecimiento sobre la abscisión de pedúnculos de aguacate *(Persea americana* Mili, cv Fuerte). II Congreso Nacional de Horticultura, Irapuato, Gto. México. Resúmenes, p 91.

CONAFRUT, 1987. Censo Frutícola. Comisión Nacional de Fruticultura Delegación Estatal Michoacán.

CORIA M, V M, 1985. Distribución y etiología del cáncer del aguacatero (*P americana*

Mili) en la región de Uruapan, Mich. Tesis Profesional. Fac de Agrobiología "Presidente Juárez". UMSNH. Uruapan, Mich, 43 p.

EMBLETON, TW & JONES, W W, 1966. Avocado and mango nutrition. In 'Fruit Nutrition' (Ed: N *F* Childers). 2nd Edition. Hortic Pubis. New Brunswick, N J p 51 - 76.

ESCOBAR GARCIA, J L, 1985. Identificación y control químico de la marchitez de puntas *(Glomerella cingulata),* (Ston) Spauld-Schrenkz, del aguacate en la región de Uruapan, Mich. Tesis Profesional. Fac de Agrobiología "Presidente Juárez", UMSNH, Mich, 38 p.

ETCHEVERS BARRA, J D, 1985. Un cuarto de siglo de investigación en suelos volcánicos de México. Serie Cuadernos de Edafología 1. Centro de Edafología, Colegio de Postgraduados. Chapingo, México, 33 p.

GALLEGOS ESPINOZA, R, 1983. Carta de climas, Esc 1 : 500 000. Síntetis Geográfica del Estado de Michoacán.

INEGI-SPP, 1985. Carta de climas, Esc 1: 500 000. Síntesis Geográfica del Estado de Michoacán.

JIMÉNEZ ROSALES, P, 1984. Comercialización del aguacate. En: Simposium sobre el cultivo, producción y comercialización del aguacate. IV Congreso Nacional de la Asociación de Egresados de la Facultad de Agrobiología, Uruapan, Mich, p 126 - 140.

LÁZARO BRIONES, V, 1985. Incidencia de antracnosis *(Colletotrichum gloesporioides* Penz) en aguacate variedad Hass almacenado en refrigeración y su relación con el manejo cultural de los huertos de Uruapan, Mich. Tesis Profesional. Facultad de Estudios Superiores Cuautitlán, UNAM, 75 p.

MARTÍNEZ BARRERA, R, 1977. Relación de enfermedades del aguacatero en la región de Uruapan, Mich, y áreas adyacentes. Publicación Pfizer, p 24.

MORALES GARCÍA, J L, 1983. Estudios sobre las principales enfermedades radiculares que atacan al aguacatero (*Persea americana* Mill) en los Municipios de San Juan Nuevo y Uruapan, Mich. Tesis Profesional. Fac de Agrobiología "Presidente Juárez", USMNH. Uruapan, Mich. 51 p.

PALACIOS ALVARADO, J M, 1986. Dinámica y balance nutrimental en árboles de aguacate (*Persea americana* Mill) cv Hass, con alto y bajo rendimiento en la región de Uruapan, Mich. Tesis de Maestría en Ciencias. Colegio de Postgraduados. Chapingo, México, 93 p.

ROBINSON, J B, 1986. Fruits, vines and nuts. In 'Plant Analysis' An Interpretation Manual (Ed: D J Reuter and J B Robinson). Inkata Press. Melbourne and Sidney, p 120 - 147.

SANCHEZ COLIN, S, 1987. Current status of avocado growing in México. *Calif Avocado Soc Yrb,* 71 157 - 163.