

The Importance of Fruit and Vegetable Production in Chiapas: Challenges and Opportunities

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ABSTRACT

Objective: To analyze the importance of growing fruits and vegetables in Chiapas, as well as the conservation of ancestral knowledge, and its contributions to food security and the economy. This analysis will discuss the challenges and opportunities of this sector.

Design/methodology/approach: A review of literature related to the diversity of native and exotic species of commercial importance and self-consumption was conducted, emphasizing information that illustrates the challenges and opportunities in agricultural sectors.

Results: A high diversity of native and exotic fruit and vegetable species was identified. Most of these species are used for self-consumption, which is related to Mexico's self-sufficiency economy, biocultural richness, and ecosystem services. These species are distributed in diverse ecosystems, including backyards, commercial orchards, and urban areas. Products of national commercial importance and export quality are scarce and face technological, social, and commercial challenges.

Study limitations/implications: The results are relevant to species diversity, consumption, and commercialization, but these considerations may change if other environmental and technological variables are taken into account.

Findings/conclusions: The diversity of edible vegetables in Chiapas is high and includes native and introduced species highly linked to society. Agricultural diversification strengthens food security and sovereignty in the state. There are species with marketing potential, but innovation is needed in production and processing to increase income through value added. There is a need to reduce food waste and innovate in terms of waste and the circular economy to reduce environmental impact. The strengthening of this sector requires the integration of the community, government and research.

Keywords: food security, horticulture and fruit growing, traditional knowledge, biocultural.

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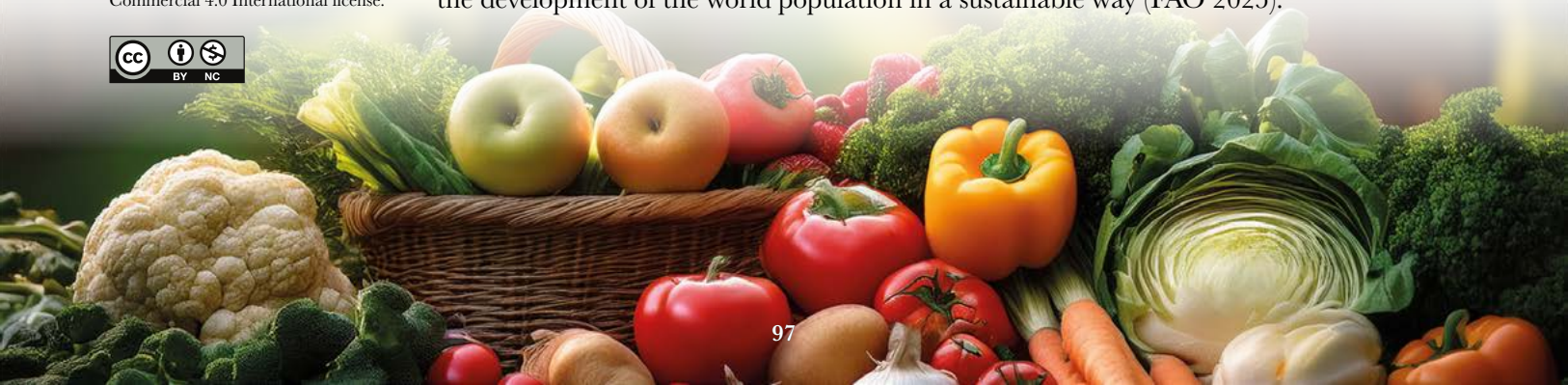
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INTRODUCTION

The world population increase, the current food insufficiency, together with the increase of diseases related to unhealthy diets, make food demand a priority issue to contribute to the development of the world population in a sustainable way (FAO 2025).



Fruits and vegetables are among the foods recommended for a healthy and sustainable lifestyle, mainly because of their contribution to nutrition as sources of vitamins and minerals. Consumption of 400 g per person/day is recommended with wide variability of colors and flavors to increase the variability of nutrients (WHO 2018; Ibarrola-Rivas *et al.*, 2022).

In addition to the direct benefits to food production, the production and consumption chain generates economic income from fresh products and their derivatives. This contributes to achieving sustainable development objectives (FAO, 2021).

Mexico has enough arable land to supply a healthy diet based on fruits and vegetables. Currently, however, cultivated species do not meet the demand for food, which is insufficient when combined with the high consumption of processed foods that induce health problems (Ramírez-Juárez, 2022; Torres-Rojas, 2018).

Chiapas is favored for its variety of ecosystems, ample diversity, and richness of vegetables, which have been linked to Mayan ethnic groups (Segura *et al.*, 2018). These vegetables are part of the state's culinary richness.

Currently, cultivated species selected for anthropocentric purposes contribute to food security, biocultural heritage, and Mexico's economy (Ubiergo-Corvalán *et al.*, 2020; SIAP, 2024).

Despite the favorable conditions in the Mesoamerican ecosystem for the wide availability of vegetables, there are high rates of poverty, malnutrition, and poor health. This calls for various actions to increase the efficiency of this sector.

This paper presents a list of fruits and vegetables that grow and are produced in Chiapas. Its biocultural importance is identified, as well as its economic importance for including export quality species. It concentrates information on the problems of this sector and presents a panorama of the need for attention through innovation in the productive sectors and the addition of added value to the products.

MATERIALS AND METHODS

A review was carried out of sources related to fruit and vegetable production, as well as sources related to floristic records that include these vegetables. Statistical records were obtained from the Agrifood and Fisheries Information Service.

The information was obtained through a literature review using the search engines Google Scholar and SciELO. The data are presented in a table that includes citation information from the literature. Additionally, the economic contributions of the main cash crops by economic region in Chiapas were plotted.

Agro-productive regions of Chiapas

The state of Chiapas is located in southeastern Mexico (14° 32' 00" to 17° 59' 00" north latitude and meridians 90° 22' 00" and 94° 14' 00" west longitude), comprising an area of 73,311 Km².

The predominant climate is represented by two climatic groups: warm-humid and temperate-humid. It has 10 hydrological basins; with 6 main reliefs identified as Mountain Range, Rolling hills, Plain, Plateau, Valley and Tacana Volcano. It is made up of 125

municipalities distributed in 15 economic regions differentiated by physio-geographical regions, altitude, soil, vegetation and land use. Forty-three and a half percent of the land is used for agriculture and livestock, and 53.6% is covered by natural vegetation (CEIEG, 2025) (Figure 1).

Agricultural production is an important activity in the state registering in 2018 sown area was 1,333,510 ha with 1,283,130 ha harvested and increased to 1,367,045 Ha sown and 1,342,685 harvested by 2023 (CEIEG, 2025).

The geographic and ecological characteristics are related to the state's biodiversity (Morales & Priego, 2022) and the particular combinations determine the type of crop and confer the high agricultural diversification in the state (Flores *et al.*, 2017; CEIEG, 2023; Fernández & Méndez, 2018; Soto-Pinto *et al.*, 2021; Ubiergo-Corvalán *et al.*, 2020).

Horticulture and Fruit growing in Chiapas

The native populations of Chiapas make use of various parts of plants, including stems, leaves, fruits, roots, and seeds. These parts have diverse purposes, including food, medicine, wood, and firewood. Therefore, plant biodiversity is part of the biocultural heritage of rural communities.

According to the FAO (2021), “fruits and vegetables are considered edible parts of plants (*e.g.*, seed-bearing structures, flowers, buds, leaves, stems, shoots, and roots), whether they are cultivated or harvested in the wild, and whether they are consumed raw or minimally processed.” A total of 174 species were identified, of which 53% are native and 47% have been introduced and acclimated to the environmental conditions of Chiapas (Table 1).

They may have been selected based on preference, family tradition, or adaptation to the environment.

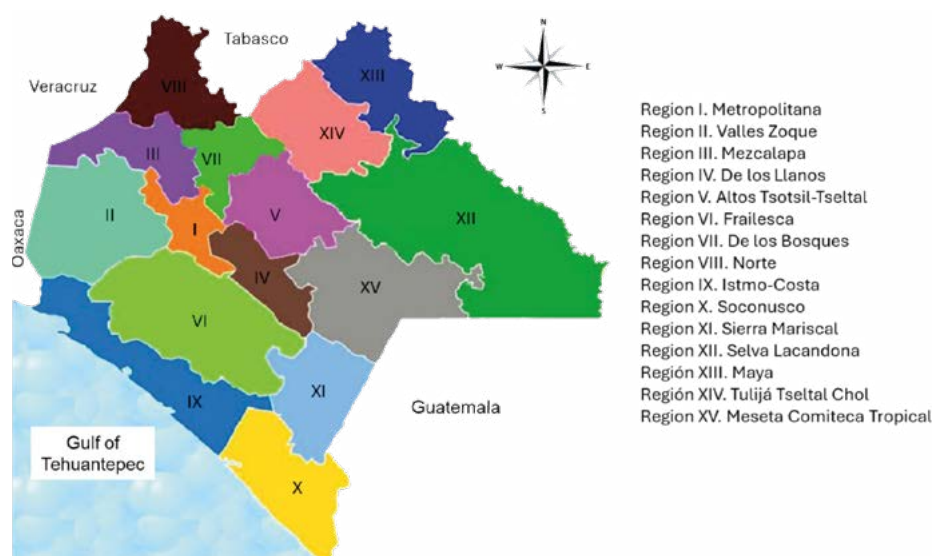


Figure 1. Economic regions of Chiapas. Made from figure of Secretaría de Hacienda (2013).

Table 1. Fruits and vegetables present in Chiapas with diverse use by the population.

Common name	Species	Origin (native/exotic)	References
Chard	<i>Beta vulgaris</i> subsp. <i>vulgaris</i>	Native	Greenberg 2015; Benítez-Kanter <i>et al.</i> , 2020;
Annato	<i>Bixa orellana</i> L.	Native	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Avocado	<i>Persea americana</i> Mill.	Native	Benítez-Kanter <i>et al.</i> , 2020; Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Basil	<i>Ocimum micranthum</i> Willd	Native	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Pond apple	<i>Annona glabra</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Spleen amaranth	<i>Amaranthus dubius</i> , <i>A. hybridus</i>	Native	Greenberg 2015; Benítez-Kanter <i>et al.</i> , 2020.
Redroot pigweed	<i>Amaranthus retroflexus</i> L .	Native	Soto-Pinto <i>et al.</i> , 2022
Cacao	<i>Theobroma cacao</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Mexican bayonet plant	<i>Oecopetalum mexicanum</i>	Native	Soto-Pinto <i>et al.</i> , 2022
Cocoplum	<i>Cryobalanus icaco</i> (L.) L.	Native	Gerardo-Mendez 2024.
Mexican star apple	<i>Chrysophyllum mexicanum</i> Brandegees ex Standl	Native	Almeida-Cerino <i>et al.</i> , 2024; Ubierno-Corvalán <i>et al.</i> , 2020; Gerardo-Mendez 2024.
Pumpkin	<i>Cucurbita</i> spp.	Native	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Jamaica cherry	<i>Muntingia calabura</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024.
Capulín	<i>Eugenia acapulcensis</i> Steud	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Capulín	<i>Prunus capuli</i> Cav.	Native	Gerardo-Mendez 2024.
Florida Trema	<i>Trema micrantha</i> (L.) Blume	Native	Almeida-Cerino <i>et al.</i> , 2024
Sacky Sac Bean	<i>Inga laurina</i> (Sw.) Willd.	Native	Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Caspirol,tzelel	<i>Inga punctata</i> Willd.	Native	Soto-Pinto <i>et al.</i> , 2022
Chalúm	<i>Inga</i> spp.	Native	Benítez-Kanter <i>et al.</i> , 2020
Mexican forest palm	<i>Astrocaryum mexicanum</i> Liebm. ex Mart.	Native	Soto-Pinto <i>et al.</i> , 2022
Tread Softly	<i>Cnidocolus aconitifolius</i> (Mill.)	Native	Greenberg 2015; Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Chayote	<i>Sechium edule</i> (Jacq.) Sw.	Native	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Naseberry	<i>Manilkara zapota</i> (L.) P. Royen	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Chili	<i>Capsicum</i> spp.	Native	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Cayenne Pepper	<i>Capsicum annum</i> L.	Native	Soto-Pinto <i>et al.</i> , 2022
Soncoya	<i>Annona purpurea</i> Moc. & Sessé ex Dunal	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Coyo Avocado	<i>Persea schiedeana</i> Nees	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Longbeak rattlebox	<i>Crotalaria longirostrata</i> Hook. & Arn.	Native	Greenberg 2015

Table 1. Continues...

Common name	Species	Origin (native/exotic)	References
Hogplum	<i>Spondias mombin</i> L.	Native	Almeida-Cerino <i>et al.</i> , 2024
Coco plum	<i>Chrysobalanus icaco</i> L.	Native	Almeida-Cerino <i>et al.</i> , 2024
Spanish-plum	<i>Spondias purpurea</i> L.	Native	Almeida-Cerino <i>et al.</i> , 2024
Coral Tree	<i>Erythrina americana</i> Mill.	Native	Soto-Pinto <i>et al.</i> , 2022
Coquil 'te	<i>Inga pavoniana</i> G.Donn.	Native	Soto-Pinto <i>et al.</i> , 2022
Correlón	<i>Solanum appendiculatum</i> Dunal	Native	Soto-Pinto <i>et al.</i> , 2022
Cow-okra	<i>Parmentiera aculeata</i> (Kunth)	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Almeida-Cerino <i>et al.</i> , 2024;
Ice Cream Bean	<i>Inga edulis</i> Mart	Native	Gerardo-Mendez 2024.
Churimo	<i>Inga vera</i> subsp. <i>Spuria</i> (Humb. & Bonpl. ex Willd.) J. León	Native	Soto-Pinto <i>et al.</i> , 2022
Chulli	<i>Prunus barbata</i> Koehne	Native	Cruz-Salazar <i>et al.</i> , 2020.
Mexican Tea	<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	Native	(Greenberg 2015; Benítez-Kanter <i>et al.</i> , 2020; Gerardo-Mendez 2024.
Yellow Passionfruit	<i>Passiflora ligularis</i> Juss.	Native	Soto-Pinto <i>et al.</i> , 2022
Guaba	<i>Inga edulis</i> Mart.	Native	Almeida-Cerino <i>et al.</i> , 2024
Bastardcedar	<i>Guazuma ulmifolia</i> Lam.	Native	Almeida-Cerino <i>et al.</i> , 2024
Guamo	<i>Inganobilis</i> Willd.	Native	Soto-Pinto <i>et al.</i> , 2022
Soursop	<i>Annona muricata</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024.
Stinking Toe Tree	<i>Hymenaea courbaril</i> L.	Native	Almeida-Cerino <i>et al.</i> , 2024
Guaya	<i>Talisia oliviformis</i> (Kunth) Radlk.	Native	Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024
Guava	<i>Psidium guajava</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Benítez-Kanter <i>et al.</i> , 2020
Banana	<i>Musa acuminata</i> Colla	Native	Soto-Pinto <i>et al.</i> , 2022
Guishnay	<i>Spathiphyllum phrynifolium</i>	Native	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022
Nightshade	<i>Solanum</i> spp.	Native	Greenberg 2015; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Mexican pepperleaf	<i>Piper auritum</i> Kunth	Native	Greenberg 2015
Common Calabash Tree	<i>Crescentia cujete</i> L.	Native	Almeida-Cerino <i>et al.</i> , 2024
Morrito plant	<i>Crescentia alata</i> Kunth	Native	Almeida-Cerino <i>et al.</i> , 2024
Tomato	<i>Solanum lycopersicum</i> L.	Native	Soto-Pinto <i>et al.</i> , 2022
Spanish-plum	<i>Spondias purpurea</i> L.	Native	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Pea eggplant	<i>Solanum mayanum</i> Lundell	Native	Gerardo-Mendez 2024.
Guinea arrowroot	<i>Calanthe allouia</i> (Aubl.) Lindl.	Native	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022
Winged water-primrose	<i>Ludwigia decurrens</i> Walter	Native	Gerardo-Mendez 2024.

Table 1. Continues...

Common name	Species	Origin (native/exotic)	References
Madrone	<i>Arbutus xalapensis</i> Mart et Gal.	Native	Cruz-Salazar <i>et al.</i> , 2020.
Macuilillo	<i>Oreopanax xalapensis</i> (Kunth) Decne. & Planch.	Native	Cruz-Salazar <i>et al.</i> , 2020.
Red inkplant	<i>Phytolacca icosandra</i> L.	Native	Greenberg 2015
White sapote	<i>Casimiroa edulis</i> La Llave <i>et Lex</i>	Native	Cruz-Salazar <i>et al.</i> , 2020.
Husk-tomato	<i>Physalis philadelphica</i> Lam.	Native	Soto-Pinto <i>et al.</i> , 2022
Maricao Cimun	<i>Byrsonima crassifolia</i> (L.) Kunth	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Naranjillo	<i>Myrsine juergensenii</i> (Mez) Lundell.	Native	Cruz-Salazar <i>et al.</i> , 2020.
Barbary fig	<i>Opuntia ficus-indica</i> , <i>Nopalea karwinskiana</i>	Native	Greenberg 2015
Pacaya	<i>Chamaedorea tepejilote</i> Liebm.	Native	Soto-Pinto <i>et al.</i> , 2022
Ilama	<i>Annona macrophyllata</i> Donn. Sm.	Native	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Papaya	<i>Carica papaya</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Bloodberry	<i>Rivina humilis</i> L.	Native	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022;
Macambo tree	<i>Theobroma bicolor</i> Bonpl.	Native	Soto-Pinto <i>et al.</i> , 2022
Theobroma	<i>Theobroma bicolor</i> Bonpl	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Paterna	<i>Inga inicuil</i> Schltld. & Cham. Ex G. Don	Native	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Dragon Fruit	<i>Hylocereus undatus</i> (Haw.) Britton & Rose	Native	Ubierno-Corvalán <i>et al.</i> , 2020
American Black Nightshade	<i>Solanum americanum</i> Mill.	Native	Soto-Pinto <i>et al.</i> , 2022
Giant potato creeper	<i>Solanum wendlandii</i> Hook. f.	Native	Soto-Pinto <i>et al.</i> , 2022
Sinzapote	<i>Licania platypus</i> (Hemsl.) Fritsch	Native	Soto-Pinto <i>et al.</i> , 2022
Tomato	<i>Solanum lycopersicum</i> L	Native	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Gerardo-Mendez 2024.
Husk tomato	<i>Physalis philadelphica</i> Lam.	Native	Greenberg 2015
Ground cherry	<i>Physalis pubescens</i> L.	Native	Ubierno-Corvalán <i>et al.</i> , 2020
Sea grape	<i>Coccoloba escuintlensis</i> Lundell	Native	Almeida-Cerino <i>et al.</i> , 2024
Pod	<i>Inga inicuil</i> Schltld. & Cham. ex G. Don	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Almeida-Cerino <i>et al.</i> , 2024.
American Black	<i>Solanum americanum</i> Mill.	Native	Alcazar-Sánchez <i>et al.</i> , 2025
Mexican pepperleaf	<i>Piper auritum</i> Kunth	Native	Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Yellow sapote	<i>Pouteria campechiana</i> Baehni	Native	Soto-Pinto <i>et al.</i> , 2022
White sapote	<i>Olmediella betschleriana</i> (Göpp.) Loes	Native	Cruz-Salazar <i>et al.</i> , 2020.
Malabar-chestnut	<i>Pachira aquatica</i> Aubl	Native	Soto-Pinto <i>et al.</i> , 2022

Table 1. Continues...

Common name	Species	Origin (native/exotic)	References
Ilama	<i>Annona macrophyllata</i> Donn. Sm.	Native	Almeida-Cerino <i>et al.</i> , 2024
Mamey	<i>Pouteria sapota</i> (Jacq.) H.E. Moore & Stearn	Native	Ubierno-Corvalán <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Randia	<i>Randia</i> sp. Houst. ex L.	Native	Soto-Pinto <i>et al.</i> , 2022
Sansapote	<i>Licania platypus</i> (Hemsl.) Fritsch	Native	Gerardo-Mendez 2024.
Coconut	<i>Cocos nucifera</i> L.	Exotic	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022
Aceituno	<i>Simarouba amara</i> Aubl.	Exotic	Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024.
Indian Almond	<i>Terminalia catappa</i> L.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020
Celery	<i>Apium graveolens</i> L.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Breadfruit	<i>Artocarpus altilis</i> (Parkinson) Fosberg	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Watercress	<i>Nasturtium officinale</i> A.P.Khokhr.	Exotic	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Coffee Plant	<i>Coffea arabica</i> L.; <i>Coffea canephora</i> Pierre ex A. Froehner	Exotic	Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Cinnamon	<i>Cinnamomum verum</i> J.Presl	Exotic	Soto-Pinto <i>et al.</i> , 2022
Starfruit	<i>Averrhoa carambola</i> L.	Exotic	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024
Chives	<i>Allium schoenoprasum</i> L.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020)
Pea	<i>Cajanus cajan</i> (L.) Huth	Exotic	Almeida-Cerino <i>et al.</i> , 2024
Sow thistle	<i>Sonchus oleraceus</i> L.	Exotic	Cruz-Salazar <i>et al.</i> , 2020.
Fig Leaf gourd	<i>Cucurbita ficifolia</i> Bouché	Exotic	Soto-Pinto <i>et al.</i> , 2022
Manzano pepper	<i>Capsicum pubescens</i> Ruiz y Pav.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Cilantro	<i>Coriandrum sativum</i> L.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024.
Wild Cabbage	<i>Brassica oleracea</i> L.	Exotic	Greenberg 2015; Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Kohlrabi	<i>Brassica oleraceavar.gongylodes</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Peach	<i>Prunus persica</i> (L.)Batsch	Exotic	Soto-Pinto <i>et al.</i> , 2022
Green bean	<i>Vigna sesquipedalis</i> L. Fruwirth	Exotic	Soto-Pinto <i>et al.</i> , 2022
Spinach	<i>Tetragonia tetragonioides</i> (Pall.)Kuntze.	Exotic	Benítez-Kanter <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022
Indian Gooseberry	<i>Phyllanthus acidus</i> (L.) Skeels	Exotic	Greenberg 2015
Silk Banana	<i>Musa</i> spp. L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Fennel	<i>Foeniculum vulgare</i> P. Mill.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020

Table 1. Continues...

Common name	Species	Origin (native/exotic)	References
Alpine Strawberry	<i>Fragaria vesca</i> L.	Exotic	Greenberg 2015; Ubierno-Corvalán <i>et al.</i> , 2020; Gerardo-Mendez 2024.
Mint	<i>Mentha sativa</i> L.	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020
Jamaica	<i>Hibiscus sabdariffa</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Kiwi	<i>Actinidia deliciosa</i> (Chev.) Liang & Ferguson	Exotic	Soto-Pinto <i>et al.</i> , 2022
Lettuce	<i>Lactuca sativa</i> L.	Exotic	Greenberg 2015; Almeida-Cerino <i>et al.</i> , 2024
Lichi	<i>Litchi chinensis</i> Sonn.	Exotic	Alcazar-Sánchez <i>et al.</i> , 2025
Lime	<i>Citrus limetta</i> Risso	Exotic	Alcazar-Sánchez <i>et al.</i> , 2025; Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Egyptian lime	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Exotic	Soto-Pinto <i>et al.</i> , 2022
Mexican lime	<i>Citrus</i> × <i>aurantifolia</i> (Lunan) Guillaumin	Exotic	Cruz-Salazar <i>et al.</i> , 2020.
Sweet Lime	<i>Citrus</i> × <i>limetta</i> Risso	Exotic	Almeida-Cerino <i>et al.</i> , 2024
King orange	<i>Citrus</i> × <i>nobilis</i> (Lour)	Exotic	Soto-Pinto <i>et al.</i> , 2022
Mandarin lime	<i>Citrus</i> × <i>limonia</i> (L.) Osbeck	Exotic	Soto-Pinto <i>et al.</i> , 2022
Canton Lemon	<i>Citrus</i> × <i>limonia</i> (L.) Osbeck	Exotic	Ubierno-Corvalán <i>et al.</i> , 2020; Soto-Pinto <i>et al.</i> , 2022; Almeida-Cerino <i>et al.</i> , 2024; Gerardo-Mendez 2024.
Persian Lime	<i>Citrus</i> × <i>latifolia</i> Tanaka ex Q. Jiménez	Exotic	Soto-Pinto <i>et al.</i> , 2022
Persian Lime	<i>Citrus</i> × <i>latifolia</i> Tanaka ex Q. Jiménez	Exotic	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024
Cravo Lemon	<i>Citrus</i> × <i>limonia</i> (L.) Osbeck	Exotic	Gerardo-Mendez 2024
Lemon	<i>Citrus</i> × <i>limon</i> (L.) Osbeck	Exotic	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Mandarine	<i>Citrus reticulata</i> Blanco	Exotic	Gerardo-Mendez 2024
Tangor	<i>Citrus nobilis</i> Lour	Exotic	Soto-Pinto <i>et al.</i> , 2022; Gerardo-Mendez 2024.
Mango	<i>Mangifera indica</i> L.	Exotic	Gerardo-Mendez 2024
Mangosteen	<i>Garcinia mangostana</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Passion fruit	<i>Passiflora edulis</i> Sims	Exotic	Soto-Pinto <i>et al.</i> , 2022
Cashew	<i>Anacardium occidentale</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Blueberry	<i>Vaccinium myrtillus</i> L. m.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Moringa	<i>Moringa oleifera</i> Lam.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Dijon Mustard	<i>Brassica juncea</i> (L.) Czern.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Field mustard	<i>Brassica rapa</i> , <i>B. campestris</i>	Exotic	Soto-Pinto <i>et al.</i> , 2022
Orange	<i>Citrus</i> × <i>sinensis</i> (L.) Osbeck	Exotic	Soto-Pinto <i>et al.</i> , 2022
Seville orange	<i>Citrus</i> × <i>aurantium</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Loquat fruit	<i>Eriobotrya japonica</i> (Thunb.) Lindl.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Japanese-medlar	<i>Eriobotrya japonica</i> (Thunb.) Lindl	Exotic	Soto-Pinto <i>et al.</i> , 2022
Indian Mulberry	<i>Morinda citrifolia</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Breadfruit	<i>Artocarpus altilis</i> (Park.)	Exotic	Soto-Pinto <i>et al.</i> , 2022
Chicken Cucumber	<i>Cucumis anguria</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Cucumber	<i>Cucumis sativus</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Pear	<i>Pyrus</i> spp. L.	Exotic	Soto-Pinto <i>et al.</i> , 2022

Table 1. Continues...

Common name	Species	Origin (native/exotic)	References
Pineapple	<i>Ananas comosus</i> (L.) Merr	Exotic	Soto-Pinto <i>et al.</i> , 2022
Banana	<i>Musa</i> spp. L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Plantain banana	<i>Musa</i> × <i>paradisiaca</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Plantain	<i>Musa balbisiana</i> Colla	Exotic	Soto-Pinto <i>et al.</i> , 2022
Cavendish banana	<i>Musa acuminata</i> Colla	Exotic	Soto-Pinto <i>et al.</i> , 2022
Red Banana	<i>Musa paradisiaca</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Malabar plum	<i>Syzygium jambos</i> (L.) Alston	Exotic	Soto-Pinto <i>et al.</i> , 2022
Pomelo	<i>Citrus maxima</i> (Burm.) Merr	Exotic	Soto-Pinto <i>et al.</i> , 2022
Blackberry	<i>Rubus ulmifolius</i>	Exotic	Soto-Pinto <i>et al.</i> , 2022
Radish	<i>Rhapanus sativus</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Rambutan	<i>Nephelium lappaceum</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Shetland cabbage	<i>Brassica oleracea</i> var. <i>capitata</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Watermelon	<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	Exotic	Soto-Pinto <i>et al.</i> , 2022
Tamarind	<i>Tamarindus indica</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Tree tomato	<i>Cyphomandra betacea</i> (Cav.) Sendtn.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Melon pear	<i>Solanum muricatum</i> Aiton	Exotic	Soto-Pinto <i>et al.</i> , 2022
Grapefruit	<i>Citrus</i> × <i>paradisi</i> Macfad	Exotic	Soto-Pinto <i>et al.</i> , 2022
Common Purslane	<i>Portulaca oleracea</i> L.	Exotic	Soto-Pinto <i>et al.</i> , 2022
Jackfruit	<i>Artocarpus heterophyllus</i> Lam.	Exotic	Soto-Pinto <i>et al.</i> , 2022

Banana, cherry coffee, cacao, papaya, mango, pear, peach, apple, pineapple, avocado, and watermelon are among the top ten nationally important crops in terms of quantity produced for commercial purposes. Production records in 2023 ranged from 3,738 tons of apples to 672,021 tons of bananas (SIAP 2024; Table 2). Although the tomato is not mentioned in this list, it is also considered a commercially important crop in the state (CEIEG, 2023).

Table 2. Fruits grown in Chiapas considered by their national economic importance.

Product	Sown area (ha)	Harvested area (ha)	Production (t)	Production Value (thousands of mexican pesos)
Cherry coffee	243,946.87	240,301.27	391,956.99	2,116,042.81
Cacao	17,923.40	17,779.40	10,936.85	377,155.02
Banana	23,496.42	23,346.72	672,020.76	1,660,642.16
Papaya	2,077.70	2,019.20	160,251.56	825,823.43
Mango	38,781.85	36,909.85	272,174.46	1,444,154.66
Avocado	3,375.71	2,705.06	17,045.15	445,361.97
Red Tomato	1,631.66	1,631.66	82,922.79	795,676.62

Own elaboration based on data obtained from SIAP (Servicio de Información Agroalimentaria y Pesquera) (2024).

According to the CEIEG (2025), the commercial value of coffee, banana, mango, papaya, avocado, and tomato production in 2023 was \$11,044,817.17, with coffee and banana production having the highest value. These six products are cultivated in the state's XV economic region, with the greatest concentration of production in Region X (Soconusco), where all six products are grown (Figure 1).

The previous crops are distributed throughout the state under different agroecosystems. Products intended for commercialization are developed in monoculture production systems. Those intended for self-consumption and local and regional trade are grown in milpa production systems alongside *Coffea arabica* L. and *Theobroma cacao* L., as well as in areas known as acahuals, which are generally associated with rural communities, family gardens, backyards, and fields. They can also be found alongside roads and in urban environments (Greenberg, 2015; Benítez-Kánter *et al.*, 2020; Soto-Pinto *et al.*, 2022; Fernández & Méndez, 2018; Ubierno-Corvalán *et al.*, 2020; Almeida-Cerino *et al.*, 2024).

Fruits and vegetables grown for self-consumption come from backyards or small plots within family production units and are part of the community's cultural, economic, and social wealth (Gerardo-Méndez *et al.*, 2024).

In addition to self-consumption, they are sold in local markets (Harvey *et al.*, 2021; Flores, 2019; Flores, 2016; Soto-Pinto *et al.*, 2022).

These vegetables are typically consumed fresh, incorporated into regional dishes, or used to make flavored water and preserves (Ubierno-Corvalán *et al.*, 2020; Gerardo-Méndez, 2024).

Family agroecological systems also preserve germplasm of edible species, primarily native ones, and contribute to the conservation of cultural traditions (Ubierno-Corvalán *et al.*, 2020). Rural communities in northern Chiapas (Ubierno-Corvalán *et al.*, 2020) and the Maya region (Martínez *et al.*, 2023) cite the extensive use of fruit trees for self-consumption.

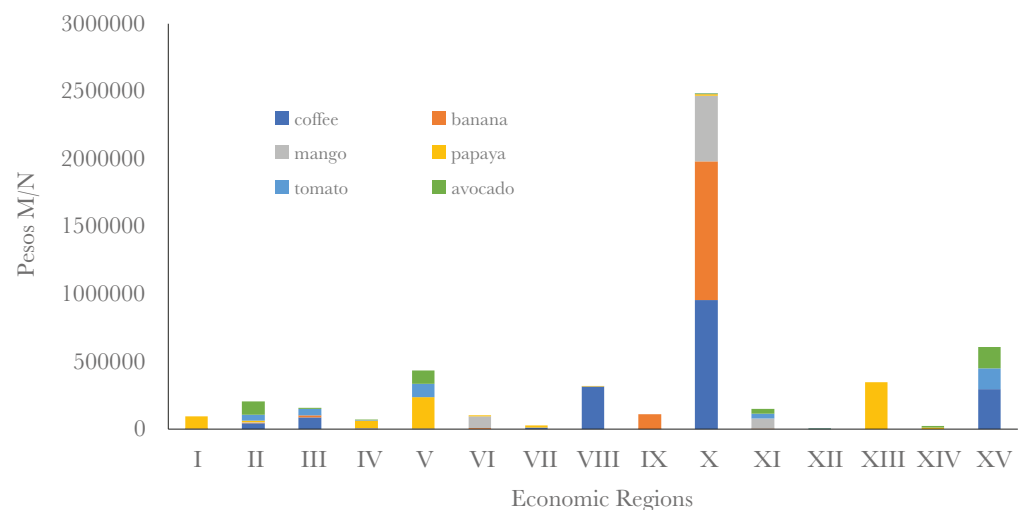


Figure 1. Production value of the six main fruits by national importance. Own elaboration based on data obtained from CEIEG (Comité Estatal de Información, Estadística y Geografía de Chiapas) (2025).

Crops in commercial productive agroecosystems

Cacao agroecosystem

Cacao, a fruit developed in Mesoamerica, has played an important role in the region's gastronomy. It was even used as currency in Mayan and Aztec cultures and is part of their cultural heritage (Mendoza, 2011). Cacao has been an integral part of indigenous cultures, such as the Mayan and Aztec civilizations. These cultures venerated cocoa as a gift from the gods, symbolizing prosperity and fertility (Coe & Coe, 2013). Cacao cultivation in Mexico dates back to pre-Hispanic civilizations, including the Olmec, Maya, and Aztecs.

The pulp can be eaten fresh, added to water as a meal accompaniment, or enjoyed as a refreshing drink.

Currently, the main use of the fruit is for producing chocolate. Chocolate is an integral part of the regional culture and economy. It is marketed locally, nationally, and internationally.

Cultivation is usually diversified with coffee or rambutan (Mendoza *et al.*, 2024). Additionally, the cacao agroecosystem is characterized by shade-loving trees. This combination favors ecosystem services.

Among the diverse species of shade trees, several fruit trees are cultivated alongside *T. cacao* L. for personal consumption and local marketing (Salgado-Mora *et al.*, 2007).

In cocoa-producing areas of Soconusco, the following fruit trees can be identified: *Mangifera indica* L., *Persea americana* Mill., *Citrus reticulata* Blanco, *Citrus × sinensis* (L.) Osbeck, *Nephelium lappaceum* L., *Manilkara zapota* (L.) van Royen, and *Pouteria sapota* (Jacq.) H.E. Moore & Stern. And shade trees including flying guava *Terminalia amazonia* (J. F. Gmel.) Exzell., chalum, *Inga micheliana* Harms (Avenidaño-Arrazate *et al.*, 2021). In the rainforest region, the following species are found: *Coffea Musa* spp., *Citrus × sinensis* (L.) Osbeck, avocado *Persea americana* Mill., lemon *Citrus limon* (L.) Burm. f. *Manilkara zapota* (L.) van Royen, *Pouteria sapota* (Jacq.) H. E. Moore & Stern., guanabana *Annona muricata* L., tamarindo *Tamarindus indica* L., and jobo *Spondias mombin* L. (López-Baez *et al.*, 2015).

Coffee agroecosystem

Coffee arrived in the country in the 17th century (Gómez-Pompa, 1997; Topik *et al.*, 2006) from its origin in Ethiopia (Smith, 1985) discovered by the inhabitants of the mountainous regions, when they noticed the energizing effect of its fruits.

This exotic fruit is recorded to have begun production in Soconusco in 1846, when plants were introduced from Guatemala and initially planted in Tuxtla Chico, Chiapas (Bartra, 1995).

According to the FAO (2022) classification, coffee is not considered a fruit because the seed is used to make coffee.

Nevertheless, coffee is an important agroecosystem in the Soconusco region, providing the region with significant economic benefits and ecosystem services to rural communities each year.

In Mexico, coffee represents a transient entry zone for the Mediterranean fruit fly, an important pest for global fruit and vegetable production (Flores *et al.*, 2016).

The state of Chiapas ranks first nationally in terms of production value. It cultivates 241,876 hectares distributed among 13 coffee-growing regions served by 183,761 producers. Small farms predominate.

Its cultivation is also associated with the shade of exotic and native fruit trees. This production system induces significant ecological richness. In the highlands of Chiapas, this crop is often combined with honey production.

Thirty-seven edible plant species, including fruits and vegetables, have been identified in the central region of Chiapas, which are produced for self-consumption or local trade (Gasco, 2008; Fernández *et al.*, 2013; Greenberg, 2015; Gómez-Martínez *et al.*, 2019; Alcázar-Sánchez *et al.*, 2022; Soto-Pinto *et al.*, 2022). Coffee-growing areas in the Sierra Madre also feature fruits and vegetables (Benítez-Kánter, 2020; Fernández & Méndez, 2018).

Export fruit farming

Fruits destined for export must meet the high quality standards set by the importing countries and comply with pest regulation standards to prevent the dispersal of pests to those countries.

The international marketing chain includes harvesting, post-harvest treatment, packing, storage, and transportation. Thus, products must comply with quality standards, including a shelf life that guarantees consumers can consume the product as intended (Fletes *et al.*, 2016; Mendoza *et al.*, 2024).

In 2023, Chiapas exported bananas, both fresh and dried, valued at US\$95.3 million, representing 48.5% of the state's exports. Second place in exports went to *Coffea arabica* L., including roasted or decaffeinated products, coffee husks and skins, and coffee substitutes containing coffee in any proportion. These exports generated US\$70.2 million (35.7%). Noteworthy exports included pineapples, avocados, guavas, and mangoes, which generated US\$27.5 million (14%). Other fruit trees exported since 2013 include rambutan.

***Coffea arabica* L.**

Coffee exports from Soconusco come from the municipalities of Mapastepec, followed by Tapachula, Acapetahua, Mazatán, Huehuetán, Escuintla, Huixtla, Villa Comaltitlán, Suchiate, Pijijiapan, Tuxtla Chico, Tuzantán, Acacoyagua, Frontera Hidalgo, Cacahoatán, Tonalá, Unión Juárez, Arriaga, and Metapa. In total, 316,351 hectares are planted, with a production value of 8,051,584 thousand pesos (SIAP, 2024). The municipality of Tapachula produces the coffee with the highest commercial value. It has a planted area of 56,313 hectares, with a commercial value of 1,268,067 thousand pesos.

***Mangifera indica* L. var Ataulfo.**

The development of the "Ataulfo" mango variety in Soconusco has achieved widespread acceptance and economic relevance. It is valued internationally for its flavor, texture, and pulp content (Rivera-López *et al.*, 2020; Mendoza-Hernández *et al.*, 2020).

Its cash crop began in 1965 and was promoted by the National Institute for Agricultural Research at the Rosario Izapa Experimental Field (now INIFAP). From there, it expanded to other Mexican states, Central America, South America, and Spain (Infante *et al.*, 2011).

The fruit has a designation of origin for the Soconusco region as “Mango Ataulfo del Soconusco, Chiapas,” published in the Mexican Official Journal of the Federation on August 27, 2003. This designation includes the municipalities of Suchiate, Frontera Hidalgo, Metapa, Tuxtla Chico, Tapachula, Mazatán, Huehuetán, Tuzantán, Huixtla, Villa Comaltitlán, Escuintla, Acacoyagua, and Acapetahua (Secretaría de Economía, 2016).

Production in this zone is attributed to the particular agroecological characteristics that favor high production and fruit quality of *Mangifera indica* L. var. Ataulfo.

Nowadays, 32,030 hectares are dedicated to this crop in the Soconusco and Costa region, generating a production value of 1,273,402.54 thousand pesos. The municipality of Tapachula has the largest production, with 8,540.72 hectares and a production value of 407,760.39 pesos.

Production has increased in other Soconusco localities; however, Huehuetán produces the highest quality mangoes for export (SIAP, 2024).

The mangoes produced in Chiapas first reach commercial quality in February and therefore achieve a better price in the market. It is appreciated for its pulp quality, intense yellow color, thin skin, small seed, high sugar content, aroma, flavor, low fiber content, and long shelf life.

***Nephelium lappaceum* L.**

The rambutan is originally from Asia and was introduced to Mexico in 1965 as part of development projects carried out by the National Institute of Agricultural and Livestock Research (INIFAP). Its commercial cultivation in the region began 30 years ago.

It has been primarily cultivated alongside coffee and cocoa, and it is currently grown in backyards, small plots, and monoculture areas. When cultivated in small plots, rambutan contributes to the family economy, local trade, and national and international markets (Bello-Mendoza *et al.*, 2024).

The region has 849 hectares planted with a production value of 117,177.63 thousand pesos. The municipality of Tuxtla Chico has the largest planted area, valued at 64,691.98 thousand pesos, and it is also cultivated in the municipalities of Tapachula, Cacahoatán, Frontera Hidalgo, Metapa, Huehuetán, and Tuzantán (SIAP, 2024).

***Carica papaya* L.**

The Maradol papaya is another export-quality product grown on 1,401 hectares, with a production value of 491,708.6 thousand pesos. The largest area is in Mazatán, with 481 hectares and a production value of 167,063.51 thousand pesos. It is also produced in Tapachula, Acapetahua, Frontera Hidalgo, and Huixtla.

The main export markets are the United States, followed by Japan, Europe, and Canada (FAO, 2022).

***Musa* spp.**

Chiapas is an important banana producer, contributing 686 thousand tons (28.1%) of the total national crop. In the Soconusco region, the municipalities of Suchiate, Tapachula, and Mazatán contribute 28.4%, 13.8%, and 10.8%, respectively (SIAP, 2023).

In Soconusco, 435 banana growers have been identified within the Association of Banana Producers, who produce export-quality bananas.

These fruits can be distributed regionally, nationally, and internationally. However, the banana crop faces several challenges, including weather phenomena, pest and disease incidence, input costs, product sales prices, access to financing, and, to a lesser extent, scarce labor, producer organization, and productive technical assistance. The most important needs are the establishment of irrigation systems and the installation of warehouses. When it comes to marketing linked to export companies, they impose conditions regarding harvesting, cultivation, quantities, and prices (León-Ayala *et al.*, 2024).

In addition to export-quality production, different varieties of bananas are cultivated in backyards and small family gardens for self-consumption and local commerce.

Problems with Growing Fruit and Vegetables in Chiapas

In general, world agriculture is exposed to various risk factors, the most important of which are related to climate change, poverty, inequality, and population growth. Agriculture can also be impacted by the collateral effects of pandemics, unsustainable land use and management practices, armed conflicts, and environmental degradation (FAO, 2024).

Fruit cultivation is particularly vulnerable to these factors (Álvarez *et al.*, 2021; León-Ayala *et al.*, 2024), especially in open fields. This vulnerability can be exacerbated by climate change conditions, such as prolonged droughts, which cause significant agricultural losses worldwide (FAO, 2024).

The soils are generally of medium fertility, and rugged terrain in some regions, such as northern Chiapas, makes mechanized tillage difficult. Cultivated areas face soil erosion problems and decreased fertility due to extensive use, primarily in the Soconusco region (Rodríguez *et al.*, 2017).

Other problems associated with crops

The presence of pests and diseases in tropical and subtropical climates, together with monoculture production systems and environmental impact, has reduced biotic competition and impacted the biodiversity of natural pest enemies (Galindo, 2022). Fruit fly pests affect fruits and vegetables, which compromises international trade (Ramírez & Ramírez, 2020).

In Chiapas, 18 plant species have been found to be potential hosts of *Ceratitis capitata*, given the state's broad plant biodiversity (SADER, 2024).

The labor force tends to be scarce due to the abandonment of the countryside by farmers, who find it more profitable to seek employment in large cities or other countries (Alcázar-Sánchez *et al.*, 2022). Social phenomena such as armed conflicts, wars, and technological and chemical threats also impact the labor force (FAO, 2024).

Market prices can be very low in cases of oversupply, to the point that there is no return on investment or profit (Luquez, 2020; Bello Mendoza, 2024).

Regarding competitiveness, small, low-income producers face challenges that demand the modernization of farming systems to increase efficiency and competitiveness, primarily

on an international level. This requires the use of more productive crop varieties, tools, and agricultural inputs (Álvarez, 2021).

Cultivated products must meet consumption and marketing parameters, which are generally determined by consumer acceptance and include visual appearance, size, and flavor, among others.

It is also important to comply with the stipulated requirements for cultivation, harvesting, packing, and shipping, taking into account food safety and agricultural risk aspects (Osei-Kwarteng *et al.*, 2024; Mazariegos-Sanchez *et al.*, 2017; NOM-076-FITO-1999; Bello-Mendoza *et al.*, 2024).

In the case of the exporting of Ataulfo mangoes, producers mainly face attacks by fruit flies (*Anastrepha ludens* and *Anastrepha obliqua*) and the threat of infestation by the Mediterranean fruit fly. This process must comply with an established protocol during and after harvest.

Additionally, production faces the challenge of expanding crops in the face of potential market loss (Infante *et al.*, 2011; Mazariegos-Sánchez *et al.*, 2017). Marketing through intermediaries is a problem for producers in Soconusco.

Those who do not comply with export standards are lost in local and national trade. To overcome these challenges, producers should increase technological innovation to reduce costs (Mazariegos-Sánchez *et al.*, 2017), produce sticks with a defined origin to ensure crop and fruit homogeneity, reduce illegal trade chains, improve fruit quality for export, and conquer other export markets in other countries (Mendoza-Hernández *et al.*, 2020).

In the case of rambutans produced in Soconusco, there are independent producers, which causes heterogeneity in quality. One quarantine barrier to rambutan cultivation is the mealy louse for the export market. Additionally, there is a lack of knowledge regarding pest management, transportation, and quality, as well as a lack of integration among producers (Flores-Trejo *et al.*, 2016).

Challenges and Opportunities

Although the recommendation for health issues is to consume raw and fresh vegetables, this limits economic development due to scarce transformation and generation of added value (Ramírez *et al.*, 2018). However, these vegetables can be offered in commercial presentations. The culinary tradition of Chiapas incorporates fruits and vegetables into dishes such as preserves, jams, and flavored water (Ubierno-Corvalán *et al.*, 2020; SIAP, 2024). Preserves, juices, jams, and cosmetics are prepared in the domestic market. Currently, the circular economy, which includes essential oils derived from fruit peels and fruit flavoring, is important. Still, the commercial importance of the industry linked to these vegetables is low.

The transformation of primary fruit and vegetable production is important because it increases income from added value. This area has not been extensively explored in the state, and its implementation requires scientific research, technological development, and agri-food innovation. To achieve this goal, interaction among producers, key stakeholders, agribusinesses, academic institutions, civil society, and government sectors

is necessary to promote innovation and more efficient production systems, improve commercial networks, and increase industrialization to generate more jobs and added value (Ramirez *et al.*, 2018).

In Chiapas, there is a wide variety of fruits and vegetables that have historically been essential components of the native population's diet. These are mainly native species, to which introduced species have been added. These vegetables are present in different agroecological environments and community sites as part of biocultural processes of cultivation and consumption. This knowledge has been passed down through generations and is an integral part of the region's culinary heritage, enriching regional gastronomy and supporting family subsistence (Ubierno-Corvalán *et al.*, 2020).

The low quantity of these commercially valuable vegetables indicates that most fruit species are underutilized. As Segura *et al.* (2018) point out, this is due to the underestimation of their potential uses and the lack of knowledge about their nutritional value. It is also due to the rapid reduction of their ecosystems. Paying attention to these species is important, mainly because they contribute to the food security of people living in extreme poverty in rural areas (Ramírez-Juárez *et al.*, 2022).

Commercially important fruits and vegetables contribute to food security at the state and national levels due to the economic benefits generated by exports and the jobs created in the production and commercialization chains. This has encouraged small producers to adopt them. However, they face difficulties complying with quality and production standards for export. They are often sold through intermediaries or local markets, which detracts from production value (Flores *et al.*, 2019).

The Soconusco zone stands out in particular for its diversity and commercial export crops, which are favored by its geographic characteristics. It is important to innovate with alternatives according to the characteristics of other areas of the state with the objective of diversifying the local food supply, including species that can potentially be commercialized.

Globalization and climate change have led to an increase in natural disasters that affect agriculture. Therefore, it is advisable to have local alternatives that guarantee food security and sovereignty. As proven by phenomena such as the pandemic, the availability of imported food can decrease, which is why regional products play a crucial role. Additionally, the current food supply in Mexico has been analyzed and found to need improvement. Fruits and vegetables are an integral part of this improvement, which can be achieved by cultivating products for which the country has arable land capacity (Ibarrola-Rivas *et al.*, 2022).

Educational and research institutions, along with governments, should promote the increased use of these vegetables in rural and urban areas. Clear examples of this can be seen with mangoes and rambutans, which, despite being exotic, have been improved to the point that they can be exported, generating foreign exchange for the country. Another important development issue is generating by-products that increase the products' added value. Another important issue in the sector is food waste.

Consuming a variety of fruits and vegetables is essential for good nutrition. The cost increases when out-of-season and imported fruits are consumed, so conserving and propagating regional fruit trees can economically complement the diet. Paying attention to

the challenges faced by commercial agriculture is also important since it has contributed to the country's development.

CONCLUSIONS

The agroecological conditions in Chiapas have influenced the wide variety of fruits and vegetables, and conserving and cultivating them contributes to regional and even global food security through exports. The commercialization and export of these fruits and vegetables contribute to the country's economic growth. However, species richness contributes to ecosystem services and biocultural heritage, which deserves particular attention because species diversification reinforces food security. It is important to strengthen the horticultural sector in the state from technological, ecological, social, and economic points of view. This involves strengthening commercially important crops and seeking new alternatives while taking into account the existing diversity, particularly of native species. These species should be conserved due to their importance in biocultural heritage.

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