UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
POSGRADO EN CIENCIAS DE LA SOSTENIBILIDAD
ESCUELA NACIONAL DE ESTUDIOS SUPERIORES UNIDAD MORELIA

AGRICULTURA TRADICIONAL Y TRAYECTORIAS CAMPESINAS ANTE LA INDUSTRIALIZACIÓN AGRÍCOLA EN UNA REGIÓN DEL OCCIDENTE DE MÉXICO. CIENCIA DE LA SOSTENIBILIDAD Y TRANSDISCIPLINARIEDAD

TESIS
QUE PARA OPTAR POR EL GRADO DE
DOCTOR EN CIENCIAS DE LA SOSTENIBILIDAD

PRESENTA:
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CIUDAD UNIVERSITARIA, CIUDAD DE MÉXICO, MAYO 2023

Coordinación de Estudios de Posgrado
Ciencias de la Sostenibilidad
Oficio: CGEP/PCS/107/2023
Asunto: Asignación de Jurado

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Presente

Me permito informar a usted, que el Comité Académico del Programa de Posgrado en Ciencias de la Sostenibilidad, en su sesión 87 del 17 de enero del presente año, aprobó el jurado para la presentación del examen para obtener el grado de **DOCTOR EN CIENCIAS DE LA SOSTENIBILIDAD**, del alumno **Subercaseaux Ugarte Diego José** con número de cuenta **519492235,** con la tesis titulada "Agricultura tradicional y trayectorias campesinas ante la industrialización agrícola en una región del occidente de México. Ciencia de la Sostenibilidad y Transdisciplinariedad", bajo la dirección de la Dra. Ana Isabel Moreno Calles y la Dra. Marta Astier Calderón.

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Sin más por el momento me permito enviarle un cordial saludo.

ATENTAMENTE,

"POR MI RAZA HABLARA EL ESPIRITU"
Cd. Universitaria, Cd. Mx., 28 de abril de 2023.

Dr. Alonso Aguilar Ibarra
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Agradecimientos

A la Universidad Nacional Autónoma de México (UNAM) y al Posgrado en Ciencias de la Sostenibilidad de dicha institución académica. No solo por aceptarme en el programa y así darme la posibilidad de continuar formándome en la investigación en sostenibilidad, sino también por emprender el camino de la transdisciplinariedad, de buscar el carácter e impronta transdisciplinaria en este programa de posgrado, con las complejidades que aquello implica. Un gran camino a transitar, ante el enorme desafío de la sostenibilidad.

Al Consejo Nacional de Ciencia y Tecnología del Gobierno de México por la beca doctoral que me permitió solventar económicamente el periodo de realización de mi doctorado. También agradezco la beca PAPIIT que me ayudo en lo económico en los últimos meses de mi tesis. Agradezco los demás apoyos económicos que recibí, correspondientes o provenientes de los proyectos DGAPA-PAPIIT IG200720 e IN-200319, y de los laboratorios y equipos que coordinan la Dra. Ana Isabel Moreno Calles (tutora) y la Dra. Marta Astier Calderón (cotutora), así como también el apoyo económico del Dr. Gerardo Bocco Verdinelli (miembro de mi comité tutor).

A la Dr. Ana Isabel Moreno Calles, Ana Isabel, mi tutora, por su humanidad, cuidado de las relaciones personales, y profundidad. Por los conocimientos compartidos en los diferentes momentos del proceso, así como también por apoyarme de diferentes maneras en este proceso investigativo, formativo y también experiencial en un sentido profundamente más integral. Además, por coordinar el Laboratorio de Estudios Transdisciplinarios sobre el Ambiente, tanto por emprender aquel camino dialogante entre diferentes campos del saber, como por el valioso grupo humano que conforma tal laboratorio y equipo.

A la Dr. Marta Astier Calderón, Marta, mi cotutora, por su apoyo para mi ingreso al Posgrado en Ciencias de la Sostenibilidad de la UNAM, su ayuda desde el comienzo y hasta el fin de este camino y por mostrarme la Cuenca del Lago Pátzcuaro e introducirme a ese mundo campesino, y sus tierras y paisajes. Le agradezco su buena voluntad para apoyarme y formar parte de este equipo, con todos los momentos y cambios del proceso, y por los conocimientos y experiencia compartidos. Agradezco también a su equipo, a Ana Clara Pla y Esperanza Arnés.

Al Dr. Gerardo Bocco Verdinelli, Gerardo, miembro de mi comité tutoral, por aceptar formar parte de mi comité tutor, por apoyarme en este proceso y por ofrecer toda su gran experiencia y conocimientos. Su claridad y lucidez fue un gran apoyo y aporte en variados momentos y decisiones claves, no solo en lo propiamente investigativo.

A los jurados de mi tesis doctoral, Alicia Castillo Álvarez, José Hernández López, Víctor Manuel Toledo Manzur, Gerardo Hernández Cendejas y Gerardo Bocco. Les agradezco sinceramente la buena disposición para apoyarme y dedicar tiempo a revisar mi tesis doctoral. Además, valoro y agradezco el interés que mostraron y expresaron hacia esta investigación, respecto al tema, la aproximación y enfoque, y las contribuciones logradas.

A los jurados de mi examen de candidatura del doctorado, Alejandro Casas Fernández, José Hernández López, Andrés Camou Guerrero, Santiago López Ridaura y Gerardo Bocco Verdinelli. Gracias por aceptar formar parte del jurado de mí examen de candidatura, por la revisión de mi proyecto de investigación y por sus aportativas observaciones, comentarios y preguntas. Además, gracias por las interacciones y colaboraciones posteriores a dicho examen.

A las personas de las comunidades San Francisco Uricho y San Miguel Nocutzepo, en la Cuenca del lago Pátzcuaro, quienes, de manera desinteresada, me dedicaron momentos de sus vidas y, además, me permitieron acceder al bello mundo del campesinado y la agricultura tradicional en

dichas comunidades. Agradezco especialmente a quienes tuve la posibilidad de compartir más directamente, con quienes platiqué y a quienes entrevisté, dedicándome parte de sus experiencias, pensamientos, sentimientos, y conocimientos, sin lo cual esta investigación no hubiese sido posible. Surgieron varios momentos sumamente bonitos y potentes, que son una ventana al México campesino y que atesoro. Gracias especialmente a Francisco Rodríguez, campesino de San Francisco Uricho, no solo por la entrevista concedida, sino también por toda la ayuda con contactos e información, y aclarándome dudas en diferentes momentos. Así también, mis agradecimientos a Paulina Odilia Molina, de San Miguel Nocutzepo, quien también me apoyó en repetidas ocasiones, además de concederme una entrevista.

A Jorge Odenthal, por mostrarme las comunidades campesinas de la Cuenca del Lago Pátzcuaro, acompañarme a recorrer la zona, darme información, y recibirme en su casa y compartirme sus visiones respecto a la cuenca y sus problemas. A Quetzal Orozco Ramírez, por ayudarme a conocer y entender el área de estudio de mi investigación, así como diferentes temas relacionados con la agricultura en México e informaciones acerca de los núcleos agrarios. A Carlos González Esquivel, por su buena disposición para compartirme información y para apoyarme en diferentes momentos del proceso de investigación doctoral. A Carmen Patricio Chávez, de la comunidad Santa Ana Chapitiro, por apoyarme para entrar en las comunidades abordadas y por facilitarme información, fotos del área de estudio y ayuda en otros momentos. A todos/as les agradezco sinceramente.

A Antonio Navarrete, del Centro de Investigación en Geografía Ambiental de la UNAM - Morelia, y a Iván Cumana, por sus participaciones y ayuda en el análisis cuantitativo de cambio de uso del suelo. Sin sus apoyos no hubiese podido realizar dicho análisis, el cual aportó no solo valiosos datos numéricos del cambio de uso de suelo, sino que también en desarrollar y concretizar la aproximación compleja de la investigación, al combinar los métodos y análisis cualitativos y cuantitativos.

A las personas del Laboratorio de Estudios Transdisciplinarios sobre el Ambiente de la ENES Morelia. Son un sólido equipo de trabajo, que está aportando tanto y con tanto por aportar, pero más importante que eso, son un bonito grupo humano, buenas personas; el compañerismo se percibe claro y fuerte. Un gusto conocerlos/as y compartir con ustedes.

A los compañeros y compañeras del Posgrado en Ciencias de la Sostenibilidad, con quienes compartí semana a semana en aquel primer semestre de este proceso en la segunda mitad del año 2018. Se les recuerda y se les seguirá recordando con aprecio y cariño.

A las amistades que este camino me ha regalado en estos años viviendo en Morelia. Grandes amistades. De la poesía, de paseos y aventuras, de la UNAM, de calles, de bares, y de tantos lugares y andares. Son una presencia de vital y de enorme importancia para mí. Que las buenas amistades prosigan por años y años.

A todos/as con quienes compartí en alguna clase, estudio, taller o trabajo de campo, ya sea en la academia o en alguna comunidad o localidad rural. A los profesores y profesoras que me dieron un curso o una clase, o que de alguna manera me compartieron sus conocimientos y aportaron en mi formación. Siempre mi agradecimiento a quienes fomentan y aportan a la circulación de los conocimientos, experiencias y saberes. Mi especial gratitud y agradecimiento a los profesores Juan Gastó Coderch y Guillermo Mann Wilcke, de Chile, grandes maestros, quienes han sido de enorme importancia en mi formación académica e intelectual, en introducirme en la ciencia, y en el pensamiento riguroso y sistémico, relacionando y mirando profundamente más allá de las fronteras del quehacer científico más convencional.

A todas las personas que hacen posible que el campus de la UNAM en Morelia sea un lugar grato para estar y realizar los quehaceres de cada quien. Gracias a los funcionarios y trabajadores en general que hacen aquello posible. Y extendidos agradecimientos a los trabajadores que mueven esta sociedad.

Gracias a Morelia. Una ciudad prácticamente desconocida para mi hasta hace unos pocos años, a la cual llegué solo con la decidida actitud de conocer y experienciar, considerablemente más allá de lo académico. A Michoacán y a México, país Latinoamericano, tal como Chile. México, país con mil y un encantos, y también oscuridades. Se hizo parte de mi historia y mi vida; querido país y pueblo.

A la poesía, la entrañable y querida poesía. Una bella presencia.

A mi amigos y amigas de Chile, amistades que aun con una enorme distancia física, prosiguen fuertes. El cariño, el apoyo y la compañía se valoran enormemente, tanto más de lo que puedo expresar.

A mi familia, por el cariño y apoyo a la distancia. A mi mamá, papá y hermano, y también a mi sobrino Lucas. Gracias.

A Leti, mi compañera en parte importante de este proceso. Su cariño, ternura, carisma, belleza y amor, tan tuyos, han sido un sostén crucial y una luz en este camino.

A toda la gente buena, amable, dispuesta a ayudar, y que quiere y actúa por construir un mundo mejor, más justo y sustentable.

Al campesinado, a los pueblos, culturas y sabidurías tradicionales, que son nuestra raíz y cuyo quehacer y legado nos muestran otros caminos posibles.
A los hermanos y hermanas que anhelan, buscan y luchan por otro mundo-sociedad. Más justo, más sano, más bello.

A la tierra, a la natura, a la vida
Al verde eterno
Al agua libre
A lo salvaje
A los paisajes antiguos y nacientes,
que nos entrelazan,
que nos inspiran e iluminan.

Relacionar, relacionar siempre, era un método más rico que las teorías blindadas, guarnecidas epistemológica y lógicamente, metodológicamente aptas para afrontar lo que fuere salvo, evidentemente, la complejidad de lo real

EDGAR MORIN - SABIO FRANCÉS

Etimológicamente conciencia quiere decir conocer con otros. Se trata de un conocimiento compartido socialmente

ROGER BARTRA – CIENTÍFICO SOCIAL MEXICANO

La vida no conquistó el globo con combates, sino con alianzas

LYNN MARGULLIS Y DORIAN SAGAN - BIÓLOGA Y ESCRITOR ESTADOUNIDENSES

Al confrontar las tesis, el pensamiento busca espontáneamente una unidad superior

HENRI LEFEBVRE - FILÓSOFO FRANCÉS

INDICE

RESUMEN

La modernidad industrial es un proceso civilizatorio que está inmerso en un laberinto complejo. La modernización e industrialización rural y agrícola (MIRA) y sus implicaciones han aumentado en las últimas décadas, transformando al paisaje rural. El modelo agroindustrial ha incidido en las formas de agricultura tradicional en todo el planeta. En esta investigación problematizamos la MIRA desde la Ciencia de la Sostenibilidad y la transdisciplinariedad. Los procesos de la MIRA no han sido lineales ni unidireccionales; han surgido heterogeneidades, mosaicos, hibridaciones, nuevas interacciones, problemas y tensiones entre diferentes agriculturas y actores. En muchas regiones rurales las agriculturas tradicional e industrial, sus hibridaciones y otros estilos agrícolas, coexisten tensa y conflictivamente. La transdisciplinariedad y el paradigma de la complejidad proveen elementos para abordar la MIRA integralmente. Planteamos una aproximación epistemológica que permite concebir y abordar las coexistencias, antagonismos, interacciones y posibles complementaciones entre diferentes modelos agrícolas y las complejidades emergentes desde los procesos de la MIRA. Corresponde a una aproximación de la investigación transdisciplinaria de sostenibilidad.

Esta investigación se realizó en la Cuenca del Lago Pátzcuaro (CLP), Michoacán, México. Dicha área tiene una fuerte tradición agrícola y presencia de pueblos originarios y comunidades rurales, con tenencia de la tierra principalmente ejidal, siendo la milpa el sistema de cultivo más importante. La CLP está inmersa en la globalización y la liberalización económica. Ha aumentado la agricultura industrial, principalmente monocultivo de aguacate e invernaderos de *berries* (fresa, arándanos, frambuesa y mora). Con la MIRA han emergido nuevas heterogeneidades mediante la llegada de nuevos actores, tecnologías y manejos, nuevas coexistencias entre diferentes tipos de agricultura y actores con diferentes culturas, así como también descampesinización cualitativa y cuantitativa, tensiones, problemas e impactos ambientales.

Abordamos dos comunidades campesinas de la CLP. Mediante un abordaje complejo, combinando un análisis cuantitativo del cambio de uso del suelo (CUS) y un análisis cualitativo de entrevistas semiestructuradas a profundidad, identificamos los principales cambios e impulsores de cambio relacionados con la industrialización agrícola y su expansión. Para el análisis del CUS, delimitamos una subcuenca parte de la CLP que incluye ambas comunidades. El 40,3% del área cambió de uso de suelo del año 1995 al 2021. El uso de suelo que más aumentó fue la huerta de aguacate, de 4,2 ha a 1.859,7 ha (442,79 veces). Los agricultores tradicionales resultan considerablemente afectados por la MIRA, ante lo que responden tomando diferentes trayectorias. Los análisis realizados mostraron que, entre las dos comunidades abordadas, las trayectorias campesinas han aportado más a construir adaptabilidad en la comunidad donde su

organización social comunitaria le permitió tomar una decisión y posicionamiento colectivo frente a la llegada de la agricultura industrial. Nuestros hallazgos sugieren que una organización social sólida es crucial para construir adaptabilidad y así contribuir a la sostenibilidad de comunidades campesinas y territorios rurales. Se requieren procesos colaborativos de articulación e integración de visiones, conocimientos y saberes.

Palabras claves: modernización e industrialización rural y agrícola; agricultura campesina; epistemología; complejidad; ruralidad; organización social comunitaria; adaptabilidad; cambio de uso del suelo; Cuenca del Lago Pátzcuaro, Michoacán; pueblo Purépecha

ABSTRACT

Industrial modernity is a civilizing process that is immersed in a complex labyrinth. Rural and agricultural modernization and industrialization (RAMI) and its implications have increased in recent decades, transforming the rural landscape. The agro-industrial model has impacted the forms of traditional agriculture throughout the globe. In this research, we problematize RAMI from Sustainability Science and transdisciplinarity. The RAMI processes have not been linear or unidirectional; heterogeneities, mosaics, hybridizations, new interactions, problems, and tensions between different agricultures and actors have emerged. In many rural regions, traditional and industrial agriculture, its hybridizations, and other agricultural styles coexist tensely and in conflict. Transdisciplinarity and the paradigm of complexity provide elements to address RAMI comprehensively. We posit an epistemological approach that allows us to conceive and tackle the coexistences, antagonisms, interactions, and possible complementations between different agricultural models and the emerging complexities from the RAMI processes. It corresponds to a transdisciplinary sustainability research approach.

This research was conducted in the Lake Pátzcuaro Basin (LPB), Michoacán, Mexico. This area has a strong agricultural tradition and the presence of native peoples and rural communities, with land tenure mainly ejidal, with the milpa being the most important farming system. The LPB is immersed in globalization and economic liberalization. Industrial agriculture has increased, mainly avocado monoculture and berry greenhouses (strawberries, blueberries, raspberries, and blackberries). With RAMI, new heterogeneities have emerged through the arrival of new actors, technologies, and management, new coexistence between different types of agriculture and actors with different cultures, as well as qualitative and quantitative depeasantization, tensions, problems, and environmental impacts.

We tackled two peasant communities of the LPB. Through a complex approach, by combining a qualitative analysis of in-depth semi-structured interviews and a quantitative analysis of land-use change (LUC), we identify the main changes and drivers of change related to agricultural industrialization and its expansion. For the LUC analysis, we delimited a sub-basin part of the LPB that includes both communities. 40.3% of the area changed land use from 1995 to 2021. The land use that increased the most was the avocado orchard, from 4.2 ha to 1,859.7 ha (442.79 times). Traditional farmers are significantly affected by RAMI, to which they respond by taking different trajectories. The analyzes carried out showed that, between the two communities tackled, peasant trajectories have contributed more to building adaptability in the community where their community social organization allowed it to make a collective decision and positioning facing the arrival of industrial agriculture. Our findings suggest that a sound social

organization is crucial to building adaptability and thus contributing to the sustainability of peasant communities and rural territories. Collaborative processes of articulation and integration of visions, knowledge, and know-how are required.

Keywords: rural and agricultural modernization and industrialization; peasant agriculture; epistemology; complexity; rurality; community social organization; adaptability; land-use change; Lake Pátzcuaro Basin, Michoacán; Purépecha people

CAPÍTULO 1

Introducción General

INTRODUCCIÓN GENERAL

1. Civilización Industrial, Problemática Socioambiental y Modernización e Industrialización Rural y Agrícola

En el Antropoceno, los seres humanos y sus actuaciones son la fuerza dominante en las dinámicas de transformación de los territorios y paisajes (Crutzen y Stoermer, 2000; Subercaseaux *et al*., 2020). La viabilidad a largo plazo y la sostenibilidad requieren que reduzcamos deliberadamente nuestros impactos sobre el sistema Tierra, modificando nuestro estilo de actuación (Gastó *et al*., 2012; Gaffney y Sttefen, 2017). La degradación socioambiental muestra que carecemos de la capacidad para manejar adecuadamente tal fuerza (Lubchenco, 1998) y para construir sistemas de vida sostenibles (Walker *et al*, 2004). La modernidad industrial se halla en un laberinto, con una visión imperante que rechaza otros conocimientos y prácticas, como las tradicionales, que han sido generadas durante gran parte de nuestra historia (Altieri, 1999; Toledo y Barrera-Bassols, 2008).

La globalización y las políticas neoliberales, encabezadas por las corporaciones y las políticas de liberalización económica, han producido nuevos factores de cambio y regímenes de perturbación que han transformado los ambientes de todo el mundo (di Castri, 1998; Naveh 1998). La configuración actual de los paisajes rurales emerge desde factores multinivel, tanto locales como regionales, nacionales e internacionales (Ribeiro Palacios *et al*., 2013). En este contexto, y en diferentes magnitudes, escalas y ritmos, en los ámbitos rurales ha venido ocurriendo la modernización e industrialización rural y agrícola (MIRA) (Guzmán *et al*., 2000; Toledo *et al*., 2002; Toledo y Barrera-Bassols, 2008), lo que ha transformado los procesos de vida, las comunidades humanas, los ambientes y los agroecosistemas en el mundo (Guzmán *et* al., 2000; Altieri y Toledo, 2011; Velázquez, 2019). Este proceso, en los a veces llamados países "en desarrollo" comenzó en diferentes momentos desde la década de 1950, y consistió principalmente en la incorporación de tecnología agrícola y proyectos de desarrollo agrícola / rural (Chamala, 1990). En los países latinoamericanos, se ha impulsado la producción agrícola para los mercados internacionales, a costa de las necesidades locales, los sistemas de conocimiento y las redes sociales (Ribeiro Palacios *et al*., 2013), resultando cada vez más afectadas las comunidades de pequeños agricultores (Speelman *et al*., 2014; Eakin y Lemos, 2010). Los monocultivos industriales, los cuales se han expandido, crecientemente dependen de las dinámicas del mercado global y responden a estas, ignorando las limitaciones productivas de las pequeñas granjas locales (Lambin y Meyfroidt, 2010; Ribeira Palacios *et al*., 2013). La especialización contemporánea de la producción agrícola conlleva subordinación y dependencia de los pequeños agricultores

respecto a las compañías transnacionales y pérdida de seguridad agrícola y alimentaria en los países agroexportadores (González, 2014).

El reemplazo, transición y transformación asociadas a la MIRA han desencadenado profundos efectos sociales, económicos, culturales y ecológicos (Conway y Pretty, 1991; Altieri y Rosset, 1995; Gliessman, 1997; Guzmán *et al*., 2000; Altieri y Nicholls, 2000; Toledo y Barrera-Bassols, 2008; González, 2014). Los nuevos sistemas rurales son ecológicamente inestables y pobres en diversidad biocultural (Farina, 2000), y las nuevas tecnologías generan dependencia y nuevos problemas (van der Ploeg, 2018). Ha ocurrido exclusión de millones de agricultores tradicionales de espacios territoriales, concentración de propiedad agraria, inequidad económica, destrucción de visiones de mundo y conocimientos, contaminación de suelos y agua, y modificación de procesos ecológicos a escalas local, regional y global (Toledo y Barrera-Bassols, 2008). El paisaje rural tradicional va reconfigurándose y la transición de las estrategias de subsistencia de los hogares campesinos es inevitable (Yang *et al*. 2018).

La problemática de la MIRA es relevante respecto a sus implicancias sociales y, a la vez, al conocimiento científico. Indagar en tal problemática, en sus implicaciones y las opciones de manejo, tiene importancia para la calidad de vida y el bienestar de las comunidades campesinas y los sistemas socioambientales de las regiones rurales; así también, desarrollar y plantear aproximaciones y reflexiones para abordarla y comprenderla, tiene valor para el desarrollo de conocimientos, modelos y metodologías científicas. Ante este problema social y científico resulta pertinente y valioso un abordaje integrador, tal como en la investigación transdisciplinaria de sostenibilidad (Klein *et al*., 2001; Jahn *et al*., 2012; Lang *et al*., 2012).

2. Aproximación y Abordaje desde la Ciencia de la Sostenibilidad y la Transdisciplinariedad

Los fenómenos y problemas de sostenibilidad ejemplifican la complejidad y la necesidad de integración y articulación conceptual y disciplinaria, estando constituidos por varios subproblemas que corresponden a diferentes campos y disciplinas científicas (Thompson, 2004). Se ha ido comprendiendo que para describir, entender y manejar tales problemas, son fundamentales los enfoques integrativos (Li, 2000; Toledo *et al*., 2002). Desde los años 90, muchos académicos concuerdan en que abordar los problemas sociales cruciales y de sostenibilidad requiere un enfoque transdisciplinario (Weinstein, 2010; Jahn *et al*., 2012; Lang *et al*., 2012; Ortega *et al*., 2014). Para abordar el desafío socioambiental actual se requiere evitar la fragmentación entre los elementos socioculturales y biofísicos (Ortega *et al*., 2014). Dada la reciprocidad biológica y sociocultural, nuestra interacción con el ambiente no puede entenderse sin incorporar factores socioculturales (Heras-Escribano y De Pinedo-García, 2018). La

emergencia de aproximaciones integradoras se enmarca en las grandes revoluciones científicas del siglo XX (Morin, 2000; Naveh, 2000).

Para manejar los desafíos de la problemática de la sostenibilidad, ha surgido la Ciencia de la Sostenibilidad (CS), la cual aborda las interacciones complejas entre los sistemas naturales y sociales (Kates *et al*., 2001; Clark y Dickson, 2003; Perrings 2007; Rapport, 2007; Perrings *et al*., 2011; Martín-López *et al*., 2012), considerando satisfacer las necesidades de las generaciones presentes y futuras a la vez que reducir la pobreza, conservar los sistemas de soporte de vida (Kates, 2011) y conectar el mundo científico con el político-administrativo y la ciudadanía (Martín-López *et al*., 2012). La CS y la transdisciplinariedad deben permitir la integración de diferentes disciplinas científicas y sus enfoques y conocimientos, así como fuentes científicas y no científicas (Spangenberg, 2011). Además, buscan abordar problemas sociales a la vez que científicos (Lang *et al*., 2012).

En la civilización industrial y en la ciencia, un error reiterado al estudiar los saberes locales es analizarlos buscando en su *corpus* propiedades y significantes similares a los de la ciencia contemporánea. Ello significa reducir los conocimientos tradicionales a meras extensiones o a formas incipientes del racionalismo científico (Toledo y Barrera-Bassols, 2008). El tradicional y el científico son formas de conocimiento diferentes (Bocco y Winklerprins, 2015). Así también, se intenta proteger los conocimientos y agriculturas tradicionales "*desde"* y no "*con*", es decir, desde las instituciones centralizadas y no con los actores vivos y activos en sus ambientes y territorios (Toledo y Barrera-Bassols, 2008). Es importante poner la ciencia al servicio del cuidado del conocimiento tradicional y también del contexto cultural donde tal conocimiento se desarrolla (Bocco y Winklerprins, 2015). A diferencia del modelo agroindustrial, donde los productores son recipientes pasivos de los conocimientos provenientes desde la ciencia convencional, en la investigación agroecológica y etnoecológica la investigación participativa y el dialogo de saberes son atributos centrales (Toledo y Barrera-Bassols, 2008). Es crucial la interacción directa y la comunicación bidireccional entre instituciones e investigadores académicos y las comunidades rurales (Castillo *et al*., 2005), de manera de co-construir comunidades epistémicas, en el sentido de comunidades intersubjetivas condicionadas social, histórica y espaciotemporalmente (Villoro, 2008). Las instituciones académicas debieran reconocer como parte de su misión científica el desarrollo de capacidades en las comunidades rurales, trabajando en estrecha colaboración (Castillo *et al*., 2005).

Es crucial abordar la complejidad asociada a los procesos de MIRA. El conocimiento y paradigma imperantes en los últimos siglos no incorporan adecuadamente la complejidad y la no linealidad de las relaciones naturaleza-sociedad (Martín-López *et al*., 2012). Actualmente existen varias escuelas de transdisciplinariedad y un cuerpo conceptual sólido y aplicable. La

transdisciplinariedad y el paradigma de la complejidad proveen elementos que permiten un posicionamiento epistemológico para el abordaje integral de MIRA, articulando conocimientos científicos y tradicionales, y propiciando procesos de aprendizaje mutuo, colaborativos y posibilidades de complementación y diálogos (Morin, 1990, 2004; Nicolescu, 2005, 2014; Jahn *et al*., 2012; Lang *et al*., 2012).

3. Agriculturas Tradicional e Industrial, Visión Imperante y Complejidades

A *grosso* modo, con agricultura tradicional nos referimos a una práctica agrícola que es parte de la *praxis* local, que surge y se desarrolla desde ese quehacer y el conocimiento tradicional, el cual es experiencial y se trasmite intergeneracionalmente a través del lenguaje, la observación y el hacer. Esta agricultura se realiza en unidades productivas (UPs) pequeñas y diversificadas, multifuncionales, altamente autosuficientes y basándose en recursos locales (Altieri, 1991, 1999; Altieri y Nicholls, 2000; Guzmán *et al*., 2000; Toledo *et al*., 2002; González-Jácome, 2004). Por otro lado, con agricultura industrial nos referimos a una modalidad que además de utilizar insumos externos, todo el proceso productivo ocurre en un contexto industrial que determina, al menos parcialmente, qué, y cómo se produce, y cómo y dónde se comercializa. Los modelos tradicional e industrial representan dos maneras de concebir, relacionarse y manejar la naturaleza, el ambiente y el territorio. El modelo tradicional surge desde el proceso de coevolución entre la sociedad humana y la naturaleza, originándose hace aproximadamente 11.000 años, con la integración del manejo de ecosistemas y la domesticación (Casas *et al*., 2016). En contraste, el modo industrial apareció hace apenas unos doscientos años asociada a la revolución industrial en Europa y con fundamentos desde el conocimiento científico convencional (Toledo y Barrera-Bassols, 2008). El primero funciona a pequeña escala, basado en el uso de energía solar y biológica, con altos niveles de autosuficiencia y diversidad, correspondiendo a una agricultura compleja y situada que combina una variedad de técnicas y manejos, frecuentemente aprovechando diferencias ambientales sitio específicas (Gliessman, 1990; Rojas, 1991; Altieri, 1999; Altieri y Nicholls, 2000). El industrial, en cambio, funciona a escalas mayores, presenta muy baja diversidad y autosuficiencia, y su principal fuente de energía son los combustibles fósiles (petróleo y gas) (Toledo *et al*., 2002; Toledo y Barrera-Bassols, 2008). En oposición a la visión y actitud tradicional, los agricultores industriales poseen una visión productivista y utilitaria de la naturaleza, concibiéndola separada de la sociedad y sujeta de ser controlada mediante la tecnología y ciencia contemporáneas. Tal visión se origina a partir de las aproximaciones reduccionista, mecanicista y positivista en la ciencia y el pensamiento occidental (Altieri, 1999; Toledo *et al*., 2002; Gastó *et al*., 2012).

La racionalidad y estrategia de la agricultura tradicional se caracteriza por el uso múltiple y la diversidad productiva, ecológica y biológica, en el tiempo y en el espacio (Toledo, 1993; Toledo y Barrera-Bassols, 2008; Toledo y Alarcón-Chaires, 2018). La combinación de prácticas y usos del suelo es importante para el manejo del riesgo, protegiendo a la familia campesina contra las fluctuaciones del mercado y ambientales (Toledo, 1993; Altieri y Nicholls, 2009). Esta visión tradicional ha mantenido mosaicos del paisaje durante cientos o miles de años (Toledo y Alarcón-Chaires, 2018). En muchas áreas los campesinos han desarrollado sistemas agrícolas adaptados a las condiciones locales que les permiten una producción continua necesaria para subsistir, aunque frecuentemente en situación de pobreza crónica, condicionados por situaciones de contexto y estructurales propias de las sociedades modernas (Reyes, Pérez y Moctezuma, 2018; González-Jácome, 2022).

Otro elemento central en esta agricultura es el conocimiento tradicional. Toda cultura es coterránea a una cierta naturaleza, estableciéndose una relación de reciprocidad (Nietschmann, 1992). La naturaleza sustenta a la cultura y la cultura da sentido a la naturaleza inmersa en el territorio (Toledo y Alarcón-Chaires, 2018). Mediante la interacción con su entorno y la naturaleza el humano ha desarrollado y afinado conocimientos que se encuentran en las mentes y manos de los llamados pueblos tradicionales y en especial los pueblos indígenas. Estas sabidurías situadas operan como la memoria de la especie (Toledo y Barrera-Bassols, 2008). Para lograr una comprensión coherente y completa de estos sistemas cognitivos tradicionales hay que considerar sus comportamientos y actividades concretas (Barahona, 1987; Toledo y Barrera-Bassols, 2008). La validación de este proceso de generación y transmisión de conocimiento ocurre con la *praxis* que permite sobrevivir a lo largo del tiempo sin destruir o deteriorar sus fuentes de sustento (Toledo y Barrera-Bassols, 2008). Las estrategias y conocimientos tradicionales han sido utilizados como base para nuevos estilos de desarrollo rural en África Occidental, el Sudeste de Asia (Marten, 1986), México (Toledo, 1993) y la región amazónica (Posey y Eddins, 1984).

La visión imperante en la civilización industrial tiene como único referente el esquema bipolar y simplista de los extremos de agriculturas tradicional e industrial. La modernización se percibe como necesaria, y las formas modernas o industriales de agricultura tienden a avasallar a las tradicionales, incluyendo los conocimientos respectivos (Altieri, 1999; Toledo y Barrera-Bassols, 2008; van der Ploeg, 2018). En dicha visión, el desarrollo rural es concebido como la transformación, ya sea súbita o paulatina, pero ineludible, de las formas tradicionales a formas industriales. Pero en la realidad la agricultura industrial no ha reemplazado del todo a la tradicional, sino que se han generado complejos mosaicos en el paisaje rural. Entre los dos tipos extremos de agriculturas existe una gama de estados intermedios resultantes de las diferentes combinaciones entre rasgos típicamente campesinos y los industriales, generándose mosaicos con

diferentes grados de "campesinidad" o "agroindustrialidad" (Toledo *et al*., 2002). Además, con la MIRA surgen nuevas coexistencias, como campesinos y nuevos empresarios, el tradicionalismo y la cultura moderna, y granjas pequeñas y grandes (van der Ploeg, 2018), con sus variadas tensiones e impactos socioambientales.

4. Trayectorias, Organización y Adaptabilidad Campesinas, y Sostenibilidad

Enfrentando riesgos y perturbaciones, las familias campesinas responden tomando diferentes estrategias de subsistencia (Yang *et al*., 2018). Así, ante la industrialización agrícola y situaciones que surgen, las comunidades campesinas toman diferentes caminos o trayectorias, las cuales tienen efectos o derivaciones de distintos tipos. Comprender y fortalecer la capacidad de respuesta de los campesinos y comunidades ante los factores de cambio locales y globales es crucial para el futuro de sus medios de vida (Speelman *et al*., 2014).

La defensa de un recurso o patrimonio comunitario fortalece el sentido de comunidad (Velázquez, 2019). Los usuarios de los recursos comunes se organizan exitosamente para solucionar problemas de sobreexplotación (Ostrom, 2014). Para el manejo de dichos recursos es clave desarrollar estrategias colectivas coordinadas y reglas de uso y/o manejo consensuadas (Ostrom, 1990; Merino, 2006). En el marco de la teoría de la acción colectiva se han identificado variables influyentes en la autoorganización y la resolución de dilemas en el uso de recursos comunes (Ostrom, 1990, 2014).

La capacidad de adaptación de los sistemas socioambientales puede utilizarse para estudiar las respuestas a los cambios e impulsores económicos e institucionales (Adger, 2006; Smit y Wandel, 2006), a la vez que la construcción de adaptabilidad mediante el desarrollo de estrategias adaptativas puede abordarse analizando tales respuestas. La capacidad adaptativa corresponde a la capacidad del sistema de aprender combinando experiencia y conocimiento, ajustar sus respuestas a los cambiantes factores externos y procesos internos, manteniendo ciertos procesos y a la vez desarrollándose, dentro del dominio de estabilidad del sistema en ese momento (Berkes *et al*. 2003; Carpenter y Brock 2008). Implica la capacidad de anticiparse a probables perturbaciones futuras y de reaccionar ante perturbaciones actuales (Speelman *et al*., 2014). La existencia de estructuras organizativas sociales sólidas es crucial para mejorar la capacidad de adaptación y desarrollar estrategias adaptativas a largo plazo (Ostrom, 1990; Adger, 2006; Speelman *et al*., 2014). La adaptabilidad y la resiliencia actualmente están determinadas principalmente por las actuaciones de los actores sociales respectivos y por las condiciones socioeconómicas contextuales y estructurales, siendo clave para ambas el cambio social. La resiliencia corresponde a la capacidad del sistema de cambiar ante perturbaciones manteniendo su función, estructura y retroalimentaciones, es decir, su identidad (Folke *et al*., 2010).

Se ha observado una baja capacidad de amortiguamiento y autorregulación en los sistemas alimentarios agroindustriales (Jacobi *et al*., 2018). Esto se relaciona con una producción cada vez más en función de las demandas de mercados distantes, que el sistema alimentario agroindustrial genera paisajes homogéneos y externalidades negativas como deforestación, concentración de la propiedad de la tierra y contaminación por agroquímicos (Jacobia *et al*., 2018). La resiliencia de los diferentes sistemas alimentarios está estrechamente relacionada con los apoyos otorgados por diferentes niveles gubernamentales (Blesh y Wittman, 2015). Las interacciones entre diferentes tipos de sistemas alimentarios pueden aumentar su resiliencia, por ejemplo, compartiendo insumos y subproductos, o pueden disminuirla, por ejemplo, mediante una exclusión productiva y de medios de vida (Jacobi *et al*., 2018). La resiliencia desempeña un papel fundamental en la sostenibilidad de los sistemas alimentarios (Jacobi *et al*., 2018).

La adaptabilidad y resiliencia en los sistemas complejos que entrelazan humanos-naturalezas-ambientes, posibilitan abordar explícitamente los problemas de renovación, novedad y reorganización de dichos sistemas y cómo interactúan multiescalarmente (Gunderson y Holling, 2002). Ambas son cruciales para la sostenibilidad, en especial en un contexto de alto dinamismo, interrelacionamiento e impredecibilidad.

5. Reforma Neoliberal y Tierra Campesina en México

5.1. Reforma Neoliberal Mexicana

En México, desde 1970 se han aplicado medidas en el sector agrícola en el marco de la liberalización comercial y la expansión de las políticas orientadas al mercado, como reformas para favorecer la propiedad empresarial de la tierra, eliminación de controles de precios, reducción de la inversión pública en el sector, fomento de la inversión extranjera y creciente importación de alimentos básicos (Calva *et al*., 1997; Davis, 2000; González, 2014). En el marco de la llamada "reforma neoliberal", desde la década de 1980 el gobierno aplicó políticas neoliberales promovidas por instituciones globales como el Fondo Monetario Internacional, el Banco Mundial y la Organización Mundial de Comercio. El gobierno se afilió al Acuerdo General sobre Aranceles y Comercio (GATT), firmó el Tratado de Libre Comercio de América del Norte (TLCAN) con Canadá y Estados Unidos (1994), cuyas economías y niveles de ingreso son considerablemente más altos, suscribió otros tratados comerciales con decenas de países en los hemisferios norte y sur, desmanteló muchas agencias e instituciones públicas y en 1999 cerró la Compañía Nacional de Subsistencias Populares (CONASUPO) (Davis, 2000; Eakin, 2005; González, 2014). La integración de México en la región comercial de América del Norte aumentó la vulnerabilidad alimentaria, ya que prioriza las demandas externas de alimentos por sobre las

necesidades internas (González, 2014); antes la política agrícola mexicana estaba orientada a la producción alimentaria para el mercado local (Davis, 2000). Estas medidas han sido un impulsor para la expansión de monocultivos de frutales, como aguacate, lima, mango, mora, guayaba y *berries*, reemplazando sistemas tradicionales diversos.

Otra medida importante fue la modificación del artículo 27 de la constitución mexicana, el cual regula los derechos y garantías referidos a la cuestión agraria y la tenencia y aprovechamiento de la tierra (Gómez de Silva, 2016). Con la revolución mexicana y la reforma agraria, el territorio nacional incluye propiedad privada (pequeña propiedad), propiedad pública y propiedad social (ejidos y comunidades) (Davis, 2000). Ejidos y comunidades tienen reconocimiento constitucional y protección especial de su patrimonio (RAN, 2021). Cada ejidatario o comunero tiene derecho de usufructo de una parcela, de acceso a las tierras comunales, derecho a un terreno urbano y a voto en las asambleas (Davis, 2000). Con la modificación del artículo 27 se autorizó el aprovechamiento por terceros de las tierras ejidales y comunales, la transmisión de los derechos parcelarios, la adquisición del dominio pleno y la enajenación de parcelas (Gómez de Silva, 2016).

A los pequeños agricultores, tales reformas les darían, supuestamente, libertad y flexibilidad para ajustarse como productores viables en una economía cada vez más globalizada. Pero tales beneficios no se han concretado y, en cambio, ha ocurrido una crisis económica en el sector y ha quedado en cuestionamiento su viabilidad (Davis, 2000; Eakin *et al*., 2018). Por variados caminos, como la eliminación de la organización campesina, el Estado intenta convertir en empresas capitalistas a las UPs ejidales, minifundistas y comunales, y al campesino en empresario rural, asalariado rural, o "socio" de empresas agropecuarias (Carton de Grammont, 2009). En consecuencia, las comunidades campesinas tuvieron que adecuar su economía, formas de organización y dinámicas socioculturales (González-Jácome, 2004). Pocos estudios han evaluado el impacto del nuevo contexto social, político y económico de México sobre la adaptabilidad de los agricultores y su influencia en la transformación del paisaje (Ribeiro Palacios *et al*., 2013).

5.2. Agricultura Tradicional y Propiedad Social Mexicana (ejidos y comunidades)

En pleno siglo XXI, hay en el mundo millones de pequeños agricultores tradicionales que contribuyen sustancialmente a la seguridad alimentaria a nivel local, regional, nacional y global (Altieri y Nicholls, 2009). A nivel mundial, la agricultura familiar[1] corresponde a nueve de cada

[1]Con el concepto de agricultura familiar se hace referencia a todos los tipos de modelos de producción basados en la familia en la agricultura, la silvicultura, la pesca, el pastoreo y la acuicultura, e incluye a campesinos, indígenas, comunidades tradicionales, pescadores, agricultores de las zonas de montaña, silvicultores y pastores (FAO y IFAD, 2019).

diez UPs y produce más del 80% de los alimentos (FAO, 2014; FAO e IFAD, 2019). En Latinoamérica, los productores campesinos ocupan parte importante del territorio agrícola, llegando en algunos países a superar el 60% (FAO, 2012). En México, en 2012 se estimó que el 81% de las unidades rurales económicas correspondían a la categoría de agricultura familiar y eran manejadas principalmente por campesinos y pueblos originarios (SAGARPA-FAO, 2012). Según el Registro Agrario Nacional (RAN, 2021), la superficie de propiedad social (ejidos y terrenos comunales), corresponde al 50,72% de la superficie nacional, totalizando 99,639,809 ha., sobre las que tienen derecho alrededor de 5,5 millones de personas, con un total de 32,211 núcleos agrarios: 29,800 ejidos y 2,411 comunidades (terrenos comunales).

6. Cuenca del Lago Pátzcuaro: Historia, Comunidades Campesinas y Agriculturas

La zona lacustre de Pátzcuaro ha sido una de las regiones campesinas más estudiadas del país (Toledo y Barrera-Bassols, 1984; Astier *et al.*, 2011). Las comunidades campesinas en la Cuenca del Lago Pátzcuaro (CLP) tienen una fuerte tradición agrícola, en especial en la producción de maíz criollo. La ocupación de este territorio data de la época prehispánica y se estima que se realiza agricultura desde hace aproximadamente 5000 años (Fisher *et al*., 2003). La cultura purépecha, aún con la complejidad de la relación con la sociedad moderna globalizada, mantiene parte importante de sus rasgos propios, expresado en lo lingüístico y en sus costumbres y tradiciones, sobre todo en su manera de relacionarse con el ambiente. Un ejemplo claro son sus prácticas agrícolas (Mapes *et al*., 1994).

La región del Lago Pátzcuaro presenta una población principalmente campesina, una porción de la cual es purépecha (Orozco-Ramírez y Astier, 2017). Los campesinos comúnmente mantienen UPs diversificadas y pequeñas (Orozco-Ramírez *et al*., 2017). En el año 2002, usando un índice de campesinidad-agroindustrialidad se estimó que el estado de Michoacán y la zona del Lago Pátzcuaro presentan mayor grado de campesinidad que agroindustrialidad, lo que se relaciona con la presencia de enclaves indígenas en la meseta Purépecha y la CLP (Toledo *et al*., 2002).

La CLP presenta alta heterogeneidad ambiental (Toledo y Barrera-Bassols, 1984; Mapes *et al*., 1994), poblacional y en actividades económicas. Las principales son la agricultura, ganadería, producción de artesanías y pesca (Orozco-Ramírez y Astier, 2017), además de silvicultura. Actualmente existen cuatro tipos de agricultura en la CLP: de riego, temporal, humedad, y jugo. La agricultura de riego está asociada a la industrialización agrícola y las UPs industriales. La de temporal se realiza principalmente para autosubsistencia, y la milpa es el sistema agrícola y agroforestal más frecuente (Orozco-Ramírez, *et al*., 2017).

La CLP está inserta en el contexto de la economía globalizada y liberalización económica, con la consiguiente reorientación del uso del suelo y la agricultura, pasando desde la milpa a cultivos y sistemas más comerciales e intensivos (Astier *et al*., 2011). Ha aumentado la superficie de cultivos como aguacate (Orozco-Ramírez y Astier, 2017) e invernaderos de *berries*. La importancia de la llegada y expansión de la agricultura industrial en la CLP, radica en el carácter, historia y tradición rural, agrícola, y campesina de la región, en la presencia de indígenas purépecha, así como de agroecosistemas tradicionales diversificados y en algunos casos considerados sostenibles.

La CLP y su población están expuestas a diferentes amenazas y problemas, como los siguientes (Astier *et al*., 2011; Herrera, 1999):

- Emigración y envejecimiento de la población campesina, que pueden constituirse como amenazas para el conocimiento y las prácticas tradicionales;
- Cambio de la milpa a cultivos comerciales e intensivos, propios de la agricultura industrial;
- Erosión de suelos. Causada por factores como los cambios de usos de suelo, la roza tumba y quema, la ganadería extensiva en áreas boscosas, suelos de textura ligera y pendientes pronunciadas;
- Contaminación y eutrofización. Asociada al uso excesivo de fertilizantes de síntesis por agricultura industrial y consiguiente contaminación de suelo y agua;
- Deforestación. Relacionada con el cambio de uso de suelo. Entre 1963 y 1991 la superficie arbolada se redujo a la mitad, en parte por la tala clandestina;
- Perdida del idioma purépecha, lo cual implica deterioro de identidad cultural y pérdida de conocimiento tradicional;
- Competencia desleal en los mercados locales y regionales;
- Políticas públicas inadecuadas.

7. Preguntas y Objetivos de Investigación

7.1. Preguntas de investigación

A partir de lo presentado en las secciones precedentes, la pregunta general de esta tesis es:

¿Cómo son, desde la Ciencia de la Sostenibilidad y la transdisciplinariedad, la industrialización agrícola y su expansión e implicaciones respecto a la agricultura tradicional, sostenibilidad local y las trayectorias de las comunidades campesinas en el contexto del occidente de México y particularmente en el caso de la Cuenca del Lago Pátzcuaro?

Las preguntas específicas que se abordan son:
i) ¿Qué aproximación y elementos epistemológicos permiten abordar y comprender integralmente la modernización e industrialización rural y agrícola en el contexto del occidente de México y particularmente en el caso de la Cuenca del Lago Pátzcuaro?
ii) ¿Qué trayectorias han tomado dos comunidades campesinas en la Cuenca del Lago Pátzcuaro en el occidente de México ante la industrialización agrícola y su expansión, y como se relacionan tales trayectorias con su organización social y construcción de adaptabilidad?

7.2. Objetivos

El objetivo general de esta investigación es:
Comprender, desde la Ciencia de la Sostenibilidad y la transdisciplinariedad, la industrialización agrícola y su expansión e implicaciones respecto a la agricultura tradicional, sostenibilidad local y las trayectorias de las comunidades campesinas en el contexto del occidente de México, abordando el caso de la Cuenca del Lago Pátzcuaro, Michoacán.

Los objetivos específicos son:
i) Comprender el proceso de la modernización e industrialización rural y agrícola, abordando el caso de la Cuenca del Lago Pátzcuaro en el occidente de México y su sostenibilidad y agricultura tradicional, problematizando dicho proceso y planteando una aproximación epistemológica para su abordaje integral.
ii) Analizar las trayectorias de dos comunidades campesinas en la Cuenca del Lago Pátzcuaro en el occidente de México ante la industrialización agrícola y su expansión, en el marco de sus estados actuales, organización social y construcción de capacidades adaptativas a nivel comunitario.

A continuación, se presentan concisamente los contenidos de los siguientes capítulos. En el capítulo dos se presenta la aproximación metodológica de esta investigación, es decir, como se aborda metodológicamente el problema de la MIRA y las herramientas metodológicas usadas. La complejidad de los problemas sociales, especialmente abordándolos desde la CS y la transdisciplinariedad, requiere considerar y articular diferentes aproximaciones y conocimientos. Se presentan algunos elementos centrales de la CS, y como aquello se llevó a la práctica en esta investigación, por ejemplo, con la incorporación de diferentes conocimientos, métodos y herramientas de análisis, y variados campos y disciplinas científicas y líneas de investigación. El proceso investigativo se manejó con flexibilidad, cruzándose el marco teórico con lo que fue observándose en el área de estudio y surgiendo con el trabajo de campo.

El capítulo tres, en el cual se aborda el primer objetivo específico, se titula "*Emerging Agro-Rural Complexities in Occident México: Approach from Sustainability Science and Transdisciplinarity*", y se publicó como artículo en la revista científica *Sustainability*. En este capítulo se presentan y explican la CS y la transdisciplinariedad, y se describe el proceso de la MIRA, el cual se enmarca en la civilización industrial, además de revisarse alternativas para el desarrollo rural sostenible que han surgido en diferentes lugares del mundo. Se presenta la manera como se formulan problemas de investigación en la investigación transdisciplinaria de sostenibilidad, y se plantea una aproximación y posicionamiento epistemológico desde la CS y la transdisciplinariedad para abordar integralmente la problemática de la MIRA. Lo anterior se aplica al caso de la CLP, Michoacán. Finalmente, a modo de síntesis, se reflexiona acerca de la MIRA, sus complejidades emergentes, las posibilidades que surgen con la propuesta epistemológica planteada en relación con la articulación de diferentes percepciones, visiones y conocimientos, junto a tensiones y complementaciones, así como posibilidades de co-construcción, y se sugieren preguntas relevantes.

El capítulo cuatro, en el cual se aborda el segundo objetivo específico, se titula "*Peasant trajectories facing agricultural industrialization at community level. Changes, social organization, and adaptability in Western México*", y está en proceso de envío a una revista indexada como artículo de investigación original. En este capítulo se aborda el caso de dos comunidades campesinas en la CLP, las cuales presentan características contrastantes respecto a la industrialización agrícola y la expansión de UPs industriales. Se identifican los principales cambios e impulsores de cambios relacionados con la industrialización agrícola y su expansión a través de un análisis cualitativo de entrevistas semiestructuradas a profundidad y un análisis cuantitativo del cambio de uso del suelo (CUS). Posteriormente, se identifican y analizan las trayectorias campesinas en estas comunidades ante la industrialización agrícola y su expansión, relacionándose con temas como sus organizaciones sociales comunitarias, el patrimonio campesino, y la construcción de capacidades adaptativas. Se aplica un abordaje complejo, el cual se concretiza en la combinación de métodos cualitativos y cuantitativos, el cruce entre marcos teóricos y la voz de los campesinos locales, y la flexibilidad del proceso investigativo según los temas, conceptos y reflexiones que fueron surgiendo durante su transcurso. Los hallazgos sugieren que una organización social sólida es crucial para mejorar la adaptabilidad y contribuir a la sostenibilidad en las zonas y comunidades rurales. Se muestra la relevancia de los temas que se discuten más allá del área de estudio y de México.

Por último, en el capítulo cinco de Reflexiones Finales, se desarrolla una reflexión y síntesis con base en temas, conceptos y planteamientos surgidos durante el proceso investigativo. En este capítulo final, se pone énfasis y profundiza especialmente en aquellos temas de mayor

trascendencia ante la necesaria y perentoria transición civilizatoria para la sostenibilidad rural en el contexto de nuestra época y sus particularidades. Como cierre, se presentan varios temas y preguntas que han surgido en esta investigación y respecto a los cuales este trabajo aporta orientaciones o elementos de trabajo, mostrándose así la proyección de la investigación y dando luces para futuras indagaciones.

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CAPITULO 2

Aproximación y Herramientas Metodológicas

APROXIMACIÓN Y HERRAMIENTAS METODOLÓGICAS

1. Aproximación Metodológica

Esta investigación problematiza y aborda, desde la CS y la transdisciplinariedad, la MIRA y sus implicaciones. Un elemento central de la investigación transdisciplinaria es la articulación e integración del conocimiento (Spangenberg, 2011). La CS reconoce la amplia gama de perspectivas respecto al conocimiento utilizable tanto en la ciencia como más allá de esta (Kates *et al.*, 2001). En esta investigación se combinaron y complementaron variadas fuentes de conocimiento e información, así como métodos y herramientas de análisis, incluyendo métodos de análisis cualitativo y cuantitativo, revisión y aplicación de teoría científica y análisis conceptual, trabajo de campo, sistema de información geográfica, análisis del CUS, codificación y análisis de contenido temático de entrevistas a profundidad. Se consideraron investigaciones, trabajos y experiencias de diferentes campos y disciplinas científicas, como la CS (Kates *et al*., 2001; Kates, 2011), inter y transdisciplinariedad (Klein *et al*., 2001; Nicolescu, 2005; Jahn *et al*., 2012), investigación transdisciplinaria de sostenibilidad (Lang *et al*., 2012), Paradigma de la complejidad (Morin, 1990), Filosofía de la ciencia (Kuhn, 1970), Epistemología (Röling, 2000; Morin, 2004; Nicolescu, 2014), Agroecología (Altieri, 1999; Altieri y Toledo, 2011), Agroforestería (Moreno-Calles *et al*., 2013), Estudios Campesinos (Toledo, 1993; Holt-Giménez, 2008), Sociología y Geografía Rural (Carton de Grammont, 2009; Rivera *et al*., 2018; van der Ploeg, 2018; Huttunen, 2019), Etnoecología y Etnobiología (Hunn, 2007), y Teoría de la acción colectiva y teoría de los bienes o recursos de uso común (Ostrom, 1990). Además, líneas de investigación como adaptabilidad y resiliencia (Eakin y Lemos, 2010; Speelman *et al*., 2014; Jacobi *et al*., 2018; Bocco, 2019), uso del suelo (Lambin y Meyfroidt, 2010; Morales *et al*., 2012), y medios de vida (*livelihoods*) (Ribeiro Palacios *et al*., 2013; Eakin *et al*., 2015). Así, la búsqueda y revisión de trabajos incluyó variados campos y enfoques, lo que proveyó un marco general amplio y abarcativo. Luego, para abordar cada objetivo se aplicaron de manera directa y especifica elementos, métodos y herramientas puntuales. En el capítulo 3 se plantea una aproximación y posicionamiento epistemológico para el abordaje integral de la MIRA, para lo cual se usan directa y específicamente elementos de la transdisciplinariedad y del paradigma de la complejidad; a su vez, en el capítulo 4 se realizan análisis cualitativo de entrevistas a profundidad, cuantitativo de cambio de uso del suelo, y de adaptabilidad, aplicando directa y específicamente métodos y herramientas adecuadas para tales análisis.

El proceso de investigación se abordó de manera dinámica, adaptativa y flexible (Holling, 1978), cruzando el diseño inicial de la investigación con la situación que se fue observando en el área de estudio, es decir con el problema del "mundo real", incorporándose temas y conceptos que

surgieron con el trabajo de campo. El abordaje de problemas del mundo real se ha planteado como un objetivo epistémico de la investigación transdisciplinaria (Klein *et al*., 2001; Jahn *et al*., 2012). La complejidad de los problemas sociales abordados transdisciplinariamente requiere ir más allá del dominio científico convencional (Jahn *et al*., 2012). Aquí, se vincularon el CUS (biofísico) con las entrevistas a los campesinos (percepciones, saberes y discursos locales). En el análisis cualitativo de las entrevistas a profundidad, se complementaron las codificaciones inductiva y deductiva (Saldaña, 2013); con la codificación inductiva surgieron nuevos códigos desde los discursos de los campesinos locales, los cuales se incorporaron a los códigos deductivos provenientes de los objetivos y marco teórico de la investigación. Así también, para desarrollar las discusiones y reflexiones se requirió cruzar los marcos teóricos preexistentes con las observaciones e informaciones surgidas en el transcurso de esta investigación, desde el trabajo de campo en las comunidades campesinas interactuando con los sujetos locales (campesinos y campesinas) y también desde el análisis cuantitativo del CUS. Todos estos métodos tienen valor para estudiar problemas de sostenibilidad, pero ante problemas sociales y científicos complejos y para su abordaje integral, el atributo epistémico y metodológico clave corresponde a sus cruces, vinculaciones y complementaciones.

La investigación respecto a problemas complejos de sostenibilidad requiere prácticas colaborativas entre diferentes campos y disciplinas científicas y con actores externos a la academia (Jahn *et al*., 2012; Lang *et al*., 2012). Se requiere el aporte constructivo de varias comunidades de conocimiento para incorporar el conocimiento crucial de todos los campos y actores relevantes (Funtowicz y Ravetz, 1993; Gibbons *et al*., 1994; Spangenberg, 2011; Lang *et al*., 2012). En este estudio, para articular el conocimiento fundamental respecto al problema de investigación desde las diferentes visiones y *expertises* de variados actores, se incorporaron información y conocimiento de autoridades comunitarias locales y campesinos de las comunidades abordadas (percepciones y saberes tradicionales), de investigadores académicos expertos en el tema y problema de investigación y/o en el área de estudio (opinión experta científica) y de consultores locales (experiencia en el área de estudio).

2. Herramientas Metodológicas

En los siguientes capítulos, en los cuales se abordan cada objetivo específico de esta tesis, se detallan los métodos y herramientas utilizadas para cada objetivo. A continuación, se presentan de manera general las herramientas metodológicas usadas en la investigación total:

(1) Búsqueda y revisión bibliográfica. Para desarrollar las diferentes partes y capítulos de la investigación total se revisaron variados tipos de documentos, incluyendo artículos científicos,

libros académicos, artículos de divulgación académica y no académica, tesis de distintos niveles y reportes técnicos. Esta búsqueda y revisión de documentos sirve, complementariamente con el trabajo de campo, para generar una visión general sobre el tema y problema de investigación y para obtener informaciones más específicas. Para desarrollar el capítulo 3, el cual aborda el primer objetivo específico, se realizó una revisión bibliográfica rigurosa de literatura científica estableciéndose términos de búsqueda según el objetivo y preguntas de dicho capitulo.

(2) Trabajo de campo.

(2.A) Salidas de campo en la CLP, comunidades campesinas y UPs. Esto para el acercamiento y conocimiento del área de estudio, obtener información preliminar y seleccionar las comunidades campesinas colaborativas a abordar. Una vez seleccionadas las dos comunidades abordadas, se tuvo un primer encuentro y conversación con el comisariado ejidal de cada comunidad, quien es la máxima autoridad local en temas del ejido, agricultura y bosque. En esa ocasión, se le presentó el proyecto, las actividades que se realizarían en la comunidad, se le solicitó su autorización para aquello, y se platicaron asuntos prácticos para la realización de entrevistas y las dudas que surgieron durante el dialogo. Además, se acordó cuando comenzar con la realización de las entrevistas a profundidad.

(2.B) Reuniones con investigadores académicos expertos en temas de la investigación y/o en la CLP, consultores locales, autoridades comunitarias y campesinos de las dos comunidades seleccionadas.

(2.C) Entrevistas semiestructuradas a profundidad con campesinos de las dos comunidades seleccionadas. Se realizaron 19 entrevistas en noviembre de 2019 y en agosto-septiembre de 2021. Se implementó el método de "bola de nieve" (Straus y Corbin, 2002), y se estableció el tamaño de la muestra según la saturación o redundancia de información (Bogdan y Biklen, 1982; Cantrell, 1996).

(3) Análisis de capacidad adaptativa. Para desarrollar el capítulo 4 se efectuó un análisis de capacidad adaptativa, examinando si las trayectorias campesinas han contribuido a construir adaptabilidad en las comunidades seleccionadas. Con base en los marcos conceptuales y metodológicos usados por Speelman *et al*., 2014 y Barthfield *et al*., 2015, se estableció si cada una de las trayectorias campesinas identificadas en las dos comunidades seleccionadas corresponden a estrategias adaptativas o no.

(4) Análisis cuantitativo del CUS. Para desarrollar el capítulo 4 se realizó un análisis del CUS, para lo cual se estudió una subcuenca parte de la cuenca del lado Pátzcuaro la cual incluye a las dos comunidades seleccionadas. Se consideraron los años 1995 y 2021.

(5) Análisis cualitativo de las entrevistas semiestructuradas a profundidad. Para desarrollar el capítulo 4 se analizaron las entrevistas mediante un análisis de contenido temático (Joffe, 2012), utilizando la técnica de codificación deductiva e inductiva (Saldaña, 2013) con el software Atlasti 9 (Friese, 2019).

Finalmente, luego de la obtención del grado de Doctor en Ciencias de la Sostenibilidad se compartirán los resultados y reflexiones logradas en esta investigación en las comunidades campesinas abordadas, lo cual corresponde a un elemento constitutivo del proceso investigativo transdisciplinario.

En la figura 1 se muestran las etapas y herramientas metodológicas implementadas en la investigación total y en cada objetivo específico, y se explican los entrecruzamientos y complementaciones metodológicas.

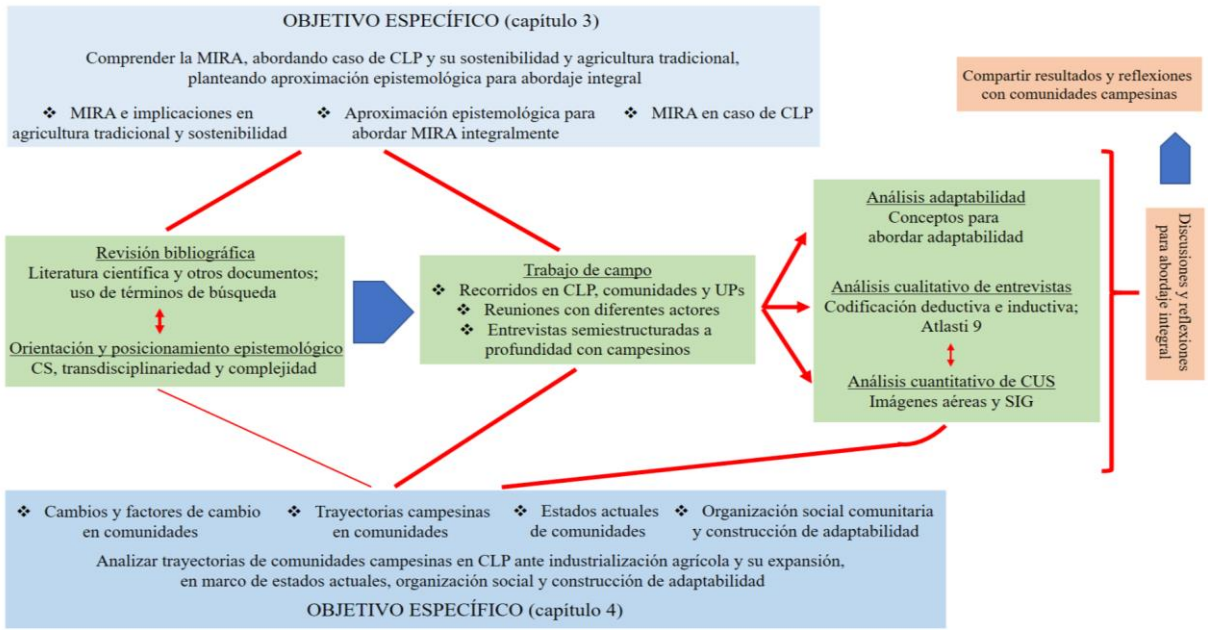

Figura 1. Vínculos entre las etapas y herramientas metodológicas de la investigación total, y los dos objetivos específicos y sus temas centrales. La aproximación metodológica para abordar el problema de investigación fue compleja, utilizándose y combinándose diferentes métodos y herramientas. En la figura, las líneas y flechas más gruesas muestran los vínculos más fuertes y las más delgadas los más débiles. Así, la revisión bibliográfica usando términos de búsqueda y la orientación y posicionamiento epistemológico son parte central del abordaje del objetivo específico al cual se da respuesta en el capítulo 3; a su vez, los análisis de adaptabilidad, de las entrevistas y del CUS son parte central de la metodología del objetivo específico al cual se da respuesta en el capítulo 4. El trabajo de campo es central para ambos objetivos específicos y para todos los análisis. Aunque cronológicamente algunas

herramientas se implementaron primero que otras, todas las partes, métodos y herramientas se interrelacionaron y complementaron, lo que contribuyó para generar una imagen total del problema y desarrollar las discusiones, planteamientos y reflexiones logradas. La literatura, antecedentes y reuniones proveyeron conceptos y orientaciones bases e iniciales, lo cual se cruzó con la aproximación y posicionamiento epistemológico para definir desde donde y como abordar el problema; la información de las entrevistas ayudaron a definir las clases de uso de suelo para el análisis cuantitativo de CUS; dicho análisis de CUS permitió discutir y complementar ciertas percepciones campesinas locales; y desde los discursos campesinos y su análisis surgieron temas relevantes para las discusiones y reflexiones para abordar integralmente las situaciones en las comunidades campesinas seleccionadas. Consiguientemente, el proceso y el abordaje y aproximación metodológica fueron recursivas.

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CAPÍTULO 3

Emerging Agro-Rural Complexities in Occident México:
Approach from Sustainability Science and Transdisciplinarity

Lo que observamos no es la naturaleza en sí misma,
sino la naturaleza expuesta a nuestro método de cuestionamiento
WERNER HEISENBERG - FÍSICO ALEMÁN

Porque de las imágenes contrarias surge la esencia de la contradicción
RAMÓN MARTÍNEZ OCARANZA - POETA MEXICANO

El cosmos se componía de fuerzas opuestas y complementarias … Las fuerzas se necesitaban entre sí,
ya que al encontrarse daban lugar al movimiento, como el sol que desplaza a la oscuridad y a la luna,
para morir al atardecer, dando lugar de nueva cuenta a la noche;
o la temporada de lluvias que lleva a la de secas
TEMPLO MAYOR MEXICA

La evolución ya no es considerada una lucha competitiva por la existencia, sino una danza cooperativa
en la cual la creatividad y el surgimiento constante de lo nuevo son las fuerzas impulsoras
FRITJOF CAPRA - FÍSICO Y TEÓRICO DE SISTEMAS AUSTRIACO

sustainability

MDPI

Review

Emerging Agro-Rural Complexities in Occident Mexico: Approach from Sustainability Science and Transdisciplinarity

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Abstract: Rural and agricultural modernization and industrialization (RAMI) increased in recent decades in a multiscalar way. RAMI has implied the rural landscape transformation through the arrival of industrial models. These processes have not been linear or unidirectional; heterogeneities, opposites, mosaics, hybridizations, new interactions, problems, and tensions, between traditional and industrial agriculture and other agriculture types, have emerged. We tackle and problematized the RAMI processes, which is a complex and a real-world problem, from Sustainability Science (SS) and transdisciplinarity. Thus, considering studies and experiences in different rural areas in the world, an epistemological positioning is presented, which allows overcoming scientific frontiers and relating it to rural sustainability. We delve into the Lake Pátzcuaro Basin (LPB), Mexico, an area with a strong agricultural tradition ("milpa" systems). Recently, the presence of industrial agriculture (mainly avocado monoculture and berry greenhouses) has increased, occurring the coexistence between peasant-entrepreneurs, indigenous–non-indigenous, and new-rural. The article aims to understand comprehensively the emerging complexities from the RAMI, deepening LPB's real case. The epistemological approach developed allow us to conceive the interaction and possible complementation between traditional agriculture, industrial agriculture and other agriculture types, and the emergence of an included middle that corresponds to an "emerging complexity". Finally, relevant topics and questions are highlighted.

Keywords: rural and agricultural modernization and industrialization; peasant agriculture; industrial agriculture; rurality; traditional knowledge; epistemology; complexity; Lake Pátzcuaro Basin;Michoacán; Purépecha people

Citation: Subercaseaux, D.; Moreno-Calles, A.I.; Astier, M.; de Jesús Hernández L., J. Emerging Agro-Rural Complexities in Occident Mexico: Approach from Sustainability Science and Transdisciplinarity. *Sustainability* **2021**, *13*, 3257. https://doi.org/10.3390/su13063257

Academic Editor: Anastasios Michailidis

Received: 19 January 2021
Accepted: 13 March 2021
Published: 16 March 2021

1. Introduction

In recent decades, industrial civilization has reached a global dimension, which affects all aspects of life [1]. The current environmental degradation derives mainly from the values and practices of this civilization [2]. We have transgressed four of the nine planetary boundaries, the critical processes that regulate the Earth System's functioning (climate change, biosphere integrity, biogeochemical cycles, and land-system change) being able to trigger abrupt and non-linear environmental changes on continental to planetary scale [3,4]. Sustainability Science (SS) has emerged as academic response to this challenge. SS recognize the limitations of conventional scientific knowledge to address the complex relationships between social and natural systems [5–9], seeking to link scientific and non-scientific

knowledge with action to address the current persistent socio-ecological crisis and promote paths for the continuity of life [9].

Globalization and neoliberal policies have promoted agricultural production for international markets at the expense of local needs, marginalizing rural activities for self- sufficiency, typical of traditional agriculture [10]. Small farmers are affected by the local impacts of these international market dynamics [11,12]. There has been a trend towards the industrialization of agriculture [1,13,14] and expansion of agricultural territories [15]. Monocultures landscape dominate some areas previously management with diversified traditional agriculture [16,17]. Industrial agriculture causes environmental deterioration, reducing ecological, and biocultural diversity, influencing the people's relationships with environments, impacting the ways of life and well-being of local communities and the multifunctionality of landscape [10,18].

Currently in the world there are millions of small traditional farmers [19]; family farming produces more than 80% of food [20]. The main authors in fields such as agroecology and agroforestry recognize in traditional systems the principles that they postulate for sustainability [13,21–23]. The prevailing vision in industrial civilization rejects the traditional knowledge and practices generated during most human history [1]. This vision, simplistic and not very adaptive to local contexts [24,25], conceives rural development as a transformation, sudden or gradual, from traditional to industrial modalities [26]. However, in practice, such a modernization process has not been so simple or merely one-way, andnew heterogeneities, problems, and complexities have emerged at different scales. From SS is possible addressing this comprehensively.

For this kind of problems, a fundamental approach from SS is transdisciplinarity [8,27].It addresses the complexity and challenges the fragmentation of knowledge [28–30], characterized by its hybrid nature, non-linearity and transcending academic disciplinarity [31], adapting to local contexts [5,28,29] and frequently oriented to real-world problems [9,32,33]. Transdisciplinarity implies intercommunicative action, with transdisciplinary knowledge because of intersubjectivity, emphasizing the importance of incorporating different perspectives and perceptions, which are key characteristics of complex systems [28,34]. People who inhabit a place tend to have different views and perceive different elements, problems, or priorities [35] on multiple nested scales [36]. These points are relevant for defining the problem, what constitutes a solution, and legitimate knowledge [35].

This paper addresses the real case of the Lake Pátzcuaro Basin (LPB), Michoacán, Mexico. This area, with a strong agricultural tradition, is inserted in the context of the globalization and economic liberalization, being exposed to the reorientation of land usetowards industrial agriculture [37,38]. The article aims to understand comprehensively the emerging complexities from the rural and agricultural modernization and industrialization (RAMI), concerning traditional agriculture and sustainability, proposing an epistemological positioning for that and deepening LPB's real case. Research questions: (1) What epistemological approach, positioning, and elements, allow to comprehensively address RAMI and emerging complexities? (2) What implications do RAMI, and such emerging complexities, have for sustainability and traditional agriculture? (3) How has RAMI happened in the LPB's real case, and which complexities, implications and concrete effects have emerged? Thus, this study contributes mainly to (1) an epistemological approach which, incorporating elements of transdisciplinarity and the paradigm of complexity (axioms of levels of reality and perception and of the included middle, and dialectics), and thus integrating different knowledge, visions, and actions, allows to perceive and incorporate the coexistences and interactions between opposites (as traditional and industrial agricultures) and hybridizations (incorporations of industrial agriculture' traits in traditional productive units (Pus)), possible complementations and tensions between different types of agriculture, and finally the emerging complexities, thus addressing RAMI in an comprehensive way; (2) a synthesis of studies and experiences in different rural areas in the world related to RAMI; and (3) the application of the epistemological approach and the synthesis of studies and experiences in the real-world case of LPB, considering its cultural, social, political, and environmental particularities and complexities.

2. Methods

A central element and challenge of transdisciplinary research is knowledge articulationand integration [27] (see Section 3), so in this study we have sought to complement differentknowledge and information sources, from different sectors and actors (local community authorities and peasants, academic researchers' experts, and local consultants) related to the research topic and problem, and different cases and experiences. Research, works and experiences from different fields of knowledge and scientific disciplines were considered, mainly SS, Inter and Transdisciplinarity, Complexity Paradigm, Philosophy of Science and Epistemology, Agroecology, Agroforestry, Peasant Studies, Rural Sociology, Rural Geography, Ethnoecology and Ethnobiology, and Land Use Studies.

[1**]** A bibliographic search was conducted, in order to collect antecedents on the re- search topic and problem. This documentary research provides inputs to achieve a vision on the state of that topic. The ScienceDirect database was used, and the following search terms: "modernization of rurality" (10); "modernization of rural areas" (35); "modernization of agriculture" (46); "industrialization of rurality" (8); "modernization of rural areas" (71); "industrialization of agriculture" (55); "modernization of rurality +/AND sustainability" (0); "modernization of agriculture +/AND sustainability" (10); "industrialization of rurality +/AND sustainability" (0/0); "industrialization of agriculture +/AND sustainability" (10); "industrial agriculture +/AND traditional agriculture" (3); "industrial agriculture +/AND peasant agriculture" (0); "industrial agriculture +/AND Patzcuaro" (0); "; "Patzcuaro +/AND sustainability" (3); Patzcuaro" (34). The search was conducted in both English and Spanish. The search terms were related to both traditional agriculture and industrial agriculture, in order to include both positions regarding the research topic and problem.

[2**]** Field work and meetings were carried out that consisted of:

(a) field trips in LPB, peasant communities and Pus;

(b) meetings with academic researchers' experts on the topics of the article and LPB, local consultants, and local community authorities and peasants, specifically of the communities San Francisco Uricho y San Miguel Nocutzepo;

(c) semi-structured interviews with peasants. The purpose of those different meetings was incorporate and articulate essential knowledge from all relevant actors related to the problem, which is key to complex sustainability problems: expert opinion (academicresearchers'), local experience from the study area (local consultants), and local perception and traditional knowledge (local communities' authorities and peasants). The field trips were made for direct observation of the phenomenon and the study area. The interviewswere carried out to acquire knowledge about the social reality in the study area based oninformation that only a person (subject) can provide us, in addition to learning about events that cannot be observed directly. This information was used in the section about LPB.

In addition, other activities contributed to developing the research and the reflections and proposals that are presented here, including congresses, meetings and discussions, and other studies. These instances include: Congress "The Transdiscipline Made Practice" (Valdivia, Chile, 2016), Course "Tools for Transdisciplinary Research" (Morelia, Mexico, 2018), Course "Sustainability assessment in rural and urban environments" (Morelia, Mexico, 2019), "III World Congress of Transdisciplinary" (online/Mexico City, 2020–2021); Project "Family and social agriculture and agroforestry in contexts of local and global changes" (Morelia, Mexico, 2020). In addition, various studies related to the topic of this article carried out in the LPB and different rural areas of Mexico and Chile. All these activities have allowed enriching the epistemological approach and positioning and the reflections and conclusions that are developed in this article.

3. Epistemological Approach and Positioning: Sustainability Science, Transdisciplinarity, and Rural and Agricultural Modernization and Industrialization

3.1. RAMI from SS and Transdisciplinarity

According to Kuhn [39], scientific progress operates by changing our perspective and perception rather than accumulating knowledge. One of the great scientific revolutions of the 20th century was the emergence of approaches and posits that involve multidisciplinary restructuring [40]. Moving from fragmentation towards integration and complementarity of the parts [41,42], recognizing the need for a comprehensive and contextual vision and the articulation of uncertainties [41,43,44]. Correspondence between our thinking and the world's and nature complexity is necessary [30].

The SS is recognized as a consolidated field of research to address global societies' complex problems [5,8,45–47]. The SS encourages the integration of different fields and disciplines and their approaches [27], connecting the scientific world with the world of citizenship and the political–administrative world [9]. There is an agreement that sustainability challenges require new knowledge production and decision-making [8]. Among what SS will need to do is the following: (1) span the range of spatial scales between such diverse phenomena as economic globalization and local farming practice; (2) deal with functional complexity of environmental degradation resulting from multiple stresses; (3) recognize the wide range of outlooks regarding with knowledge usable within both science and society [5].

Since the 1990s, there has been a growing call for transdisciplinary approaches to address crucial societal challenges, especially those related to sustainability [8,48,49]. SS is considered a transdisciplinary science rather than a discipline for sustainability [27]; indeed, transdisciplinary research is a key attribute in SS. SS is a problem-driven and solution-oriented field, so transdisciplinary research is a promising option. One of its goals is to bridge the gap between solving real-world or societal problems and scientific innovation [8]. A conceptual and methodological framework in transdisciplinarity facilitates integrating different knowledge bodies that participate in the research process [8]. Integration is the main cognitive challenge of transdisciplinary [49].

The 2000 conference "Transdisciplinarity: joint problem solving between science, technology, and society" [50] referred to the approach to real-world problems as an epistemic goal of transdisciplinary research [49]. The complexity of a societal problem requires to go beyond the exclusive domain of scientific experience [49]. Therefore, research practices that focus on collaborations between scientific of different disciplines and actors from outside academia, are crucial [8,27]. Some critical arguments for this type of research are: (1) Research on complex sustainability problems requires the constructive input of various knowledge communities to incorporate essential knowledge from all relevant disciplines and actors related to the situation, as well as to reconcile values and preferences; (2) Collaboration between researchers and other actors promises to increase legitimacy and accountability regarding the problem and the solution options [8,27,51,52]. It is necessary to establish mutual learning processes between the different scientific researchers and non-academic actors [8,49]. Mutual learning is a fundamental principle of transdisciplinarity [53].

In addition to being oriented to real-world problems, transdisciplinary research is appropriate both for the requirements associated with such problems as well as SS goals as a scientific field [8]. Therefore, transdisciplinary research in general and SS in particular, can be considered an "interface practice" since they integrate two ways to approach their problems: the exploration of new options to solve societal issues and the development of approaches, methods, and knowledge related to the scientific question [8]. So then, in transdisciplinary sustainability research addresses social or real-world problems which also are of interest to that scientific field.

RAMI and its social, environmental, and regarding with sustainability implications correspond to a complex situation, requiring integrating and the contribution of knowledge from different scientific fields and other perspectives and experiences, including traditional knowledge. A complex and transdisciplinary approach requires incorporating traditional perception and experience, in this case of peasant communities, to foster collaboration between researchers and local actors and mutual learning processes. Furthermore, it is a real-world or societal problem and at the same time one of scientific interest, which as has been said, is one of the distinctive characteristics of addressing problems in transdisciplinary sustainability research [8,9,32,33,49]. This problem includes strictly social aspects, such as local insecurity and resource hoarding by actors external to the communities [54]. RAMI and its impacts on sustainability are for the interests of various social sectors such as environmentalists, agrarian policymakers, social leaders, extension workers, and agricultural workers [55]. A complex and transdisciplinary approach allows addressing this societal problem and contributing to the development of scientific knowledge. In addition, the scientific literature has identified the evaluation of the sustainability of different development pathways as a central theme for the SS [46], and the study of RAMI and its effects on local sustainability are relevant on this regard.

3.2. Axioms of Transdisciplinarity and Dialectics

Transdisciplinarity is aimed to building bridges and articulating different fields of knowledge [28,40]. There are several schools of Transdisciplinarity; Klein [56] has referred to the discourse of transcendence, the problem-solving discourse, and the discourse of transgression. Nicolescu [57] has differentiated between the phenomenological Transdisciplinarity of Gibbons and Nowotny, the theoretical one of Nicolescu, Piaget, and Morin, and the experimental one; and schools such as Mode 2 Science [52], Post-normal Science [51], and the proposal of the Zurich International Conference on Transdisciplinarity [50] can be recognized. Below, we presented elements of transdisciplinarity and the paradigm of complexity [42,57,58], which allow us an epistemological positioning in the face of the problems of RAMI, for its comprehensive approach.

Nicolescu [57,59] posit three axioms of transdisciplinarity: the ontological, the logical, and the one of complexity. The first is related to the levels of reality and perception. By "level of reality" is designated a set of systems that are invariable under specific general laws (in natural systems) and general rules and norms (in social networks). Transdisciplinarity extends its action through various levels of reality [30]. According to Nicolescu, these different reality levels are accessible to our knowledge due to the different levels of perception that are potentially present in our being. These, in turn, allow a unifying and encompassing vision of reality, requiring a correspondence between the levels of perception of the observing subject and the levels of reality of the observed object [57,59].

The logical axiom: the included middle. Quantum physics has led us, in theory and scientific experiment, to verify the coexistence of pairs of opposites, such as wave and corpuscle, local and global causality [57,59]. However, our mental habits, scientific or not, still tend to be governed by classical Aristotelian logic that does not tolerate contradictions [57,59]. Morin [42,60] has emphasized that at the heart of the paradigm of complexity is the dialectical confrontation of contradiction. It is necessary to move toa logic of the included middle that allows coherently unifying different levels of reality and perception, and elements that initially may seem merely antagonistic [30]. *Contraria sunt complementa* was the motto of the Nobel Prize in Physics Niels Bohr: opposites as complements that converge without losing their identities [30].

The axioms of transdisciplinarity presented, and the dialectic, permit a comprehensive vision, allowing the integration of different knowledge fields and overcoming disciplinary and scientific boundaries. This approach also allows conceiving and proposing the coexistence and unification of elements that initially may seem merely antagonistic, such as industrial and traditional agriculture. The latter is the result of a historical coevolutionary process between humans and their environments, which results in complex traditional environmental knowledge [1,61,62] and highly diverse agriculture [1,19,21,63,64]. With modernization, new heterogeneities and interactions arise between traditional and industrial agriculture and other types of agriculture, which through this approach can be viewedand approached as opposite and at the same time complementary.

4. Traditional Agricultures: Particularities, Their Knowledge and Contrasts with Industrial Agriculture

In Mesoamerica, complex and millenary agriculture emerged based on manual labor, with little few animals' domestication, which resulted in a set of management techniques and strategies, such as the domestication of plants, construction of terraces to conserve humidity and expand the surface of cultivation, irrigation, annual polycultures, plant rotation, among others [65]. Another interesting strategy is that each PU cultivated scattered lands, located in areas with different characteristics of soil, humidity, or topography, which can be interpreted to manage risks and take advantage of microenvironmental differences [65], and as a sample of socio-environmental complexity.

Agriculture arises based on a gradual accumulation of ecological knowledge about local diversity, with the management of ecosystems and domestication [66,67], developing through the generation and transmission of said knowledge and with the adoption and adaptation of technical innovations in various areas of the world, including Mexico. Thus, arises the so-called "traditional agriculture" [66]. Every culture is related to nature and the local environment, establishing a mutual and complex adaptation relationship [68,69]. This relationship is diverse in cultures that inhabit a territory for extended periods (tens, hundreds, or thousands of years) since they generally develop knowledge and sophisticated management strategies to avoid the rapid decline of natural resources and optimize their renewability [25,63,65,70]. Modernization and industrialization have modified the relationship between peasant communities and their environments [69].

To carry out the diverse environmental interactions, traditional peoples and peasants have required an appropriate cognitive system, since a corpus of knowledge always corresponds to each praxis. Traditional knowledge is comprehensive and holistic, encompassing various thematic fields [71–73]. It is valuable to explore this repertoire of perceptions, symbols, and concepts of traditional peoples and peasant's cognitive structure since such knowledge systems have been necessary for human survival, are adaptive and built based on local realities and experiences in the real-world [1,61,62]. That correspond to a legacy of the historical process of humanization of nature and the human's naturalization [64]. The product of this process is currently in the minds and hands of traditional peoples, especially in indigenous communities [1,74]. This knowledge is threatened by industrial civilization, which rejects traditional life forms [1].

Traditional agriculture contributes substantially to food security at the local, regional, and national levels [1,19,21] and its agroecosystems present a high diversity and adaptive capacity to changes social, economic, and environmental [19,21,63,75], achieving theabove under marginal conditions and with a low use of external inputs of industrial origin [76]. Peasant rationality presents a "multiple use strategy", which has been widely documented [64,77,78].

Traditional and industrial agriculture have different objectives and contrasting traits: (1) type of energy used during production; (2) scale of productive activities; (3) degree of self-sufficiency of the PU; (4) level of the labor force; (5) level of diversity (ecological, productive, and biological) maintained during production; (6) level of environmental (energy) productivity; (7) level of labor productivity; (8) type of knowledge used during production; (9) worldview associated with productive rationality [26,79]; and (10) consumption and commercialization. As one progresses from traditional agriculture to industrial agriculture, in general the following transition occurs with respect to each one of the ten contrasting traits: (1) energy, from solar and biological energy to fossil; (2) scale, from a scale manage- able by the members of a peasant family, to larger PU sizes, in ha. or in animal heads; (3) self-sufficiency, reduces self-sufficiency, considering food, productive, genetic, and financial self-sufficiency; (4) labor force, from family and occasionally community labor force, to the use and need of external and paid wages; (5) diversity, decrease in diversity, considering ecological or ecogeographic, productive, and biological diversity; (6) energy productivity, decreases considerably with agricultural industrialization; that is, energy efficiency is lost in the total process [80–82]; (7) labor productivity, increases with agricultural industrialization, that is, efficiency is gained, increasing the yield for each hour or day of work of each day; (8) commercialization and consumption, it goes from self-consumption and commercialization in the community itself or in nearby communities, to commercialization on a regional, national and/or international scale [16]; (9) knowledge, from a knowledge that the peasant has regarding nature and the local environment, holistic and experiential, to a specialized, exogenous and standardized, usually requiring external technical advice; (10) worldview, it is passed from a vision in which nature, and its elements and processes, appear as living entities with which or within which human beings interact and with whom it is necessary to dialogue during the production process, to a materialistic, productivist, and pragmatic vision that conceives of nature as an entity separate from society to be manipulated by modern technology and scientific research. This differentiation concerning worldview is clearer in those peasant communities that belong to original people's culture, and it tends to weaken in those communities acculturated by modernity [26]. This can be applied at the PU scale or regional or other territorial unit scale.

Between the types of traditional and industrial agriculture, there is a range of intermediate states that are the result of the different combinations between typically traditional or peasant traits and industrial ones at PU scale, mixed traditional/industrial farming systems, hybridizations. In other words, different moments in the process by which modernizing mechanisms transform the traditional way into one industrial, and at regional or basin scale mosaics with different degrees of "peasantinity" or "agro-industriality" can be observed [26]. Different types of agriculture emerge that coexist and interact, making it necessary to consider such complexity to understand the future of rural and

agriculture. From these multiscale hybridizations, mosaics, and interactions, emerge tensions, and different types implications, and thus a complex whole is formed. With RAMI an equilibrium or static state or situation does not emerge in rural areas, but one dynamic and far-from-equilibrium, result of processes that are not linear, as will be seen with thedevelopment of this article.

5. Rural and Agricultural Modernization and Industrialization

5.1. Modernization and Industrialization Processes

The modernization of agriculture is part of industrial civilization [83]. In developing countries, such a process began mainly from the 1950s [13]. Previously in Mexico, a program began in 1941 between the Ministry of Agriculture and Livestock and the Rockefeller Foundation, which later was called the Green Revolution and whose starting points were [66]: (1) experimentation and application of innovations of American agricultural sciences; (2) generation of knowledge for the specific situation in Mexico; (3) preparation of Mexican professionals; and (4) analysis of the agricultural economic situation in Mexico.

Agricultural intensification has spread widely in developing countries in recent decades [13,84]. The modernization of agriculture in such countries consists mainly in the incorporation of agricultural technology and in agricultural/rural development strategies and projects [55]. This complex process is influenced by internal forces in each country and by external mega-forces. Among the internal forces are demographic pressure, political system, research and extension policies and programs, agroclimatic conditions, and historical experience. Among the external mega-forces are international trade, international agricultural research centers, international organizations for the development of agriculture, and bilateral aid from developed countries [55]. In Mexico, the introduction and adoption of the agro-industrial model was a complex process in which various actors participated, teaching and experimentation institutions, and extension and financing programs were founded [63].

A central idea was that the modernization of traditional agriculture, including production, processing, storage, and marketing, was considered a sine qua non of the prosperity of developing countries [85]. Modernization is associated with the notion that traditional agriculture and peasants were backward, not very productive, that multifunctional PUs were something of the past, and modern agriculture was perceived as the only way to feed the world [66,85]. This modernization implied depeasantization [86] and was perceived as part of the natural order of "progress" [85]. The PUs had to specialize in the production of a single product [13], and peasant agriculture had to give way to another type of agriculture much less autonomous, based, and dependent on external resources (technology, seeds, agrochemicals, and capital), instead of being based mainly on resources produced and reproduced in the PU itself [13,21].

Agricultural modernization was a manifestation of changes that had been germinating for some decades in the agricultural sciences, and it was outlined by intellectuals who helped design it [85], it was an externally devised and gestated process. European agricultural modernization was the laboratory that shaped the Green Revolutions and Programs for Integrated Rural Development in most of the Global South. In Latin American countries, in recent decades, globalization and neoliberal policies have fostered agricultural production for international markets at the expense of local needs [10], and small farmer communities are increasingly seen more and more affected by the local impacts of the dynamics of such a market [11,12]. In Mexico, since the 1980s, the State's agricultural policy has focused on farmers with larger properties and more market potential [87], impacting the viability of small producers, who have frequently been forced to seek other means of life [86,88].

The initial methodologies in agricultural modernization presented a series of short-comings and biases, such as a top-down approach, without any sociological basis or understanding of the community structure, of small farmers [25] or land tenure. Research was conducted in irrigated crops and high-potential regions that were already endowed with infrastructure, and research and extension on dryland crops was neglected, as was research on polycultures [25]. Soil and water conservation studies were conducted only after degradation was a serious problem; indigenous knowledge about biological control and other management was not thoroughly examined; there was no integrated rural development approach, with little coordination between different areas, such as agriculture, animal production, irrigation, or education; little NGO participation in agricultural projects; in some countries large projects were emphasized, which accelerated environmental deterioration and human displacement [55].

The modernization of agriculture has intrinsic and self-generated limits, which has led to new agricultural crises [85]. For a long-term reduction of rural poverty, the modernization of traditional agriculture can contribute, but is insufficient in itself [89]. Furthermore, entrepreneurship within the framework of agricultural modernization was far from a "free" praxis. The agricultural "entrepreneur" is obliged to implement practices prescribed by scientists, policy makers, bankers, and the agro-industrial complex. New technologies create dependency: they solve specific problems, but also create new ones that, in turn, require additional technologies, repeating the same cycle. These new technologies, to be economically viable, must be applied at scales that frequently involve investment in agricultural expansion and credit [85]. The use of the best farmland in agricultural modernization gave great results in the short term with respect to agricultural yields, but in the long term the reality was different, and some yields decreased [13]. Although the results of the green revolution initially produced some euphoria [66], the modernization of agriculture through technological intensification has been severely criticized since the 1970s [25,55]. In Mexico, the modernization process implied controversies and oppositions on the part of various actors, motivating interesting debates about the convenience or not of the agro-industrial model in the country and its foreseeable consequences [63].

Gradually, it became clear that the focus on intensive food production had failed to deliver the expected benefits for the development of rural areas. Only when the green revolution produced significant social and environmental impacts did agricultural policymakers, researchers, extensionists, administrators, and people in the environmental movement question total reliance on agricultural technology and demanded that human well-being and environmental protection should be at the fore central to sustainable agricultural development [55].

5.2. Industrialization Process and Implications

Industrial agriculture, gradually replacing or transforming traditional agriculture and rural landscape in different ways and degrees, has unleashed profound social, economic, cultural, and ecological impacts, for example, on soil, atmosphere, water, genetic resources, wildlife, ecosystems at different scales, impacts on humans at level of people, communities, and societies, on traditional knowledge and world views, and on sustainability, since all the dimensions and scales of such impacts are constitutive of the sustainability problem. These impacts have been described and analyzed by numerous researchers (see [1,13,14,21,90–92]). According to González [16], the modern specialization of agricultural production in the industrial model entails: (1) adopting a mode of agriculture that degrades regional and local natural and human resources; (2) subordinate local producers to the intervention of transnational companies and foreign government agencies that cooperate with national governments, increasing the dependence of these local producers; and (3) harm to domestic consumers regarding access to a diet that is sufficient, healthy, and culturally acceptable.

The new scenario created to optimize crop quality and agricultural and economic productivity is characterized by extensive monocultural fields in which most natural patterns, such as geomorphology, drainage network, forest mosaic, buffer zones, and ecosystem processes have been simplified [70]. Regarding traditional agriculture, there is a loss of multiple use of resources and ecological and biological diversity [13], observing a low adaptive capacity and resilience of industrial agroecosystems [75], of buffering, and self-regulation in agro-industrial food systems [92] and threatened food security [21].

The degrading effect on peasant communities includes the breakdown of the form of social and ecological coevolution that the peasantry had maintained through their historical ways of managing natural resources [13,93]. A subjugation occurs, not only of agriculture models, but also of life styles and conditions, with land grabbing by entrepreneurs and/or agricultural investors and the exclusion of peasants and indigenous people from their lands and key resources for their traditions, worldview, lifestyles, and well-being, thus becoming precarious their living conditions [54]. On the other hand, several authors have highlighted that with agricultural modernization, the development of PUs does not imply the prosperity of rural regions [83,94,95], that is, a disconnect has been generated between development at the PU level and rural development at the regional level.

6. New Pathways for Sustainable Rural Development and Emerging Complexities

The predominance of industrial agriculture and its scientific base is not functional in the face of hunger and sustainability problems [21,96,97]. The conventional approach to increasing the food supply, given the perception of "successful" in the recent past, suggests a rejuvenation of the agribusiness model of the last century [98]. The above would result in agricultural intensification and expansion ("new productivism"), especially in Mexico (exporting country) [97]. In contrast, prosperity in rural contexts is increasingly understood as multidimensional, and people seek to reconcile economic parameters with social and environmental well-being [95]. Implies that economic efficiency at the PU level and economic growth at the regional level is not adequate indicators of farmers well- being. Large specialized and capital-intensive PUs are less and less the ideal agricultural model [95].

In contrast to agricultural modernization, there is evidence of alternative farming and rural developments, often leading to more sustainable farm production and rural areas [83]. The literature describes practices that seek greater sustainability, labeled as low-input agriculture, agroforestry systems, polyculture agriculture, natural agriculture, permaculture, regenerative agriculture, agroecology [96,97]. On different continents, there are examples of culturally, socio-economically, and ecologically integrated agricultural systems in communities, more resistant to external threats and globalization, which con- tribute to environmental care and improve productivity [97]. The agricultural matrix at the landscape level is key to addressing, simultaneously, the food crisis and the biodiversity crisis; there is a growing consensus among ecologists that metapopulations, metacommunities, and landscape processes are determinants for biodiversity [96]. Likewise, emerging agri-food networks are platforms where farmers and consumers innovate and seek alternative development models, which be laboratories for social change and prosperity in rural areas [95]. Diversity and multifunctional are crucial. The latter allows PUs to contribute to rural areas' social and environmental sustainability [83,99]. The most diverse PUs in many regions is connected with cultural landscapes and mosaics that have an emotional and aesthetic value for the local residents [100].

Horlings and Marsden [97] emphasize that for the other rural and agricultural developments and initiatives to be a real alternative to the prevailing industrial model, it is required that sustainable agri-food networks be expanded, integrated, and supported through new and innovative institutional and market arrangements, with the participation of farmers and consumers, and with a regionally integrated and place-based eco-economy. These authors highlight elements corresponding to the dimensions: (1) economic: agrifood network, comprehensive approach to food production, added value at PU level; (2) technological: technological generation as a demand-driven and spatially sensitive process;
(3) ecological: agroecological principles, flexible and adaptable to local ecosystems; (4) socio-cultural: autonomy, human-nature synergy, demand-driven research; (5) spatial: locally integrated into the community, use of local resources; (6) politics: participatory approaches, influence of communities in agri-food networks, local institutional actors) [97]. These findings are frequently not reflected in rural policy, which often remains oriented towards an entirely commercial PU ideal, treating other PU types as obstacles to productivist agriculture [95].

The transition and transformation from traditional agriculture to industrial agriculture is complex and multidimensional. With the modernization process, a series of supposed dichotomies were generated, such as the dichotomy between peasants and new entrepreneurs, between the laggards and the first to modernize, between traditionalism and modern culture, between small and large PUs, to mention only some [85]. Further- more, this modernization has implied depeasantization [85,86,101] and in some regions repeasantization, the emergence of "new peasants," "peasants of the 21st century," and neo-ruralities [83,85,101]. Such depeasantization and repeasantization are quantitative (decrease or increase in peasant farmers and peasant PUs) and qualitative (change in the type of agriculture, becoming more or less peasant or industrial) [85]. The repeasantization process includes agriculture based on local natural resources, with soil fertility as a crucial element; a return to mixed PU (polyculture and animal husbandry), and participation in newly built local markets [83,101]. In Mesoamerica, the "Peasant to Peasant" movement (PTPM) works for sustainable agriculture led by peasants, based on the transmission of traditional agriculture knowledge and techniques from, by, and to the peasants themselves [102].

These processes of depeasantization and repeasantization, and different types of agriculture, apparently dichotomous and contrary, can coexist and even feed each other. Although in the modernization project there was the notion that history could only move in the direction of the traditional to the modern, from the peasants to the entrepreneurs [85], in practice, it has not been unidirectional. Instead, coexistences and mosaics have been generated between traditional and industrial agriculture and different types of agriculture [21,26], in the context of dynamic situations and non-linear processes. Farmers who base their production on local resources and agroecological techniques, that is, they continue to operate in a traditional form of agriculture, others with a commercial orientation that use and depend on external inputs and links with international markets, other cases of intermediate states, and different types of agriculture, coexist in a same region [21].

Jacobi et al. [92] analyzed the interaction between agro-industrial food systems and local and agroecological food systems in Bolivia and Kenya. This interaction can increase the buffering capacity against disturbances, for example, by sharing inputs and by-products in periods of drought. On the other hand, such interaction and its intensification can decrease resilience, exacerbate externalities, and impact food sustainability. The spatial and economic expansion of

agro-industrial food systems can cause productive and livelihoodexclusion of small farmers, and local and regional effects such as deforestation, competition for water resources, concentration of land ownership, low generation of employment, health impacts, increased carbon footprint, decreased energy efficiency and increased non- reusable waste [92]. Hogeland [103] studied the response of agricultural cooperatives to theindustrialization of agriculture in the United States in the 20th century, which challengedthe primacy of family farming by disseminating a competitive production model based on vertical integration. Decisions commonly made by family farmers, such as what to produce, where, when, and for what market, were co-opted by the corporate hierarchy. He showed that with cooperatives as a facilitating or connecting actor between both, family agriculture can be better linked to industrial agriculture.

In Latin America, an interesting case is the PTPM. The strength of the PTPM is its ability to generate agroecological knowledge in a horizontal and decentralized way. ThePTPM continues to achieve success in developing and extending sustainable agricultural practices in the field, among other achievements, thus consolidating itself, mainly in Mesoamerica [102]. However, the joint work of the PTPM and the NGOs' has achieved little impact in the political context. The Green Revolution transformed Mesoamerica's fields in a couple of decades, precisely because it linked governments, research institutions, banks, development agencies, and producer associations in a joint effort at agricultural modernization. The PTPM works with NGOs, government development projects, research institutions, farmers' unions, also with local churches and religious groups, parent–teacher associations, and local governments, but has not played a coordinating role, and all that has been done has certainly not penetrated policies or other institutional spheres [102]. Multi-actor interaction and coordination, knowledge complementation, and mutual learning processes, are essential. For rural and agricultural sustainability, the articulated action of different sectors and social actors is required: the purposely adoption of technologies, managements and practices by farmers, the support of the government, and also NGOs, universities and research centers, consumers, among others.

Koopmans et al. [94] explored multi-actor approaches to rural and environmental governance. Based on empirical evidence from eleven case studies in a variety of national and regional contexts, they distinguished five governance strategies faced with the challenge of reconnecting agricultural modernization and sustainable rural development: (1) integrating diverse land-use interests; (2) sustainable farmers reconnecting with consumers; (3) cooperation between farmers in quality production and along the food chain; (4) resource-efficient agriculture; and (5) self-governance for smaller PUs. Some difficulties in developing these new forms of governance have been that certain local actors accept responsibilities that traditionally belonged to the government, the peer pressure that participating farmers may experience, incoherent policies, poorly directed or coordinated from different government departments, and levels of bureaucracy. New governance approaches must be developed with vertical and horizontal coordination to foster synergies between PUs modernization and sustainable rural development, strengthening multi-sector and multi-actor links [94].

To overcome the supposed dichotomies that arose with modernization, it is necessary to integrate the different types of development and agriculture. The interconnections between these different types of agriculture, actors, and PUs are critical. In some cases, adapting to local particularities and with the necessary participatory and dialogue processes, combine and integrate some aspects of both traditional and industrial PUs, it maybe convenient for rural and agricultural sustainability. For example, traditional PUs can benefit from industrial elements in storage, processing, and distribution. Huttunen [83] studied different processes of agricultural modernization and rural development in the Nordic context, observing connections between PUs of different types of agriculture at regional scale, which are produced through various exchange practices, such as buying, contracting, hiring, sharing, bartering, co-ownership, and exchange of work, with inter- twining of elements such as materials and skills associated with agricultural practices at PU scale. PUs creates marketing and exchange opportunities with each other, which tend to be, at least partially, not market-based; for example, product and job exchanges related to animal feeding, cultivation, and the use of machinery [83]. In the Finnish case, for example, current rural development is characterized by the co-production of food and other rural products and services in PU of different types of agriculture. All types of PU play different roles in cooperation and reciprocal relationships, generating a complex networkof interconnected agricultural practices at the regional scale. In these types of situations, it is appropriate to characterize rural development as a co-production resulting from the interconnection between different types of agriculture [83]. The process of modernization at regional scale relates to the agricultural practices at PU scale and the processes there,such as the incorporation of elements of industrial agriculture in previously traditional systems and the resulting hybridization of the PU. The interactions and certain exchanges between PUs can promote hybridizations at that scale, for example, exchanges of machinery, technologies, practices, knowledge, and skills. This is how the arrival and operation of industrial models in rural areas affects in regard with RAMI, triggering, promoting, and materializing such modernizing processes.

Through the interconnections between PUs and actors that practice different types of agriculture, the supposed dichotomy is no longer such. Instead, these different PUs and actors are part of the same total system and the same process of regional rural development.This allows conceiving certain alignment between the agricultural modernization project with a more sustainable rural development [83]. Good examples along these lines include the role of cooperative approaches and agricultural cooperatives in the transition to a more sustainable agri-food system and opportunities for diversification

[104], the role of agricultural modernization in agreements of environmental and rural governance that contribute to regional sustainable rural development [94], and the contribution of multi-actor governance in aligning agricultural modernization at the PU level with sustainable rural development, fostering synergies between both [94]. The total process is multiscale, connecting and interacting processes at PU scale (such as hybridizations) and at regional scale (such as mosaics and interconnections between PUs from different types of agriculture). To visualize this possibility of sustainable rural development and possible complementarities more than mere dichotomies, a holistic, transdisciplinary, and complex approach is fundamental. Thus, it is a reconceptualization of rural and agricultural modernization.

7. Lake Pátzcuaro Basin Case

7.1. Characterization of the LPB, Its People and Agriculture

The LPB is in the State of Michoacán, in western Mexico. Approximately 81% of its surface corresponds to the municipalities of Pátzcuaro, Tzintzuntzan, Quiroga, and Erongarícuaro (Figure 1). The basin has an area of around 100,000 ha [37]. Geographically it is located between 19°25′–19°45′ N and 101°25′–101°54′ W [105], and its altitude ranges from 2040 to 3400 masl [37]. It is an endorheic basin [106]. The climate is temperate subhumid, with most of the rainfall in summer and an annual rainfall of 1010 mm. The average yearly temperature is 16.9 °C, with a minimum of 8.0 °C and a maximum of 25.7 °C [107]. There are eight soil types: andosol, luvisol, lithosol, acrisol, gleysol, rankers, vertisol, and feozem. Most of them are young soils, highly susceptible to erosion [108].

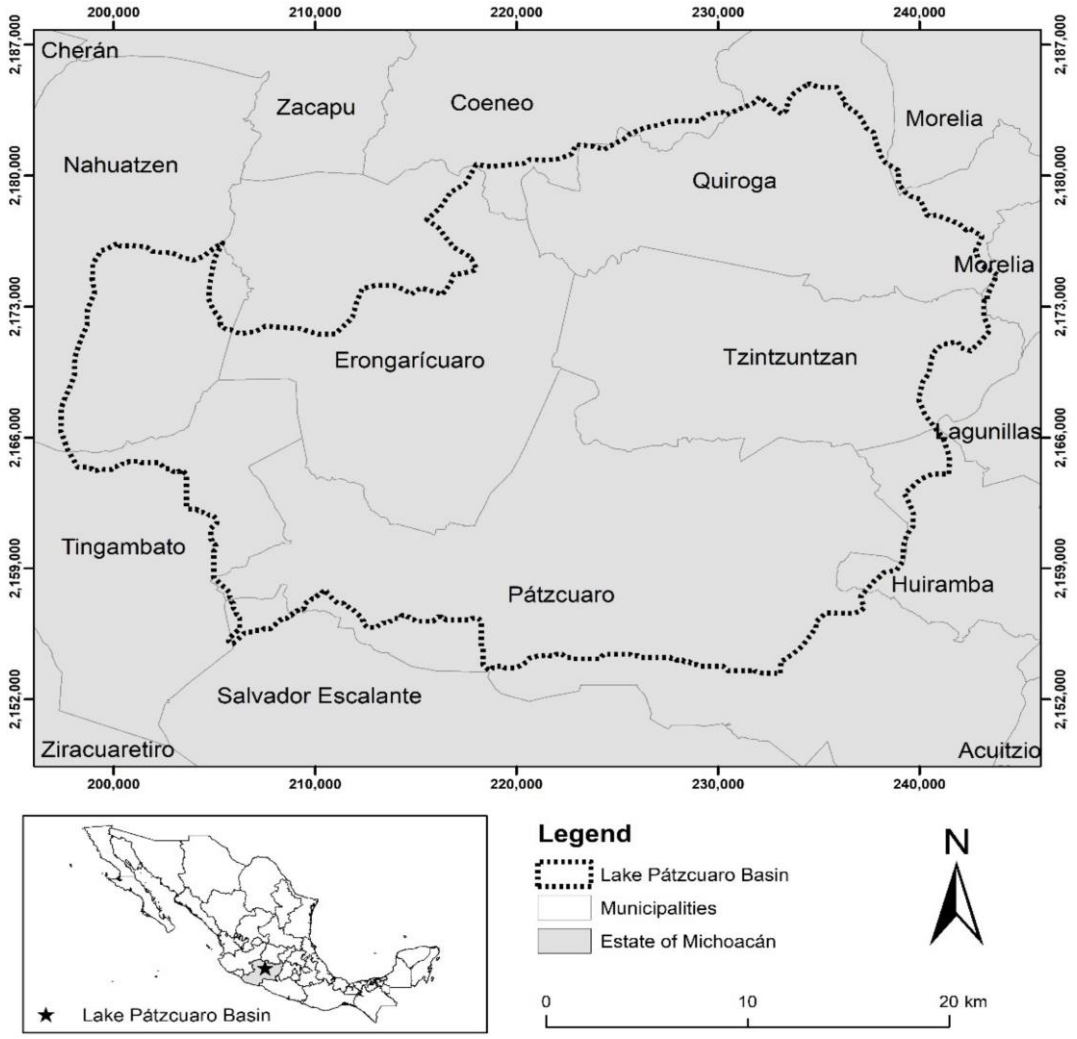

Figure 1. Lake Pátzcuaro Basin (LPB) in the State of Michoacán, Mexico, its delimitation, and the corresponding municipalities.

The LPB population is mainly peasant, distributed in more than 100 human settlements that include small *rancherías*, communities of 500–3000 inhabitants, intermediate settlements, and colonial origin cities [109,110]. LPB is part of the Purépecha region, the demographic and territorial majority ethnic group in Michoacán [37,109]. Original people represent 20% of the total population of the region [111]. Basin population includes migrants from other areas of Mexico, including large urban centers.

The main economic activities are agriculture, livestock, forestry, crafts, and fishing [37], with agriculture as the most usual way of transforming the landscape from natural to cultural [112]. The communities in the LPB have a strong agricultural tradition, especially in the production of maize. Peasants had practice agriculture for approximately 5000 years [113], commonly maintain small and diversified PUs (usually < 5 ha) [37]. They employ family labor and produce goods for self-sufficiency, such as crops, livestock, forest products, and commercialization [38]. In recent decades, most farmers use pesticides, chemical fertilizers, and machinery [114]. Maize is the most important crop [17,37]. Most of the peasants obtain their seeds from growing or from local neighbors for growing maize. Peasants cultivate "*milpa*", a system typical of Mexican traditional agriculture, combining maize with beans, squash, and chilacayote [38].

LPB is highly heterogeneous (Figure 2). Six maize races exist in the basin: conical, purépecha, western maize, chalqueño, tabloncillo, cacahuacintle, and four other lessfrequent races [37,38]. This high variability is the product of the interaction between biophysical and cultural heterogeneity [115]. Toledo and Barrera-Bassols [109] reported ten types of vegetation, high soil heterogeneity (9 major types, 13 subtypes, and morethan 20 edaphic associations), and 12 types of agricultural systems [109]. Considering temporality, water, topography, and geographical distribution, Mapes et al. [112] distinguished 14 agricultural landscapes in LPB: temporary humidity agriculture; temporary rain agriculture without modification of the terrain; seasonal rain agriculture with terraces; uncontrolled spring irrigation agriculture; controlled spring irrigation agriculture; manual lake watering agriculture with bucket; manual lake flooding agriculture with a scoop; agriculture irrigation of the lake or wells mechanized with pumps; mechanized lake irrigation agriculture with waterwheel; juice agriculture; mountain arboriculture; riverbank arboriculture; solar or backyard in high areas; solar or backyard on the shore.In the LPB, irrigation, moisture, juice or riverine, and seasonal (rain-fed), agriculture is practiced, each associated with specific edaphoclimatic conditions present in different basin areas (Figure 3). The latter, which uses rainwater, is currently the most important, with the milpa being the most frequent agricultural and agroforestry system [17].

Figure 2. The LPB is highly heterogeneous, considering its variety of human settlements, landscape forms, historical sites, and types of agriculture, with their corresponding management and products. (A) A part of the CLP, seen from its south side, with some of the 9 islands present in the lake. In the foreground is Janitzio Island, where several pre-Hispanic traditions of the Purépecha culture are maintained. (B) The town of the peasant community of Arocutin, with approximately 572 inhabitants, in the municipality of Erongaricuaro. (C) Milpa, an agricultural system typical of traditional Mexican agriculture, which in this region usually combining maize with beans, squash, and chilacayote. In the image there are peasants in the San Andrés Tziróndaro community working the land with a yoke of oxen or horses, a typical tool of traditional agriculture. (D) Products from the milpa in the San Francisco Uricho peasant community.

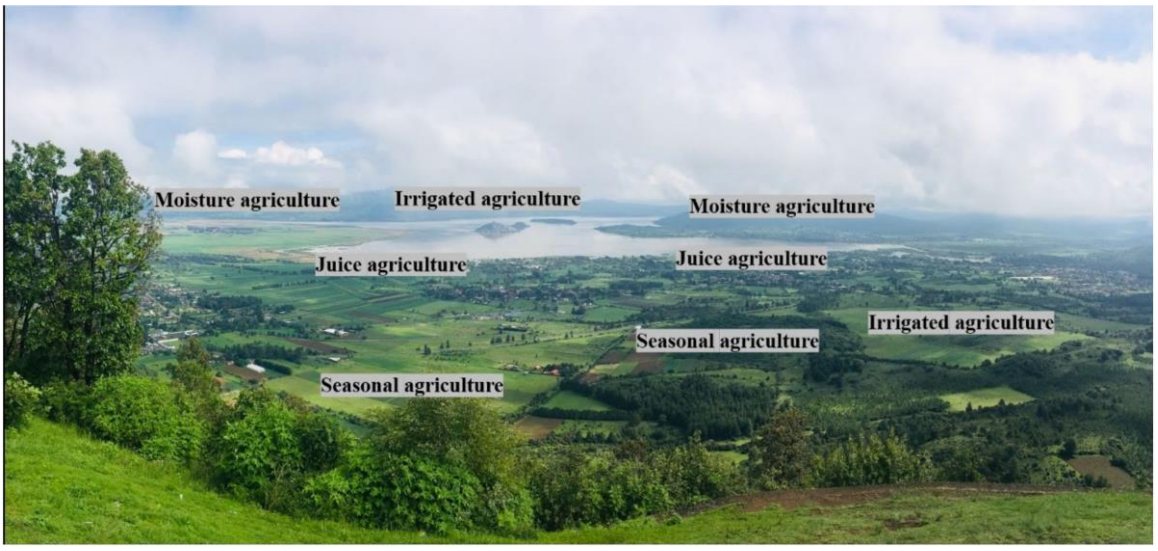

Figure 3. Agriculture, frequently as agriculture–cattle–forest systems, is the main activity transforming the landscape in LPB. The figure shows the four types of agriculture in the basin: irrigation, juice or riverine, moisture, and seasonal (rain-fed), and the locations in the basin: irrigated agriculture in different parts of the altitude gradient of the basin, in luvisol soils; juice agriculture in always humid lands on the shore of the lake (2040–2060 masl), in vertisol soils; moisture agriculture on slopes mainly in the upper part of the basin (2040–2800 masl), in andosol soils; and seasonal or rain-fed agriculture mainly at the piedmont and in the plain (2040–2800 masl), in acrisol and litosol soils [17,38,112]. The latter is currently the main one; it takes advantage of rainwater, and it is carried out mainly for self-subsistence. The milpa is the most frequent agricultural and agroforestry system [17]. Each of these types of agriculture is associated with specific edaphoclimatic conditions, taking advantage of the geoform, the availability of humidity, and the properties of the different soil types present in the LPB. There are eight soil types: andosol, luvisol, lithosol, acrisol, gleysol, rankers, vertisol, and feozem.

7.2. Traditional Agriculture and Neoliberal Reform: The Context of RAMI in Mexico, Michoacán,and the LPB

Since 1970, and especially since the second half of the 1980s, Mexico has undergone a series of changes in its agricultural sector because of trade liberalization and policies oriented to the international market, within the frame of the so-called neoliberal reform,with TLCAN and domestic agricultural reforms [16,116–118]. One of the main drivers of agricultural land use in Mexico is the international market [88]. These policies have created favorable conditions for developing extractive industries with transnational capital in territories rich in natural resources, which coincide with areas historically occupied byindigenous peoples [54]. Neoliberal policies have affected mestizo and indigenous communities, modifying not only environments but also social actors and customs, traditional social dynamics disappearing and new ones emerging [119].

Mexican policy for more than three decades has promoted an agro-export specialization in the Mexican countryside, at the cost of the weakening of traditional agriculture and causing a high food dependency of the country, concentration of wealth, and social and environmental impacts [119]. Before the 1980s, Mexican agricultural policy was oriented towards the production of food for the local market; later, the economic policy adopted by the State sought to promote the competitiveness of agricultural products, focusing on farmers with larger properties and greater commercial potential [87]. The idea of subsidized peasants was abandoned by public policy [120]. These policies led to a crisis in the traditional farmers sector [117,118], having impacts on their livelihoods, traditional economics, land use, and Mexican rural ecosystems [10,54], leaving the viability of this sector in question [88,117]. This process of industrialization of agriculture and its effectsoccurs at different scales, manifesting itself in different ways in the PU, in the communities and on a regional scale. Faced with these impacts, traditional farmers have responded in different ways, either by expanding their lands, diversifying their activities off the farm, migrating, or incorporating new technologies [117,118].

In the State of Michoacán, the Federal Government has promoted the agro-export model [54], increasing the areas planted with fruit trees for exports and advancing land grabbing and accumulation due to dispossession by actors external to the communities [54,119]. Some areas that had traditional polyculture landscapes are now dominated by fruit monocultures. This expansion of export agriculture implies a loss of food security for national and local consumers as well as of agrobiodiversity [17].

Michoacán is the main avocado producer and exporter at the national level [119,121], the expansion of this crop being linked to the modernization projects of the State, and measures have been applied that have promoted it in recent decades, such as preferential credits, low-cost inputs, among others [54]. Avocado production in Michoacán usually implies high use of external inputs, cutting-edge technologies, high income, concentration of capital, and various socio-environmental impacts [119,122]. The expansion of avocado implies a productive reconversion of the field to the detriment of the production of basic grains, displacing or subordinating peasant production [119]. The avocado area increased from 13,045 ha in 1974 to 153,018 ha in 2011, showing exponential growth in that period [123]. This growth has occurred on the lands of Purépecha communities [119], developing an agro-export enclave economy in the Purépecha Plateau [54].

In the LPB, within the context of the modernizing project of the State and the Mexican neoliberal reform, and the associated agricultural reforms, also the industrialization of agriculture has been promoted [37]. Since the 1970s, traditional agriculture has been incorporating traits of industrial agriculture. Many of the peasants have incorporated into their PU elements such as the use of mechanized machinery with fossil energy, agrochemicals, industrial feed for livestock, improved seeds and/or livestock, financial support from the government, and some have planted non-creole avocados on peasant lands replacing milpa. These incorporations and the resultant hybridizations have implications on the operation of the PU, and finally on its sustainability. Table 1 shows the traits and the variables corresponding to each trait that have been industrialized, the specific hybridization that has occurred, and its implication on PU's functioning.

The arrival of PUs of industrial agriculture to the LPB begins in this century; indeed, Toledo et al. [26] do not mention this region among the industrial agriculture poles of the State of Michoacán. Like other regions of Mexico, the LPB is exposed to the land use change from milpa to commercial crops [38]. In recent years, through the purchase and lease of land, there has been an increase in the area with industrial agriculture in the basin, with avocado (*Persea americana*) [37] and other intensively produced crops, such as blackberries (*Rubus* sp.), strawberries (*Fragaria x ananassa*), blueberries (*Vaccinium* sp.), raspberry (*Rubus idaeus L.*), tomato (*Solanum lycopersicum*) and potatoes (*Solanum tuberosum*), also producing hybrid maize from other regions. According to a study carried out by Cumana [106] about the land-use change in the LPB in the period 2004–2014, the agricultural area increased 7.14%, with forest being one of the lands uses partially replaced by agriculture. Considering the climatic requirements of avocado [124], it can be assumed that this crop replaced the forest area in the LPB [106]. Land-use change for avocado production has taken place at the expense of mainly native pine and oak forests, and also milpa [122], and berries greenhouses are located mainly in the basin plain, so they directly use land suitable for milpa. Table 2 shows the avocado surfaces in the municipalities of Pátzcuaro, Erongarícuaro, Quiroga and Tzintzuntzan between the years 2003 and 2018. In these four municipalities, which cover 81% of the total surface of LPB, there was a considerable increase in the avocado area, increasing 133 times in the case of Pátzcuaro, 42 in Erongarícuaro, 43 in Quiroga, and 11 times in Tzintzuntzan; additionally, in the four municipalities the total of the avocado area in 2018 was conventional production (non-organic), and the total was Hass variety, which is usually destined for export or to large urban centers [121].

Table 1. Traits and variables that have been industrialized at the productive units (PUs) scale in the LPB within the context of the Mexican State's modernization Project, the specific incorporations and hybridizations that have occurred, and its implication on the PU's operation.

Traits and Variables	Incorporations and Hybridizations	Implications
Energy Variables: Productive energy Domestic energy	Incorporation of tractors, heavy machinery, agrochemicals, industrial feed for livestock. Use of gas in domestic work.	Increase the use of fossil (non-renewable) energy and other inputs external to the system.
Self-sufficiency Variables: Productive self-sufficiency Genetic self-sufficiency Financial self-sufficiency	Incorporation of agrochemicals, industrial feed for livestock, improved seeds and/or livestock, dependence on financial support (credit and insurance).	Decreases the self-sufficiency of the system.
Diversity Variables: Productive diversity	Avocado plantation on peasant lands, replacing milpa and forest.	Decreases the diversity of the system.
Energy productivity	Incorporation of tractors, agrochemicals, improved seeds.	Decreases the productivity or energy efficiency of the system.
Work productivity	Incorporation of tractors and heavy machinery.	Increases the productivity or efficiency of work of the system.

Table 2. Avocado surfaces in Pátzcuaro, Erongarícuaro, Quiroga, and Tzintzuntzan, in the LPB, between the years 2003 and 2018 (Source: [121]).

Municipality	Area Planted with Avocado (ha)															
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Pátzcuaro	8	40	50	40	60	140	180	128	305	197	197	211	228	256	786	1063
Erongarícuaro	16	0	42	71	79	82	250	255	540	455	477	485	514	590	632	670
Quiroga	5	5	0	0	0	20	0	20	105	65	65	73	90	150	193	213
Tzintzuntzan	5	5	5	5	6.5	10.5	10.5	10	12	14	14	17	25	45	48	54

7.3. Traditional Agriculture—Industrial Agriculture and Emerging Complexities in the LPB

Based on the contrasting traits between traditional and industrial agriculture presented above, Toledo et al. [26] applied an index that estimates the degree of peasant-agro-industriality, corresponding 0 to high peasantness and 1 to high agro-industriality. After analyzing the 113 municipalities of the state, Michoacán obtained a value of 0.43, placing itself in a position towards the peasant. This inclination towards the traditional is related in part to enclaves of original people in the Las Cañadas area, the Nahua portion of the Michoacán coast, the Purépecha Plateau and the LPB. The three municipalities that the index revealed as the most traditional are precisely those of the Purépecha Plateau and the LPB: Charapan, Nahuatzen, and Tzintzuntzan [26]. Eighteen years after this work, the current state of the situation is not exactly known.

The LPB is culturally and environmentally complex. It is heterogeneous in population and economic activities; peasant communities share the same space with cities with population speaking and non-speaking Purépecha language, and different economic activities and land uses coexist in the landscape [37,112]. Different types of agriculture are practiced associated with different environmental conditions. There are communities more agricultural and others more forest, there are some with a larger population of native peoples than others, there are some with larger environmental heterogeneity. The arrival of a new type of agriculture, industrial agriculture, with new actors, technologies, and management, implies new heterogeneity in the LPB. Different degrees of presence and incidence of industrial agriculture are observed in the basin. While in some communities its presence is already noticeable in the landscape, such as in San Miguel Nocutzepo, Santa María Huiramangaro, Erongarícuaro, San Juan Tumbio, or Estacion Ajuno, in other communities it is practically absent, as in San Francisco Uricho, San Andrés Tziróndaro, San Jerónimo or Santa Fe de la Laguna.

The particularities of the LPB, especially its heterogeneity, its rural and agricultural character, and the way in which industrial agriculture has arrived and expanded, coexisting with traditional agriculture [122], is leading to the emergence of various interactions, mosaics, and hybridizations. The region still shows a predominantly traditional character, with agriculture being carried out mainly by peasants in small PUs [17,37], with a tendency to increase industrial

agriculture. Different types of agriculture coexist in the basin, and in the same community. Large and industrial growers imply technologies and managements as greater amount and the latest technologies for fertilization, irrigation, pest and disease control, higher frequency of cutting herbaceous plants, large greenhouses, post-harvest management, and a strong cooling and packing industry [122,125], all this coexisting with more traditional PUs and managements. Different actors also coexist, such as peasant-entrepreneurs, indigenous–non-indigenous, with their cultural contrasts. Quantitative and qualitative depeasantization has occurred in the basin. For some decades, peasants have been incorporating characteristic elements of industrial agriculture, such as the use of agrochemicals, tractors, and fossil energy, resulting in hybridizations, which corresponds to qualitative depeasantization, and more recently, industrial farmers have arrived in thebasin [37,38], which corresponds to quantitative depeasantization.

Industrial agriculture is causing impacts: (1) deforestation due to the replacement of forest by avocado orchards; (2) water pollution and competition for water resources; (3) eutrophication; (4) soil erosion and possible contamination by agrochemicals; (5) re- placement of crops of cultural and nutritional importance; (6) increased greenhouse gas emissions [38,122]; (7) exclusion of spaces that were of free movement in the peasant communities; and (8) feeling of local insecurity in the face of new, external and unknown actors. In addition to such impacts, certain connections occur between industrial PUs and traditional PUs: (1) employment of labor. Some members of peasant families who worked in their own traditional PU, now go on to work as wage earners in industrial agriculture, usually as seasonal workers in avocado orchards or berry greenhouses, or combining work in both types of agriculture, occurring some work hybridization; (2) purchase of peasant land by industrial farmers or investors. For now, there are no connections between both that imply the exchange of materials or equipment, knowledge and skills, or co-ownership. On the other hand, in the basin there is little organizational innovation by local actors to strengthen traditional agricultural production, innovating in commercialization and exchange opportunities, including some not-market based. Examples of this would be self-managed local fairs, coordination and agreements between organized farmers and consumers, new forms of diffusion using new technologies to attract other buyers and tourists, cooperation between farmers from different communities, combine crop production with offering traditional dishes at fairs or local kitchens, selling product baskets, among others. A planning and management culture of local authorities that seeks to establish dialoguesand partnerships with local communities, and develop new forms of coordination, is key [83]. Table 3 shows a synthesis of the emerging effects with the arrival and increase of industrial agriculture in the LPB and the respective expressions and concretions.

Table 3. Emerging effects with rural and agricultural modernization and industrialization (RAMI) and the arrival and increase of industrial agriculture in the LPB, and their expressions and concretions.

Effect	Expressions and Concretions in LPB
New heterogeneity	➢ New actors ➢ New technologies ➢ New management and practices
New coexistences	➢ Between different types of agriculture, and their technologies and management ➢ Between different actor, as ✓ peasant-entrepreneurs ✓ original–non-original people
Qualitative and quantitative and depeasantization	➢ Peasants have been incorporating elements characteristic of industrial agriculture (qualitative) ➢ Industrial farmers and PUs have arrived to the basin (quantitative)
Main impacts of industrial agriculture	➢ Deforestation ➢ Water pollution and competition for water resources ➢ Eutrophication ➢ Soil erosion and possible contamination by agrochemicals ➢ Replacement of crops of cultural and nutritional importance ➢ Increased greenhouse gas emissions ➢ Exclusion of spaces that were of free movement in the peasant communities. ➢ Feeling of local insecurity in the face of new and unknown actors
Interactions and connections between industrial PUs and other more traditional PUs	➢ Employment of labor. Members of peasant families who worked in their own traditional PU, now go on to work as wage earners in industrial agriculture, usually as seasonal workers in avocado orchards or berry greenhouses. ➢ Purchase of peasant land by industrial farmers or investors. ➢ There are no connections that imply the exchange of materials or equipment, knowledge and skills, or co-ownership.

The context conditions associated with the Mexican neoliberal reform, and the arrival and increase of industrial agriculture in the LPB with its emergent effects and theirexpressions and concretions (Table 3), have influenced some peasants to have incorporated elements into their PUs such as mechanized machinery, agrochemicals, industrial feed for livestock, improved seeds and/or livestock, financial support, and occasionally non-creole avocados (Table 1). The implications on the functioning of the PUs of such incorporations and the consequent hybridizations that have occurred with agricultural industrialization in the LPB, that is, the increased use of energy fossil (non-renewable) external to the system, and the decreases of the system's energy efficiency, system's self-sufficiency, and occasionally system's diversity (Table 1), negatively affect sustainability. Along the same lines, industrial PUs also are negative for sustainability in LPB, mainly the impacts mentioned in Table 3. In this way, we can relate the contextual conditions associated with the Mexican neoliberal reform with the arrival and increase of industrial agriculture in the LPB (industrial PUs) and with the incorporation of industrial traits in the PUs (hybridizations), thus addressing RAMI processes and phenomenon in a com- prehensive way. In general, all these different effects and impacts at different levels and scales, be they political, socials, land-use change, agricultural practices, or others, tend to result detrimental to sustainability (Figure 4). They are also detrimental to sustainability the scarce development of complementary connections between traditional and industrial PUs, and little organizational innovation and in commercialization by part of local actors such as farmers, communities, NGOs, among others. In addition, as peasants lose their land, there will also be a decrease in food self-sufficiency at rural household level and regional level. Finally, we can visualize RAMI in the LPB real case comprehensively, interrelating all multiscalar different processes posited in this article, that is, mosaics, interactions, hybridizations, tensions, and the consequent different types derivations, as subjugation, grabbing and dispossession, complementation possibilities, and different agriculture types, forming a complex whole. This approach and vision differ from a linear and unidirectional one, as RAMI has sometimes been visualized and posited, without more options than just the combination of traits or aspects of traditional and industrial agricultures (Figure 5).

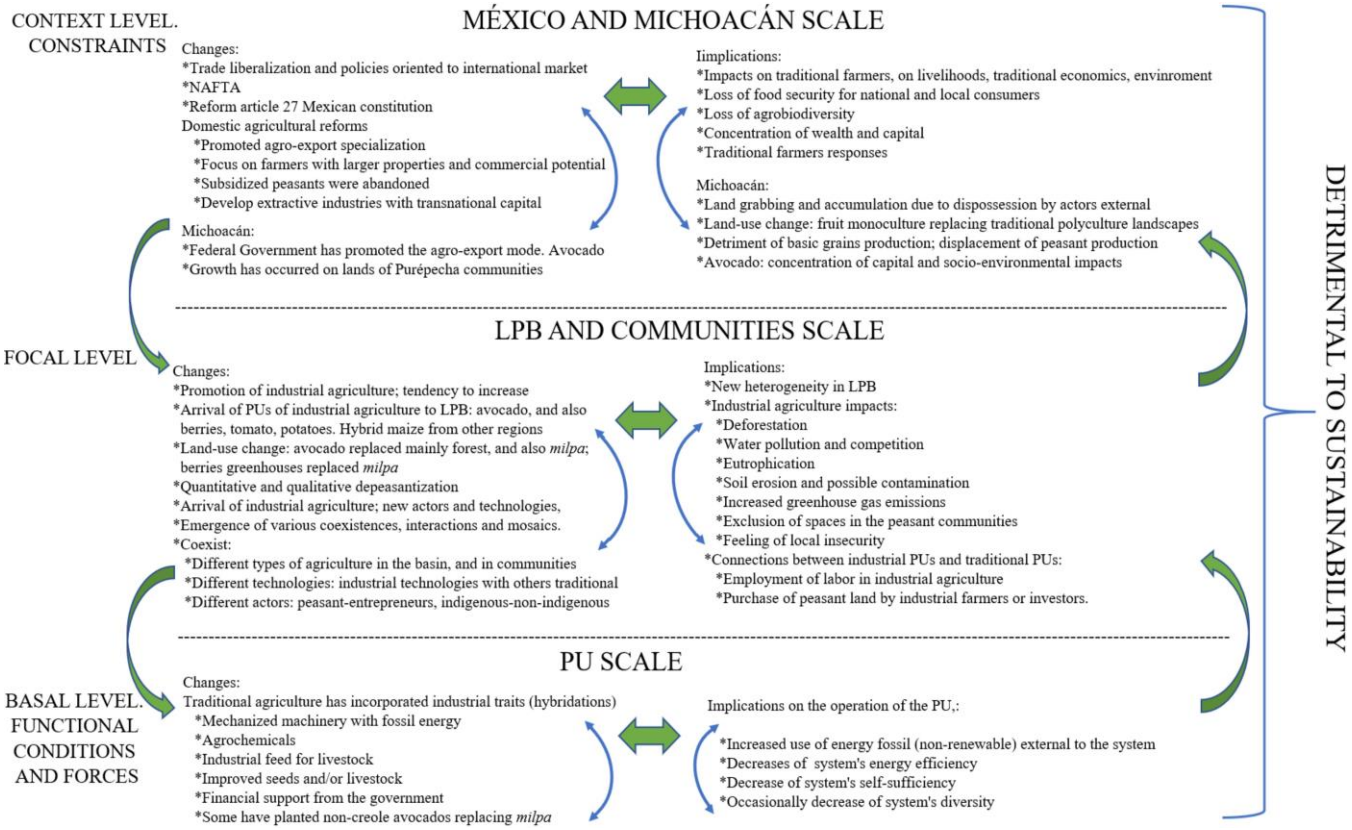

Figure 4. RAMI-related change processes at different levels and scales, from Mexico to the PUs of LPB, represented in a nested multi-scale complex hierarchy. While the changes at the level of Mexico and Michoacán began in the 1970s, the arrival of industrial PUs to the LPB began at the beginning of the present century. In general, the effects and impacts presented here, at different levels and scales, be they political, socials, land-use change, agricultural practices, resource management (such as forest and land), or others, tend to result detrimental to sustainability. The changes at the contextual level, that is, in Mexico and Michoacán, political, economic, sectoral, and social changes, establish constraints conditions to the operation of the LPB (top-down), and changes at the basal level; that is, in the PUs, corresponding to the hybridizations associated with the incorporation of industrial traits, provide the conditions and functional forces to the LPB (bottom-up). All these levels are nested interrelatedly as parts of a complex whole, from a comprehensive approach.

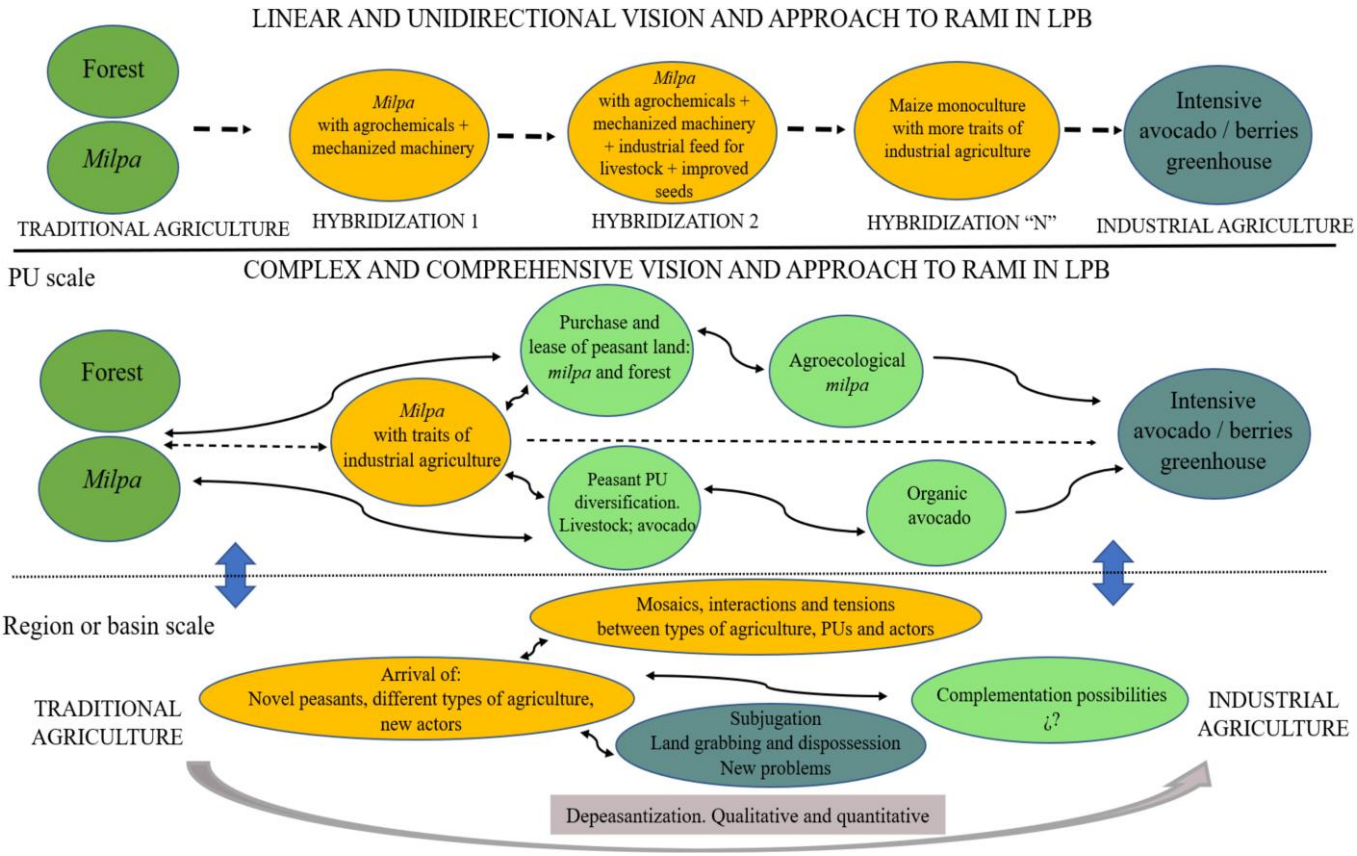

Figure 5. Model of RAMI in LPB real case, contrasting a linear vision and approach with respect to a complex and comprehensive one, as was developed and applied in this study. While in the first one RAMI is conceived as unidirectional, just going from the traditional to the industrial, in the second approach it is conceived as the integration of different interrelated, multidirectional and multiscalar processes, forming a complex whole. With RAMI, the region is declining in peasantinity, that is, is increasing in agro-industriality, in a process of depeasantization. While from the linear and unidirectional vision and approach such process is seen like just the transformation from milpa and forest to berries greenhouses and intensive avocado orchards, from the complex and comprehensive vision and approach that looks different. Be able to be perceived peasant PUs diversifying with the incorporation of livestock and/or avocado, milpas with traits of industrial agriculture in different degrees (hybridizations), peasants renting or selling their lands of milpa or forest in different parts of the basin, organic avocado orchards, all these processes in a network of multidirectional interrelations, including also at the basin or regional scale the emergence of new peasants, the arrival of new actors and types of agriculture, the generation of mosaics, interactions, and tensions between such actors and types of agriculture, and different derivations both cultural, social, economic, environmental, well-being, and quality and lifestyle. New possibilities (as possible complementations between different types of agriculture, which in LPB are scarce and uncertain) and also new problems (as subjugation, grabbing and dispossession, and exclusion and insecurity) emerge for rural development and sustainability; that is, new complexities emerge.

8. Conclusions

Like the evolution of science, rather than accumulating information on traditional and industrial agriculture, and the effects of RAMI, it is crucial to address the problem from an adequate approach. This modernizing process is multiscale, with different processes of change and variables at each scale. While at the PU scale there is a transition from traditional agriculture to industrial agriculture through the incorporation of traits of the latter, and also the interaction and combination of different types of agriculture, at higher scales, such as basin, region, or other territorial unit, larger industrial PUs arrive that transform the rural landscape and emerge tensions and problems such as subjugation, land grabbing and dispossession by actors external to communities, concentration of capital, exclusion and insecurity, and loss of autonomy and food security.

RAMI processes have not been linear or unidirectional, but hybridizations and mosaics have been generated between traditional and industrial agriculture and different types of agriculture. More than one type of agriculture that replaces another in a uniquely homogenizing process, it has been processes of transition, multidimensional transformation, and interactions with new emerging heterogeneities. Regional rural development can benefit from different interconnected types of agriculture, and thus move towards a possible convergence between modernization and co-constructed sustainable rural development. We must approach the processes of world construction as a collective construction, considering the interaction between different actors and their perspectives and perceptions, and not imposing visions and interests or modernizing processes.

Transdisciplinarity and the paradigm of complexity provide elements to approach modernization in a comprehensive manner, integrating knowledge from different scientific fields and disciplines as well as traditional non-scientific knowledge. It is key to properly perceive a phenomenon to deal with it. Perceiving different interacting levels of reality and from the dialectical confrontation between opposites, the coexistence and interaction between traditional agriculture and industrial agriculture can be approached not as merely dichotomous and antagonistic but at the same time as complementary. Thus, depeasantization and repeasantization, industrial agriculture and traditional agriculture, traditional knowledge and scientific knowledge, actors with different cultures and perceptions, among others, be complementary. For this, an integrative approach is required and not a dichotomous one, which allows us to re-understand modernization and emerging complexities. The levels of reality, the included middle logic, and the dialectic, allow us to perceive and address the coexistence, interaction, tension, and possible complementation between industrial agriculture and traditional agriculture, and the emergence of an included middle that does not correspond to traditional agriculture or to industrial agriculture. However, what arises is not only an intermediate state, but an "emerging complexity", which corresponds to the hybridizations resulting from the different combinations of traits typical of traditional agriculture and others of industrial agriculture and the coexistence and interaction of those hybridizations and different types of agriculture in the LPB and other regions of the world. Thus, it is possible to go beyond the Aristotelian logic (traditional agriculture or industrial agriculture) and the included middle logic (traditional agriculture and industrial agriculture, and a third that emerge from the coexistence and complementation between both), being able to be perceived with a look closer and finer, not three situations but a greater variety of situations tending to interrelate with each other, that is, an emerging complexity. In short, the epistemological approach and positioning developed and presented in this article allow us to perceive, and thus consider and incorporate in the analysis and reflections, the emerging complexities from the RAMI processes, corresponding to an own approach and positioning of transdisciplinary sustainability research.

Such as approach allow us moving from one level to another, from the perspective and perception of some actor to another and integrating opposites. In this way, allows to perceive heterogeneities, differences, and at the same time link them, and to conceive the complementary coexistence of antagonistic elements and processes as part of the identity constitution of a territory, landscape, or region. This approach allows perceiving new possibilities and research lines for rural sustainability.

The history and rural, agricultural and peasant character of the LPB, and its environmental and cultural heterogeneity, are adequate to address RAMI in all its multidimensionality and complexity. The rural landscape transformation associated with RAMI implies new heterogeneity. The region still shows a predominantly traditional character, but with different degrees of modernization and increase of industrial agriculture. There has been quantitative and qualitative depeasantization, hybridizations between traditional and industrial agriculture, and different coexistence has emerged: between different types of agriculture; between different actors, such as peasant-entrepreneurs, original–non-original people, with their cultural contrasts. Although there is some interaction between industrial PUs and more traditional PUs, the connections that can be observed between both for now are scarce, and its development is uncertain. For complementary connections between traditional and industrial agriculture or other agricultures types can be developed, an effective dialogue is required between the corresponding actors, a participatory land use planning and design adjusted to local skills and needs, and a governance with multi-sector and multi-actor interaction, knowledge complementation, and mutual learning processes. In this way, synergies between the PU-scale modernization process and regional development can be fostered and thus achieve a co-construction of regional sustainable rural development.

Among the relevant topics and questions regarding the problem that is addressed in this article, the following stand out: (1) governance and alignment of modernization with rural sustainability, What is the role and how can industrial agricultural models and PUs contribute to construct connections and synergies with other more traditional types of agriculture, conducive to more sustainable rural development? How can such connections and synergies be fostered and realized, in order to align modernization with rural sustainability?; (2) peasant communities and their perception, How do the peasants of the communities perceive industrial agriculture and associated actors, and their arrival in the territories they inhabit?; (3) social justice, what is the role and how can industrial agricultural models and PUs contribute, coexisting and interacting with other more traditional types of agriculture, in reducing the poverty gap and construct more equitable life conditions?; (4) institutions and public policies, What is the role of the State in relation to the coexistence and interaction between different types of agriculture and rural actors? What incentives, supports, norms and regulations are required?; (5) food sovereignty and security, What is the role and how can industrial agricultural models and PUs contribute to these objectives, coexisting and interacting with other more traditional types of agriculture?; (6) academia and science, How do we generate an research according and sensitiveto the concerns of the peasant communities that inhabit the territories where industrial agriculture and associated actors have arrived, addressing it comprehensively?; and (7) sustainability, How does RAMI and the arrival and increase of industrial agriculture affect rural sustainability, considering the perception of the local peasantry, the local environmental, cultural and socio-economic particularities, and the inherent multidimensionality and multiscalarity of that phenomenon?, How can systems of monitoring and assessment to report on the socio-environmental conditions in complex rural systems with coexistence and interaction of different types of agriculture and actors and with new emerging complexities (as those shown in this article), in order to co-construct a more sustainable rural development? All the above, especially in the context of Latin America and Mexico.

Author Contributions: The original idea for the article, D.S. and A.I.M.-C.; initial literature search, D.S.; conceptualization, D.S., A.I.M.-C. and J.d.J.H.L.; field visits to LPB, D.S., M.A. and A.I.M.-C.; writing—original draft preparation, D.S.; critically reviewed and discussed the first draft, D.S., A.I.M.-C., M.A. and J.d.J.H.L.; writing—review and editing, D.S., A.I.M.-C., M.A. and J.d.J.H.L. All authors worked closely in further review, discussed, and editing leading to the final manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research was made possible thanks to a doctoral fellowship granted by the Mexican National Science and Technology Council (Consejo Nacional de Ciencia y Tecnología/CONACyT) to Diego Subercaseaux. The publication of this article was funded by DGAPA PAPIIT IG200720, project titled Agricultura y agroforestería familiar y social en contextos de cambios locales y globales. For field work was used UNAM DGAPA-PAPIIT (No. IN-200319), project titled Análisis de la dinámica de sistemas mixtos agricultura-ganadería y sus impactos en la distribución de los recursos productivos, la diversidad de maíz y la configuración de los paisajes rurales en el Centro-Oeste de México.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Acknowledgments: We would like to show our gratitude to the members of the Laboratory of Transdisciplinary Studies on the Environment at the National School of Higher Studies, and of Marta Astier's team, both at Universidad Nacional Autónoma de Mexico (UNAM). Finally, we thank to the Postgraduate in Sustainability Science of the UNAM.

Conflicts of Interest: The authors declare no conflict of interest.

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CAPÍTULO 4

Peasant Trajectories Facing Agricultural Industrialization at Community Level. Changes, Social Organization, and Adaptability in Western México

Volver a la raíz significa quietud
quietud significa volver a la condición original
volver a la condición original esa es la Ley Eterna.
Conocer la Ley Eterna es estar esclarecido
…
Cuando los buenos soberanos
habían cumplido su tarea y realizado su trabajo
las familias decían: vivimos con arreglo a nosotros mismos
LAO TSE – SABIO CHINO, TRADUCCIÓN DEL TAO TE KING DE GASTÓN SOUBLETTE

Desea el cambio. Oh, sé entusiasta de la llama;
dentro una cosa se te escapa que hace alarde de transformaciones.
…
Lo que se encierra en la permanencia está ya petrificado;
¿es que se cree seguro al amparo del gris anodino?
…
Y Dafne, la transformada,
desde que se siente laurel quiere que tú te conviertas en viento
REINER MARIA RILKE - POETA AUSTRÍACO

Peasant trajectories facing agricultural industrialization at community level
Changes, social organization, and adaptability in Western Mexico

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Keywords: sustainability, resilience, traditional agriculture, land-use change, livelihoods, rurality, Lake Pátzcuaro Basin, Michoacán-Mexico

Abstract

In Mexico, rural and agricultural modernization, and industrialization along with neoliberal policies have intensified the transformation of rural landscapes for decades. The modernizing project of the state has promoted industrial agriculture models in the Mexican countryside. Small farmers have been strongly affected by the local impacts of international market dynamics and policies at different levels, to which they respond in different ways. This paper aims to analyze the trajectories of peasant households in two communities in Michoacán, Western México, facing agricultural industrialization and its expansion in the frame of their current states, social organization, and adaptive capacity building at the community level. We identify the main changes and drivers related to agricultural industrialization and its expansion through a qualitative analysis of in-depth semi-structured interviews and a quantitative analysis of land-use change. Subsequently, the research team recognized and analyzed peasants' trajectories. It analyzed the role of social organization, adaptive capacity building, and other issues such as livelihoods, peasant heritage, and traditionalism. Of the study area, 40.3% changed land use from 1995 to 2021. The land use that increased the most was the avocado orchard, from 4.2 ha in 1995 to 1,859.7 ha in 2021 (442.79 times). The main peasants' trajectories, in some cases different between both communities, have been increase in non-agricultural sources of income, continuing with traditional agriculture, working as day laborers in industrial agriculture (avocado orchards or berry greenhouses), planting avocado in their productive units, selling their land to outsiders for avocado orchards, and community social organization and decision-making regarding the sale of land to outsiders. The only adaptive trajectories identified are the peasants' social organization and community decision and the peasants who plant avocado and *milpa*. Peasant trajectories have contributed more to building adaptability in the case of the community that took a collective decision and position regarding the arrival of industrial agriculture. Our findings and conclusions are in line with previous research suggesting that a sound social organization is crucial to improving adaptability while contributing to sustainability in rural areas.

1. Introduction

Rural and agricultural modernization and industrialization (RAMI) involved multi-scale intersecting processes of transformation of the rural landscape, such as deagrarianization and depeasantization (Carton de Grammont, 2009; van der Ploeg, 2018). RAMI corresponds to the modernization of rural areas, which, within the framework of industrial civilization, materializes with the incorporation of industrial elements in the processes related to agriculture: agrochemicals, tractors and machinery, fossil energy, improved seeds, industrial feed for livestock, greenhouses, external wages, external companies, investors, and export. This has multidimensional implications, including cultural, social, economic, territorial and ecological. Agricultural industrialization and intensification have spread extensively in developing countries in recent decades (Guzmán et al., 2000; You et al., 2018). Such modernization in those countries consists mainly of the incorporation of agricultural technology and agricultural/rural development strategies and projects (Chamala, 1990). An important idea was that agricultural modernization was a necessary condition for the development of developing countries (van der Ploeg, 2018).

RAMI has increased worldwide in recent decades (Carton de Grammont, 2009). Globalization and neoliberal policies have promoted agricultural production for international markets at the expense of local needs and traditional agriculture, thereby marginalizing rural activities related to self-sufficiency and local food sovereignty (Ribeiro Palacios et al., 2013), and affecting small farmers (Eakin and Lemos, 2010; Speelman et al., 2014). Gradually it was seen that the focus on intensive agriculture did not benefit rural development as expected (Huttunen, 2019; Koopmans et al., 2018; Rivera et al., 2018). The modern specialization of agriculture in the industrial model entails the degradation of regional and local natural and human resources, subordinate local producers to the intervention of transnational companies and foreign and national government agencies, and harm to domestic consumers regarding a sufficient, healthy, and culturally acceptable diet (González, 2014). RAMI and industrial agriculture have unleashed profound socio-environmental impacts which include decreasing biocultural diversity, low adaptability and resilience (Altieri and Nicholls, 2013), and low self-regulation in agroindustrial food systems (Jacobi et al., 2018), and affecting sustainability, which has been addressed by numerous international researchers (see Conway and Pretty, 1991; Altieri and Rosset, 1995; Altieri and Nicholls, 2000; Guzmán et al., 2000; Toledo and Barrera-Bassols, 2008; Altieri and Toledo, 2011; Jacobi et al., 2018).

Various studies have provided background information regarding peasant trajectories in different regions facing changes and impacts related to RAMI. By trajectories, we refer to the paths taken by peasants, and the associated changes made (or not) facing agriculture industrialization. These trajectories are social; they are paths taken by peasants as social actors. Academics have classified such peasant trajectories as coping or adaptation (Speelman et al., 2014), anticipatory or not, and responsive or not (Bathfield et al., 2015), and translate into the adaptive capacity of peasant households and their communities (Speelman et al., 2014; Bathfield et al., 2015). Improving the ability of peasants and communities to respond sustainably to global and local drivers is essential for the future of rural livelihoods (Eakin and Lemos, 2010).

These processes are complex, emerging new interactions, possibilities, problems, and tensions between different types of agriculture (Subercaseaux et al., 2021). New multi-level drivers of change, and disturbance regimes, generate repercussions in environments worldwide (Naveh and Lieberman, 1994; Lambin et al., 2021). For example, agricultural and land-use responses, such as diversification of activities, especially off-farm wage labor, land-use change (LUC), incorporating new technologies, land acquisition by those with more resources, and an increase in livestock stocks; management, such as modifying management, improving technical level, innovating, and maintaining food security; economic, such as borrowing (getting into debt), and saving; social, such as participation in collective means of action, strengthening of decision-making and social organization, local land tenure arrangement; and migration to urban centers in Mexico or the United

States (see Davis, 2000; Speelman et al., 2014; Bathfield et al., 2015). Social dynamics, including peasant ones, imply change. Although the attributes supporting the adaptability and resilience of socio-environmental systems are already accepted, studies that provide evidence on how rural communities can improve their adaptability facing such drivers are still valuable and necessary (Eakin and Lemos, 2006; Speelman et al., 2014).

Since the '80s, in the international context described above and in the frame of the so-called Mexican neoliberal reform, a series of changes have occurred that have affected the peasantry. These include trade liberalization and international market-oriented policies, which led to macroeconomic impacts on the agricultural sector coupled with privatization and reduction of subsidies. The free trade agreement with the United States and Canada (NAFTA) in 1994 exacerbated these shifts (see Calva et al., 1997; Davis, 2000; Eakin, 2005; Sweeney et al, 2013; González, 2014; Eakin et al., 2015). Before the 1980s, politicians and other actors oriented Mexican agriculture toward food production for the local market; subsequently y focused on supporting farmers with bigger properties and more commercial potential (Appendini, 2014). Mexican policies in recent decades have promoted an agro-export specialization at the cost of weakening traditional agriculture (González, 2014). It has caused the country to have a high food dependency, concentration of wealth, and socio-environmental impacts (Toribio et al., 2019). Neoliberal policies have considerably affected peasant communities, deteriorating the original structure and function of their community organization (Toribio et al., 2019; González-Jácome, 2004), as well as land ownership, and traditional community life of the lands under communal and *ejido* tenure[2]. Their social and cultural dynamics, social institutions (Toribio et al., 2019), livelihoods, traditional economies, and Mexican agricultural landscapes, have also been affected (Ribeiro Palacios et al., 2013; Velázquez, 2019). Currently, one of the main drivers of Mexican agricultural land use is the international market (Eakin et al., 2018).

These policies led to a crisis in Mexico's traditional farmer's sector (Davis, 2000; Eakin, 2005; Eakin et al., 2018). While today native people, peasants, and small farmers lack capital, access to institutional services, and possibilities to take advantage of economic and technology opportunities, they have developed and mastered the capacity of responding through change and diverse mechanisms to those conditions since that allows their survival, albeit frequently in chronic poverty and vulnerability (Davis, 2000; Eakin, 2005; Eakin et al., 2015). The incidence of a new factor and its threats on communities does not generate conditions of vulnerability *per se* but reveals social, political, cultural, economic conditions that, in the face of new threats, constitute vulnerability. Such vulnerability can be reduced through successful adaptation processes, which may include participatory research, integration of local and scientific knowledge (Forsyth, 2013), and transdisciplinary efforts (Bocco, 2019). Their subsistence strategies are dynamic and are mainly affected by subsistence assets, the environment, and government policy (Patel, 2008; Yang et al., 2018).

In Michoacán state, Mexico, the Federal Government has promoted the agro-export model (Velázquez, 2019), increasing the areas planted with fruit trees for export and advancing land grabbing by outsiders to rural communities (Velázquez, 2019; Toribio et al., 2019). Some areas dominated by monocultures today were previously traditional polyculture and agroforestry landscapes. This expansion of export agriculture implies a loss of food security for national and local consumers and a loss of agrobiodiversity (Orozco-Ramírez et al., 2017). This growth has occurred on

[2] In Mexico, after the peasant revolution and agrarian reform, the national territory was divided into private property, public property, and social property (*ejidos* and communal lands) (Davis, 2000; Speelman et al., 2014). According to the National Agrarian Registry (RAN, 2021), socially owned land corresponds to 50.72% of Mexico´s surface, over which around 5.5 million people have rights. *Ejidos* correspond to 82.73% of the surface of social property and 41.96% of the total surface of the Mexican territory. In each *ejido*, the group of *ejidatarios* has rights to the land within the *ejido*, shared resource management is carried out (de Ita, 2006), and decisions are made by all *ejidatarios* in assemblies (Speelman et al., 2014).

Purépecha communities' lands, displacing traditional production (Toribio et al., 2019). In recent decades, traditional productive units (PUs) have incorporated elements of industrial agriculture. Between both agriculture types, there is a range of intermediate states resulting from different combinations between typically traditional traits and industrial ones, i.e., mixed traditional/industrial farming systems or hybrid PUs (Subercaseaux, 2021). In more recent years, there has been an increase in the area under intensive agriculture through the purchase and lease of land. Due to its rural, agricultural, and peasant character and history, its heterogeneity, the considerable presence of diversified traditional agroecosystems, and how industrial agriculture has arrived and has gradually expanded, combining with traditional agriculture in the rural landscape, this region is appropriate for addressing the peasant trajectories facing agricultural industrialization and its expansion.

The research questions of this paper are: (1) What processes and drivers of change have the peasant communities experienced concerning agricultural industrialization and its expansion? (2) What trajectories have peasant households taken facing agricultural industrialization and its expansion? (3) How do these trajectories differ between peasant communities and relate to their current states? (4) How do such trajectories relate to social organization and adaptive capacity at the community level? The general aim is to analyze the trajectories of two peasant communities in western Mexico facing agricultural industrialization and its expansion in the frame of their current states, social organization, and adaptive capacity building at the community level.

2. Methodology

2.1. Concepts and considerations for addressing adaptive capacity

The trajectory or response of social systems is defined not only by structural variables but also by social actors' individual and collective agency (Davidson, 2010). Peasant communities and households respond differently to global, national, or local changes with important impacts at the local level. Scholars have classified such trajectories and responses as (1) coping: characterized as a reaction response triggered by past or current factors; (2) adaptation: characterized as management adjustments in response to past, current, and future factors (Nelson et al., 2007). Coping is an immediate and habitual response, but it does not necessarily prepare the system for future changes and is mainly effective in the short term. On the other hand, adaptation anticipates future or anticipated changes and is often effective for a long time (Speelman et al., 2014). Coping responses may include (temporary) emigration and increased non-agricultural income sources (Ribeiro Palacios et al., 2013). Adaptation strategies, instead, are usually based on strengthened social networks, reorientation of agricultural production, improvement of infrastructure, diversification of production systems, or improvement of local organizational structures (Saldaña-Zorrilla, 2008; Huber-Sannwald et al., 2012). The adaptive capacity of a system is the basis for developing adaptive strategies and for transforming initial coping responses into them (Speelman et al., 2014).

Based on Bathfield et al. (2015), perceived adaptive capacity is the system's ability to anticipate (or not) possible disturbances and/or to respond (or not) to them. When there is a possibility of a disturbance, systems (communities/families) make changes (or not) to buffer or take advantage of the possible disturbance. These changes reveal a level of anticipation; those who implement them are considered anticipative, while those who do not are considered non-anticipative (Bathfield et al., 2015). On the other hand, when the disturbance is a reality, systems implement changes (or not) in response to the disturbance. Who implement such changes are considered responsive, while those who absorb disturbances with little or no changes are considered non-responsive (Bathfield et al., 2015).

The level of adaptability, anticipation, and responsiveness is partially conditioned by context and structural conditions. While a certain vision regarding the notion of adaptation supposes adjusting to the conditions that have generated the propensity to vulnerability without questioning the socio-economic context that produces them, critical visions of said approach propose adaptation as a process of social transformation (Bocco, 2019). It is important to consider variables such as power relations and social actors' agency, and a trans-scalar approach (Bocco, 2019). One path is working in local communities with a community-based adaptation (Forsyth, 2013; Bocco, 2019).

Adaptability allows the system to avoid an undesirable state or go from an undesirable one to a desirable one (Folke, 2006). The basis of adaptive capacity has already been described and includes, e.g., flexible institutions, knowledge sharing, and equitable access to resources (Yohe and Tol, 2002; Folke et al., 2003). Adaptive capacity and resilience are critical to the sustainability of any complex system (Wu, 2012). Resilience is crucial to the sustainability of food systems (Jacobi et al., 2018). Jones and Tanner (2016) have re-conceptualized resilience as the passage of a given system to a "desired" state (Jacobi et al., 2018). Adaptability improves resilience and reduces vulnerability, while said reduction in vulnerability strengthens the resilience of socio-environmental systems.

2.2. Study Area: Lake Patzcuaro Basin Region and Peasant Communities

The study region is Lake Patzcuaro Basin (PLB), Michoacán state, located in Western Mexico. Approximately 81% of its surface corresponds to the municipalities of Pátzcuaro, Tzintzuntzan, Quiroga, and Erongarícuaro (figure 1). The basin has an area of approximately 100,000 ha (Orozco-Ramírez and Astier, 2017). Geographically it is located between 19°25′–19°45′ N and 101°25′–101°54′ W (Arnés et al., 2013), and its altitude ranges from 2040–3400 masl (Orozco-Ramírez and Astier, 2017). It is an endorheic basin (Cumana, 2016). The climate is seasonal temperate subhumid, with most rainfall in summer and an annual rainfall of 1010 mm. The average yearly temperature is 16.9°C, with a minimum of 8.0°C and a maximum of 25.7°C (CICESE, 2015).

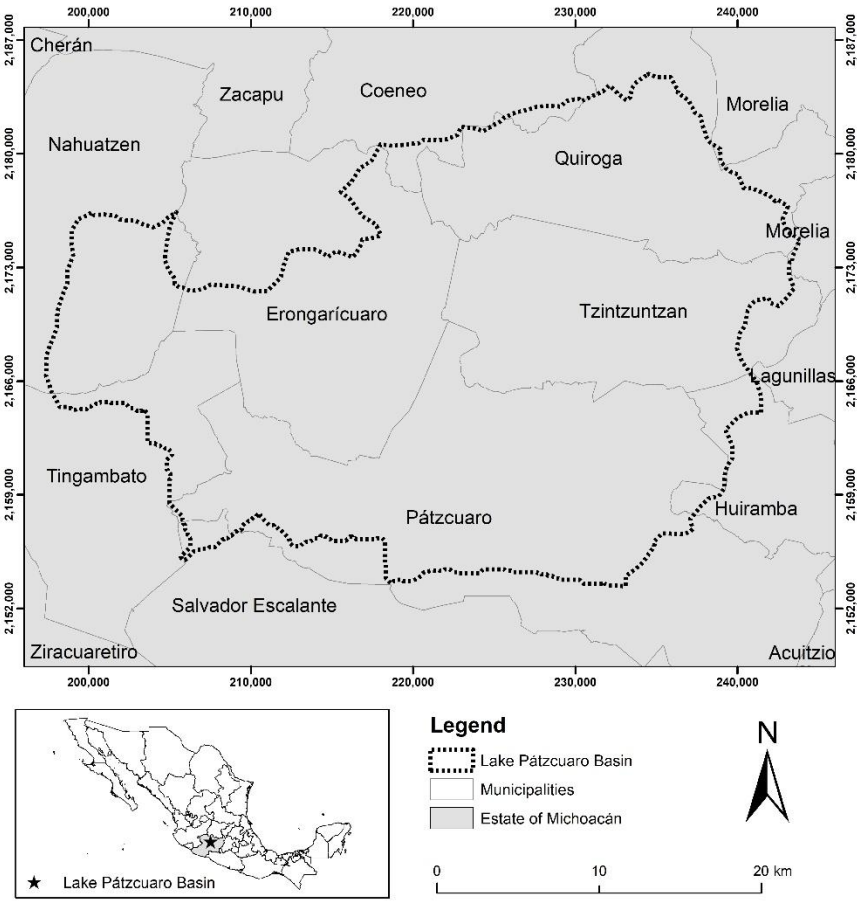

Figure 1. Lake Pátzcuaro Basin in the State of Michoacán, Mexico, its delimitation, and the corresponding municipalities (Source: Subercaseaux et al., 2021).

The dominant social land tenure regime in the PLB is *ejido*. The population is mainly peasant, distributed in more than 100 human settlements, including small *rancherias*, peasant and native communities, and colonial cities (Toledo and Barrera-Bassols, 1984; CENTROGEO, 2020). The PLB is part of the Purépecha region, the demographic and territorial majority ethnic group in Michoacán (Toledo and Barrera-Bassols, 1984; Orozco-Ramírez and Astier, 2017). The basin population includes 11.55% native people (INEGI, 2020), along with migrants from other regions as well as urban centers. Biophysical and cultural interaction (Astier and Barrera-Bassols, 2007) supports a highly heterogeneous PLB in vegetation types, soils, and agricultural systems (Toledo and Barrera-Bassols, 1984) and a variety of maize races (Astier et al., 2011; Orozco-Ramírez and Astier, 2017).

The main economic activities are agriculture, livestock, forestry, crafts, and fishing (Orozco-Ramírez and Astier, 2017). Agriculture is the leading form of landscape transformation from natural to cultural (Mapes et al., 1994). Communities in the PLB have a strong agricultural tradition. Farmers are mainly peasants who maintain small and diversified PUs (usually < 5 ha) (Orozco-Ramírez et al., 2017). They employ family labor and produce goods for self-sufficiency and commercialization (Astier et al., 2011). Maize is the most important crop (Orozco-Ramírez and Astier, 2017). The most important system is *milpa* which combines maize (*Zea maiz* L.) with beans (*Phaseolus* spp.), and *Cucurbita* spp. (Astier et al., 2011). People practice irrigation, moisture, juice or riverine, and seasonal (rain-fed) agriculture, each associated with specific edaphoclimatic conditions present in different basin areas (Orozco-Ramírez et al., 2017).

Within the framework of RAMI, traditional agriculture in the PLB since the '70s has been incorporating traits of industrial agriculture. Most peasants have included mechanized machinery, agrochemicals, industrial livestock feed, and government financial support (Toledo et al., 2002;

Altieri and Toledo, 2011; Subercaseaux et al., 2021). In recent years, there has been an increase in the area under more industrial agriculture, mainly avocado orchards (*Persea americana* Mill.) (Orozco-Ramírez and Astier, 2017) and greenhouses of blackberries (*Rubus* spp.), strawberries (*Fragaria x ananassa*), blueberries (*Vaccinium* sp.), raspberry (*Rubus idaeus L.*), in addition to tomato (*Solanum lycopersicum*) and potato (*Solanum tuberosum* L.), also producing hybrid maize from other regions (SIAP, 2020; Subercaseaux et al., 2021). Land-use change for avocado production has taken place, for the agroecological requirements of the crop (principally soil and frost), mainly at the expense of native pine and oak forests in hills, and also in lands used for *milpa* (González-Esquivel et al., 2015). Michoacán is the leading producer and exporter of avocado in México (SIAP, 2019), with the expansion of this crop and others such as berries linked to the State's modernizing projects, applying measures that have promoted that in recent decades, such as preferential credits and low-cost inputs (Velázquez, 2019). Avocado production in Michoacán usually involves high external inputs, state-of-the-art technologies, capital concentration, and various socio-environmental impacts (González-Esquivel et al., 2015; Toribio et al., 2019). The avocado area increased from 13,045 ha in 1974 to 153,018 ha in 2011, showing exponential growth (Morales et al., 2012). Berries greenhouses are located in the basin plain, using land usually for *milpa*. The arrival of a new type of agriculture, the industrial one, with new actors, technologies, and practices, implies further heterogeneity and complexity in the PLB along with new problems and tensions. Different degrees of industrial agriculture exist in the basin; while in some communities its presence is already noticeable in the landscape, in others it is practically absent (Subercaseaux et al., 2021).

The communities participating in the study were San Francisco Uricho (SFU) and San Miguel Nocutzepo (SMN). Together they are illustrative of what is happening in the region with respect to agricultural industrialization and its expansion. The research group held meetings with academics, local consultants, and authorities of these communities. We reviewed documents, data from the National Agrarian Registry (RAN), aerial images, and polygons of the *ejidos*. With this information, the academic group selected these collaboration communities for this study, applying the following criteria: (1) contrast in the presence of industrial agriculture between both, observed through fieldwork and GoogleEarth images; (2) present environmental heterogeneity representative of the PLB; (3) both present an *ejido* social land tenure regime, with part of the *ejido* land parceled out and another in common use, and private property; (4) similar sizes in *ejido* area and the number of *ejidatarios*; (5) communities are located close to each other in the basin, in the southwestern part, SFU in the lower part, and SMN in the upper part. Table 1 presents their main characteristics. Figure 2 shows the location of both communities in the PLB.

Table 1. Main characteristics of San Francisco Uricho and San Miguel Nocutzepo communities, in Lake Pátzcuaro Basin.

Variables		**Communities**			
		San Francisco Uricho		**San Miguel Nocutzepo**	
Municipality		Erongarícuaro		Erongarícuaro	
Latitude and longitude		Lat 19°32'33''–19°34'59'' N Long 101°42'51''-101°46´21'' O		Lat 19°28'33''-19°32'13'' N Long 101°39'51''-101°42'43'O	
Altitude (masl)		2050		2059	
Land tenure		*Ejido* land (Social property) Private property		*Ejido* land (Social property) Private property	
Ejido area[1] (ha)	Parceled area (ha)	1,359	386	1,514	679
	Common use area (ha)		972		835
Population (PHINA, 2020)		1832 912 men and 920 women		939 457 men and 482 women	
Number of *ejidatarios* (INEGI, 2010)		96		102	
Soils		Recent volcanic origin		Recent volcanic origin	
Presence of industrial agriculture		No		Yes, avocado orchards	

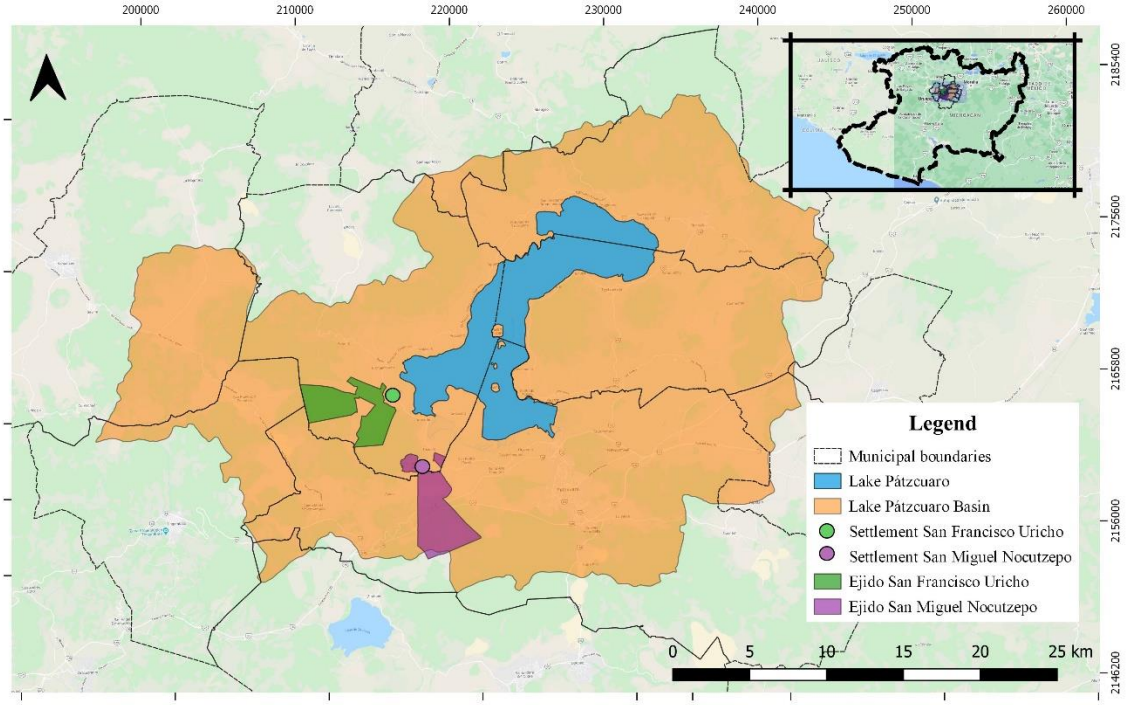

Figure 2. San Francisco Uricho and San Miguel Nocutzepo communities, in the Lake Pátzcuaro Basin. Their urban settlements (villages) and their ejidos are shown.

2.3. Methods

2.3.1. Primary data collection

(1) Quantitative analysis of LUC. Data generation.
The LUC resulting from the arrival and expansion of industrial agriculture in SFU and SMN was analyzed. We calculated LUC on high-resolution images of 1995 (aerial orthophotographs, 2m pixel size) and 2021 (Google Earth, 0.6 m pixel size). The research group selected a sub-basin which is part of the PLB as a study area, which includes the *ejidos* and villages of SFU and SMN. LU categories were defined and mapped based on a visual inspection of image patterns, fieldwork, and local peasant opinion. ArcMap 10 was used for digitizing LU polygons at 1:6,000 scale. We computed further changes in map area per category.

(2) Information collection through fieldwork:

(2.A) field trips in the PLB, peasant communities, and PUs.

(2.B) in-depth semi-structured interviews with peasants from SFU and SMN. We addressed the following main topics: community history, management of peasant UPs, changes and drivers of change in the study area, perception regarding industrial UPs, the arrival of industrial UPs, and peasant trajectories facing agricultural industrialization and its expansion. The in-depth semi-structured interview is suitable for recording people's perceptions. The research team conducted interviews to delve into the reality of the study area based on information that only a subject can provide, thus addressing local perceptions and traditional knowledge. We implemented the "snowball" method (Straus and Corbin, 2002). The inquiry group deliberately chose to leave the snowball circuit (Mancini-Texeira et al., 2018) to introduce variation in the sample through generational variety among the interviewees, thus opting for a directed snowball (Straus and Corbin, 2002). We select the sample size according to information saturation or redundancy (Bogdan and Biklen, 1982; Cantrell, 1996). After the first round of interviews, we defined new interviewees

according to identified information gaps: young people from peasant families, peasants who have planted avocado in their PUs, and knowledgeable about the community history. We conducted 19 in-depth semi-structured interviews: 10 in November 2019 and nine in August-September 2021. The age range of the interviewees was 23–92 years (Table 2).

Table 2. Farmers interviewed in the SFU and SMN communities, in Lake Pátzcuaro Basin.

Interviewed subject	**Community**	**Position in the community**	**Gender**	**Age**	**Occupation**	***Ejidatario***
1	SFU	*Ejido* Commissariat	Male	81	Peasant	Yes
2	SFU	--	Male	69	Peasant, before also mason	Yes
3	SFU	--	Male	73	Peasant	Yes
4	SFU	Head of the sub-municipal territory	Male	42	Peasant, and mason	No
5	SFU	--	Male	93	Peasant	Yes
6	SFU	--	Male	36	Peasant And currently working for the federal government	No; son of *ejidatario*
7	SFU	--	Male	37	Mason	No; son of *ejidatario*
8	SFU	--	Male	64	Peasant and trade (small family store)	No
9	SFU	--	Male	37	Peasant, and musician	No
10	SMN	Head of the sub-municipal territory (2019)	Male	45	Peasant, and Mason	No
11	SMN	*Ejido* Commissariat	Male	66	Peasant, and Mason	Yes
12	SMN	*Ejido* treasurer (2019)	Male	71	Peasant, and Mason	Yes

Interviewed subject	Community	Position in the community	Gender	Age	Occupation	*Ejidatario*
13	SMN	*Ejido* secretary	Male	72	Peasant, and Mason	Yes
14	SMN	--	Male	89	Peasant	Yes
15	SMN	--	Female	53	Artisan, collaborates in the community food bank and in the church	No; daughter of *ejidatario*
16	SMN	*Ejido* treasurer (2021)	Male	45	Traditional (*milpa*) and industrial (agucate) agriculture	Yes
17	SMN	--	Male	23		No
18	SMN	--	Male	57	Peasant, and different trades	No
19	SMN	Head of the sub-municipal territory (2021)	Male	28	Day labor in avocado orchard and pesant	No; grandson of ejidatario

2.3.2. Data analysis

(3) Quantitative analysis of LUC. Analysis of data.
The spatial analysis consists of the spatial overlap of the two dates using ArcGIS Pro 2.9.0, which detects differences between coverages and quantification changes for each land-use class. We linked the LUC (biophysical) to the interviews (perception and discourse), crossing both sources. The classes considered were: (1) Forest, (1.1) Closed Forest: forest vegetation covering 80% or more of the area, (1.2) Open Forest: forest vegetation covering 30–79% of the area. (2) Secondary Vegetation, (2.1) Forest Vegetation: forest vegetation covering less than 30% of the area, (2.2) Scrub in Forest Area: scrub in originally forest area, without forest vegetation (probably regenerating forest), (2.3) Induced Scrub in Traditional Agricultural Area: scrub in the plot area, without forest vegetation. Induced scrub vegetation cover is the result of anthropogenic intervention for agricultural purposes. In the categories Scrub in Forest Area and Induced Scrub in Traditional Agricultural Area, and, to a lesser extent, in Forest Vegetation and Open forest, there are polygons with some grass cover where animals graze. (3) Traditional Agriculture: polygons of plots in a rotation where there are annual crops, either *milpa* (maize-beans-squash) or crops for animal feed (*janamargo*/others). These polygons are multi-purpose; animals also graze here, either janamargo or *milpa* stubble. This multi-use and rotation strategy is characteristic of traditional Purépecha agriculture. (4) Industrial Agriculture, (4.1) Avocado Orchard, (4.2) Greenhouse Berries. (5) Hydrophilic Vegetation. (6) No Apparent Vegetation. (7) Human Settlement and Infrastructure.

(4) Qualitative analysis of in-depth semi-structured interviews.
The research group carried out a thematic content analysis (Joffe, 2012) using the deductive and inductive coding technique (Saldaña, 2013) with the Atlasti 9 software (Friese, 2019). For deductive coding, the manual coding matrix or "code book" was developed, with the code families or categories and the codes. The families of codes were: changes (five codes), drivers of changes (four codes), peasant responses/trajectories (four codes). Later, with inductive coding, new codes emerged in changes and drivers of change, and also outside of those families. To analyze the categories, greater rootedness (more presences in the interview quotes) (Miles et al., 2014) and the co-occurrences (when two codes match in the same quote, which shows that they are linked) (Friese, 2019) were considered.

Figure 3 shows the links between elements of the Methodology section, and themes and subsections in the Results and Discussion sections, showing the combination and complementation of methods and tools.

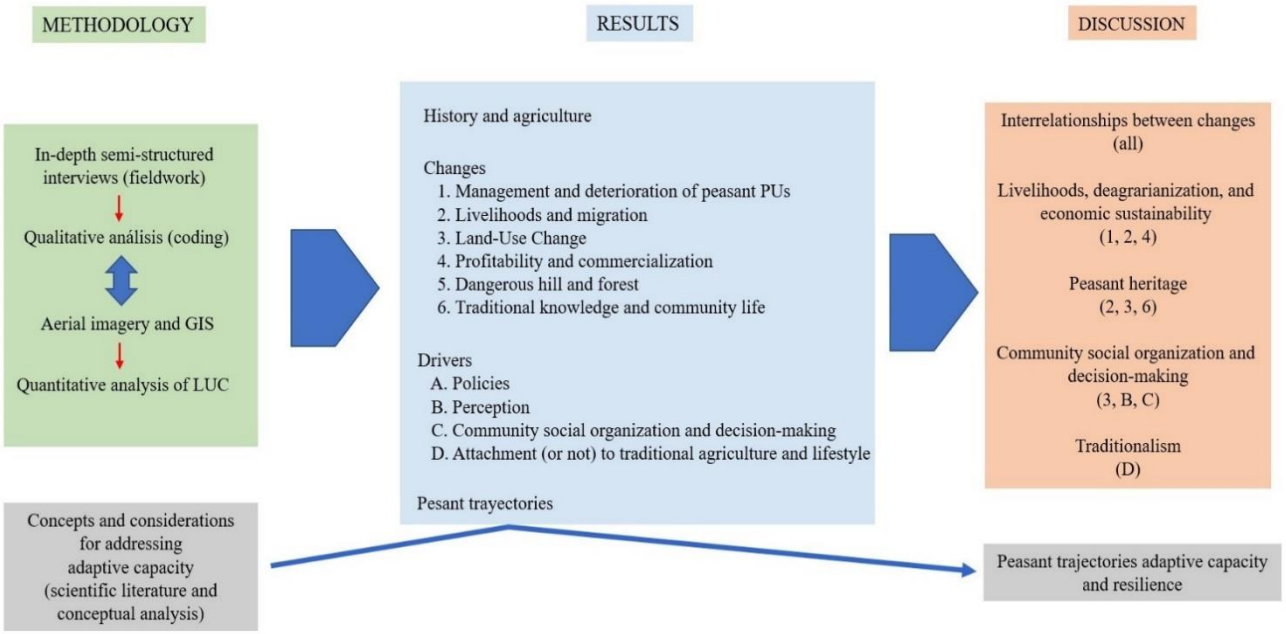

Figure 3. Links between the elements (concepts and tools) of the Methodology section, and themes and subsections in the Results and Discussion sections. Different methods and tools are combined and used in different parts of the article. Thus, scientific literature and conceptual analysis, fieldwork, GIS, coding of in-depth interviews, and qualitative and quantitative analysis, are combined. With the qualitative analysis of in-depth semi-structured interviews, we identify the peasants' trajectories, and then with the concepts and considerations for addressing the adaptive capacity of section 2.1, we analyze those trajectories concerning the construction of adaptive capacity. On the other hand, the combination of the qualitative analysis of in-depth semi-structured interviews and the quantitative analysis of LUC allowed us to combine biophysical (LUC) with perception and discourse (interviews) in the Results and Discussion. The numbers and letters in parentheses in the Discussion column indicate the subsections of the Results that were more directly used for each subsection of the Discussion section, although strictly speaking all parts of the results contributed to generating a total picture of the problem in the study area and to develop the Discussion. The process was more recursive and dynamic than what is seen in the figure, both in the analysis of the interviews, with the deductive and inductive coding iteratively, as well as the interaction between theory and field observations and information. A considerable part of the central themes of the Discussion emerged during the course of the investigation when dealing with the real-world problem or situation.

3. Results

In this section, we first tackle the history of the *ejidos* of SFU and SMN, the traditional Purépecha agriculture and agriculture industrialization there. Then, the following sections and subsections of results are arranged as follows: changes, driver of changes, peasant's trajectories facing agricultural industrialization and its expansion, and the similarities and differences between both communities.

3.1. History and agriculture in SFU y SMN

SFU was founded in 1526 and has historically been a farming community. Peasants founded the *ejido* in 1938 on land that previously belonged to the Porumbo hacienda. Similarly, SMN lands have their origin in the Charahuén hacienda. In 1918, the procedures for obtaining land began. In 1925, the land endowment to Nocutzepo was completed, expropriating 1,500 ha of Charahuén distributed among the *ejidatarios* (Molina et al., 2011). Local people express that the community has a history of many differences in ideas and divisions. There have been divisions over church issues, local school teaching staff, and, in recent years, political preferences; however, when faced with a problem, such as a fire, they come together to face it.

> "Two characteristics that have defined the community, on the one hand, the union of a principle, to separate, as autonomy, and another, that we have not seen that union again as a community, there have been many divisions, different visions" (Peasant SMN, 28-years-old)

The peasants of both communities have practiced traditional Purépecha agriculture, with a strategy of multiple land use (agriculture, livestock, forestry, and agroforestry), polycultures, and rotation (with two cycles a year, and 10-month fallow). Other crops are oats, broad beans, wheat, and lentils, although the latter is less than in previous decades. This agriculture in both communities is mainly rain-fed and, to a lesser extent, juice in SFU and moisture in SMN[3]. There are direct sales in the communities themselves, according to the moment-to-moment needs of the neighbors. There is also commercialization with nearby communities, and at harvest time, a buyer comes from Pátzcuaro. Peasants learn to work the land accompanying an adult since they are children, i.e., by direct transmission of local traditional knowledge.

Peasants in both communities usually have small herds of animals (most <10 heads), including sheep, cows, horses, donkeys, and bulls, generally keeping them in the home gardens or backyards, for self-consumption and as a form of saving for economic needs. SFU peasants give more importance to livestock.

In both communities, tractors and agrochemicals began to arrive mainly in the '80s within government programs that promoted them. Currently, most peasants use them. Although very few, some peasants do not use agrochemicals or a minimum. Avocado orchards began to arrive at the beginning of this century. In SMN, many *ejidatarios* sold peasant lands to outsider avocado growers, losing *ejido* land gained during the Mexican peasant revolution of the last century. Such avocado orchards incorporate more external inputs from agribusiness, technified irrigation, and production for export. In SFU, the presence of industrial agriculture is in the neighboring community, Arocutin, with berries greenhouses. Both situations, i.e., the use of tractors and agrochemicals in the traditional PUs and the arrival of industrial avocado orchards, are novel processes of changes in the history of these communities.

[3] Moisture agriculture uses the water found in the form of mist, dew, and the humidity that is produced by the topography, thanks to the Andosol soils, in the upper parts of the basin. Juice or riparian agriculture is practiced in the vicinity of the lake on always humid lands corresponding to Vertisol soils.

3.2. Changes

3.2.1. Management and deterioration of peasant PUs

Changes in the management of peasant PUs, according to those interviewed, have occurred similarly in both communities. Such changes correspond to the incorporation of traits of industrial agriculture in peasant PUs, such as agrochemicals, improved seeds, industrial livestock feed, and tractors.

> "Right now, a lot had changed, because before we used to work but without fertilizers and nothing, just what the land produced and nothing but good things, well, because right now it's just chemicals that we have, that we're eating, it already has chemistry, so at that time, I started working with yoke, we just planted and the *milpa* was born and grew with the water that God poured down on us, the *milpa* grew, without adding anything" (*Ejidatario* SFU, 81-years-old)

One consequence is that dependency on State aid is generated since these incorporations into the peasant PUs have been fostered by government programs. This change of incorporation of industrial elements is new in these communities, starting from such policies and programs.

> "The substitution of native seeds for some hybrid or improved seeds, which was promoted by government programs, by municipal presidents, in the 2000s" (*Ejidatario* SFU, 37-years-old)

Peasants think that agroecosystems are no longer producing as in previous decades. All interviewees express that now, it is necessary to apply chemical fertilizer so that the *milpa* develops satisfactorily.

> "Before, when I grew up with my dad, we didn't apply anything to it. But now, if we don't throw it out, it won't grow, it stays here like this, and it's very yellow, it doesn't have any maize. Now we have to put chemicals" (*Ejidatario* SFU, 69-years-old)

The deterioration of the peasant agroecosystem corresponds to both a change and a driver of change. It promotes changes in management in the peasants' PUs, with the application of agrochemicals, which leads to an increase in production costs, a decrease in the profitability of traditional agriculture, and the search for another economic sustenance for peasant households. Thus, changes occur in peasant livelihoods, some related to industrial agriculture, such as working as a day laborer, planting avocado, or selling land for avocado orchards.

3.2.2. Livelihoods and migration

The changes have been occurring for decades in the Mexican countryside (Carton de Grammont, 2009) and in these communities. They correspond to new labor activities that have emerged or increased, mainly masonry in the same community and other communities of the PLB, local commerce, carpentry, plumbing, transporters, welders, and electricians. Also, more professionals and more young people studying, which implies new ideas, access to information, and influences.

> "Masonry has been more booming, the masonry trade" (Peasant SFU, 36-years-old)

Due to the new labor activities, some peasants even relativize that SMN is currently a mainly agricultural community.

> "I think that the agricultural issue has lost a lot. Most people right now already go out to work, other activities, such as construction, and merely the people dedicated to agriculture are already the older people. The day labor, for example, most of the young people right now work as avocado cutters" (Peasant SMN, 28-years-old)

A new occupation for young people in these communities is to work as day laborers in industrial agriculture PUs, in SFU mainly in the berry greenhouses in the neighboring community (Arocutin) and SMN mainly in the avocado orchards in the same community. It is a possibility only for young people due to the physical demands of the work. The motivation to work as a day laborer is to earn more money more frequently than in peasant agriculture.

"Right now, day labor activity is very strong because most of the boys who are here go to work day labor harvesting avocados, strawberries, and blueberries" (Peasant SMN, 53-years-old)

Another new labor and economic possibility is planting avocado and selling land to outsiders for industrial agriculture. Thus, there are new labor opportunities in these communities with industrial agriculture to solve peasant households economically.

"The new generations could be in bad shape, but they are not worse off than before, because right now they say I'm not going to eat just beans, I'm going to work because I want to eat better, so somehow, we're not the same, there are already more sources of employment, if they are not in the community, they are outside, but there are from where" (Peasant SMN, 53-years-old)

There have been differences between SFU and SMN since, unlike SFU, in SMN considerable LUC has occurred with the expansion of avocado orchards in the *ejido*. In SMN, *ejidatarios* have sold numerous lands to install orchards, and many peasants have also planted avocados in the *ejido*. In SFU, on the other hand, very few peasants have sown avocados, and they have not sold land to outsiders. Some young people from peasant families are working as day laborers in the berry greenhouses in the neighboring community; however, these are fewer than in SMN.

Following the discourse of the interviewees, the factors of these changes in livelihoods have been the disinterest of young people in working in traditional agriculture and the search, convenience, and need for another lifestyle and more income. This is due to the decrease in the profitability of such agriculture, the deterioration of the peasant agroecosystem, and the incentives of government programs.

"I am going to say something, which is something sad, right now, our young people no longer want to work on the crops, right now almost the majority here are masons, and they earn more, and they don't bother so much, and they bring their little money, well" (Peasant SFU, 64-years-old)

"That is why the majority of young people right now prefer to dedicate themselves to something else, construction, emigrate to the United States, other cities because agriculture is no longer something that sustains" (Peasant SMN, 28-years-old)

The migration began decades ago in these communities, mainly among young people; both seasonal as well as longer migration took place, either to cities such as Uruapan, Morelia, and Mexico City or to the United States, occurring similarly in both communities. Migrations affect the culture and lifestyle of the people in the communities, influencing various aspects such as community relations, festivals, recreational activities, use of technological devices, clothing, and food, among others. Currently, in these communities, some *ejidatarios* do not live there.

"I think that the change in migration is very important. When migration occurs, the parties are also transformed, because they already come with other ideas, and they come to acculturate what we used to do as a culture, and it is becoming more modern, more open way, I don't know. Also, in the way of dressing, migration is a very, very noticeable change in many aspects. Even in gastronomy, even in the way of eating, pizza, hot dogs, even in the organization of family parties, that camaraderie is over, that support that one had for these family parties" (Peasant SMN, 53-years-old)

In a context of declining profitability of traditional agriculture, migrations contribute to the economic sustainability of peasant households since, frequently, the remittances by the family member who is away make said sustainability possible.

3.2.3. Land-Use Change

3.2.3.1. Quantitative analysis of LUC

The LUC resulting from the arrival and expansion of industrial agriculture in SFU and SMN is new in these communities. About 40% of the analyzed sub-basin (13,486.7 ha) changed land use in the last 26 years. The land use that increased the most was the avocado orchard, from 4.2 ha in 1995 to 1,859.7 ha in 2021 (442.79 times). The Avocado Orchard replaced mainly Secondary Vegetation and Traditional Agriculture (20.75%). The land use that decreased the most was Traditional Agriculture (40.52%), replaced mainly by Avocado Orchards (20.75%), followed by Forest and Induced Scrub in Traditional Agricultural Area. Figure 4 shows the land uses in 1995 and 2021. In the former, just after the signing of NAFTA and before the arrival of industrial PUs, and 16 years later with the presence of avocado orchards and berry greenhouses.

In SMN, the class that increased the most was also Avocado Orchard, from 0 to 306.43 ha in 2021 (20.2% of the *ejido*). The class that decreased the most was Traditional Agriculture (51.74%); the Avocado Orchard replaced it the most (34.68%). In the *ejido* of SFU, the class that increased the most was Closed Forest; Avocado Orchard rose from 0 to 22.2 ha, representing only 1.63% of the *ejido* in 2021. The class that decreased the most was Induced Scrub in Traditional Agriculture Area; Traditional Agriculture decreased from 338.33 ha to 335.43 ha, only 0.86%.

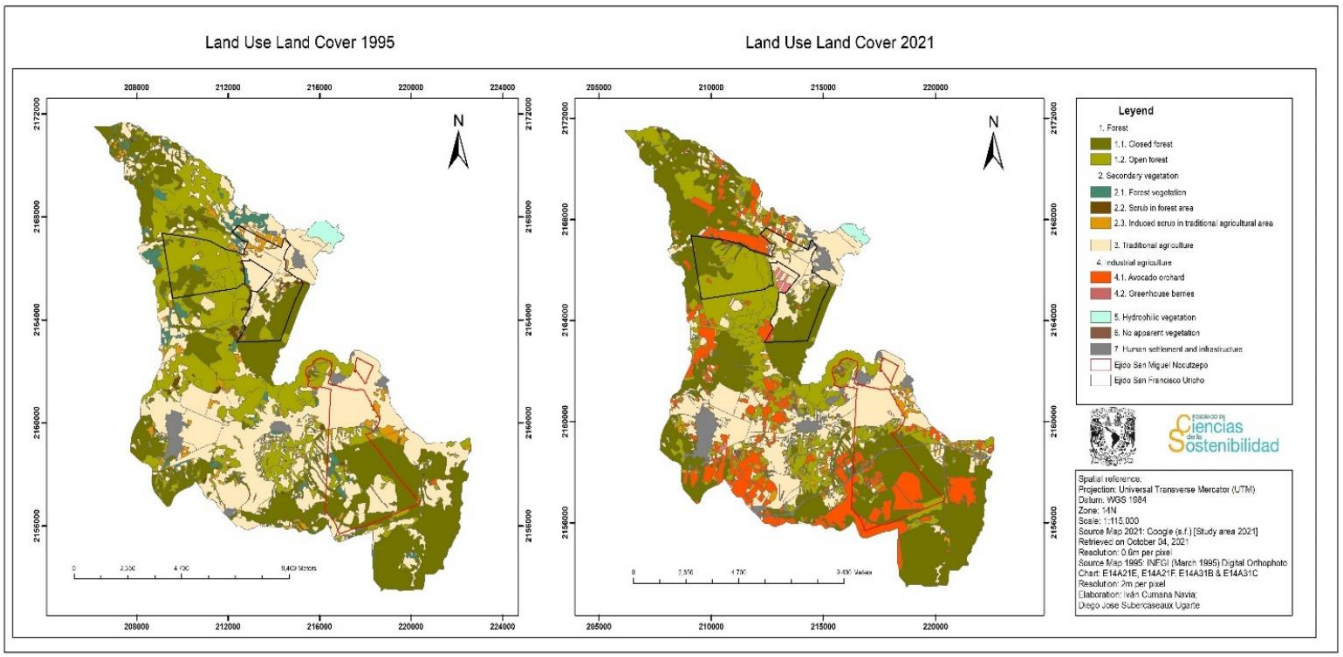

Figure 4. Sub-basin, part of the PLB, which includes the ejidos and urban settlements (villages) of SFU and SMN. Land uses are shown in the year 1995 (A), before the arrival of industrial PUs, and in 2021 (B), already with the presence of avocado orchards in the ejido of SMN and in the surroundings of both communities, as well as berry greenhouses in the community neighboring to SFU.

3.2.3.2. LUC perceived and declared

There have been substantial differences between both communities. In SMN, when the possibility of selling land to outsider avocado growers began in the first decade of this century, they sold numerous *ejido* lands. In SFU, on the other hand, very few peasants have planted avocados and have not sold *ejido* land to outsiders. Later, in the second decade of this century, the sale of *ejido* lands to outsider avocado growers decreased in SMN, with *ejidatarios* opting more to experiment by planting avocado on their land. Usually, these peasants grow avocado in only one or two of their plots, while in the others, they maintain *milpa*.

"Much of the part of the hill, part of the *ejido*, is no longer *ejido* of San Miguel Nocutzepo" (Peasant SMN, 23-years-old)

"Those from here, to appropriate this great project (the avocados), that people now appropriate it as a change for themselves" (Peasant SMN, 53-years-old)

The avocado orchards in SMN are on the hills. These orchards, bigger than the peasant plots, are achieved by outsider avocado growers buying many peasant plots of 0.25–2 ha each. In SMN *ejido*, there is an avocado orchard of approximately 165 ha.

While the lands that SMN sold to outsider avocado growers are located mainly in the upper part of the hill in the *ejido*, the plots where the *ejidatarios* have planted avocado are in the middle part of the hill. In the plain, there is traditional agriculture. Some areas with forest remain in the hills, and in their avocado orchards, the peasants usually maintain strips of forest (Figure 5).

"In the upper part already sold everything. And it was when the new guys stopped because they had already been buying downwards, and they said no! no more selling, we are going to take over and we prefer to plant avocado ourselves" (Peasant SMN, 53-years-old)

Figure 5. Avocado orchards on the hill in SMN. The images upper show warehouses, roads, and fences that have appeared with the arrival of avocado orchards. Previously, these infrastructures did not exist on the hill or in the ejido in general, and there were no fences were closing the plots or blocking passage, but rather people and animals moved freely through the area. The images at the bottom show avocado orchards on the SMN hill, owned by local farmers, who preserve strips of trees remnant from the forest that were previously there. The harvest and commercialization of these local peasant's orchards are carried out by a company, with its day laborers and its commercialization channels, for export.

3.2.4. Profitability and commercialization of traditional agriculture

The peasant families interviewed argue that traditional agriculture does not provide sufficient economic income. The reasons include the increase in production costs, the deterioration of the peasant agroecosystem and the consequent need to apply agrochemicals, and the low prices of peasant agricultural products. This started with and resulted from the State policies being favorable to industrial agriculture and detrimental to traditional agriculture. This change of incorporation of industrial elements is new in these communities, starting from such policies and programs.

> "Insecticides have gone up a lot, chemical fertilizers have gone up a lot, agricultural machinery has gone up a lot, labor is quite expensive. So, it is no longer so profitable to cultivate the land"
> (Peasant SFU, 36-years-old)

Whether or not traditional agriculture alone is enough to meet the needs of peasant families also depends on lifestyle and material desires. The decrease in the profitability of traditional agriculture, combined with other factors such as the lower interest of young people to work in agriculture, has led to some *ejido* lands currently uncultivated. This low profitability also leads to the search for other labor and economic options (changes in livelihoods).

"No, well, the field doesn't leave anything, it's a lot of work, but it doesn't leave anything. That is why more people are beginning to dedicate themselves to construction. And there's faster money" (Peasant SFU, 37-years-old)

The commercialization of traditional agricultural production has also changed. Peasants comment that there were more commercialization possibilities in previous decades, with more points of sale and exchange and more buyers. Nowadays, a buyer from Pátzcuaro goes to both communities at harvest time. The prices of various crops have also dropped significantly.

"There were buyers in those years, and now there is no buyer, here only what we sell is only for some people who do not plant and buy" (*Ejidatario* SFU, 69-years-old)

"It is because the government is already bringing from other countries" (*Ejidatario* SFU, 73-years-old)

3.2.5. Dangerous hill and forest

In SMN, in addition to land dispossession due to the large amount of *ejido* land sold for avocado orchards to outsiders as well as unknown and sometimes dangerous people, the situation on the hill has become risky. This a new situation in the community.

"They are putting a lot of people to take care of, but they are people who are determined to kill or die, and we have seen, on some occasions, it has happened to me that they have stopped me on the hill, they are armed people, we do not know who be, or where they come from, we do not know them, so for me, it is a danger" (Peasant SMN, 57-years-old)

3.2.6. Traditional knowledge and community life

In recent decades, traditional community life has deteriorated; for example, traditions and coexistence around the countryside, festivals less oriented to religion and more to fun, consumerism, and alcohol. The communities have lost practices associated with traditional agriculture and the corresponding utensils, such as shelling maize manually and the manual sheller. This is specially mentioned in SMN and is related to the local identity and culture deterioration.

"It was like a party in the field, at planting time, all the families went to plant with a yoke, and the people were like our mothers, they would bring food to our fathers, it was like an obligation, to bring a taco to those people, they received it's so well. It was like a family gathering. It was another level, another life" (Peasant SFU, 64-years-old)

Traditional knowledge has also deteriorated. In SMN, according to some interviewees, there are peasants who do not know the *ejido* soils. Besides, there has been a loss of knowledge in the *milpa* management, regarding the benefits of combining maize-beans-squash, a basic element of traditional Purépecha agriculture.

"Here there are many people who don't know about the types of soil and sites. Even *ejidatarios*" (Peasant SMN, 45-years-old)

"They grew beans alternated with maize; the harvest is more difficult, and today something I discovered is that planting beans elsewhere, it will be better and more comfortable for you" (*Ejidatario* SMN, 45-years-old)

3.3. Drivers of change

3.3.1. International, national, and local policies

This driver is multi-scale, including agreements and policies of different types, at the international level (globalization, NAFTA, and other trade agreements), national policies, and those of the state of Michoacán. This driver has operated similarly in both communities. Government policies and programs within the framework of the neoliberal reform, detrimental to traditional agriculture, have encouraged tractors, agrochemicals, and improved seeds and have increased production costs and lowered prices of peasantry agricultural products.

"There were support programs, large government projects that transformed many regions, and this was one, where, this community was given five tractors" (*Ejidatario* SMN, 45-years-old)

According to peasants' criticism, the government does not design programs considering the local context and the reality of the respective communities. In addition, they comment that the support usually reaches the landowners, but in these communities, some landowners do not work their land, but another peasant from the community works it, sharing the harvest.

"Like all programs here in Mexico, everything is done from the desk; it is done suddenly with people who effectively study but do not study the situation or the context of the communities to which they are going to apply for the programs" (Peasant SFU, 36-years-old)

This driver presents a high co-occurrence with the change in the management of peasant PUs.

3.3.2. Perception[4]

This driver refers to the perception of peasants of SFU and SMN; therefore, it operates at the local level. In general, the interviewees perceive the expansion of avocado orchards as more negative than positive, although they usually express that they have a good part, mainly the generation of employment. They mention negative impacts such as high-water consumption, security problems, and loss of forest and land. When asked about some characteristics that differentiate avocado orchards from peasant PUs, they perceive as negative that avocado orchards are larger, that they use more agrochemicals, and that they do not implement polycultures or rotation. All the peasants interviewed perceive the orchards as detrimental to local nature.

"He who bought and already has 40 hectares, is because he's bought to the 40 that they had there. And then he finished with roads, with the common forest, and he became even bigger. He said: they don't come in here anymore, and I clean everything because everything is mine. They no longer respected and that is very bad" (Peasant SMN, 53-years-old)

"Because these are heritage, the lands have the price of blood and life, they fought to collect the lands that were in the hands of the Spanish, and that is why the revolution was formed because the leaders said that the lands belong to Mexico, they are not from these people, they are invading us, we are going to fight to collect them, and that is how it was done, many people died for having land, that is why I say that they are heritage, that is why as long as I live I am not going to sell them" (*Ejidatario* SFU, 69-years-old)

[4] The relationship between perception, knowledge, and action has been consistently developed and shown (Maturana and Varela, 1987). Several studies have shown the importance for agricultural and rural sustainability of studying the peasant's perception (Tatlidil, et al., 2009; Bernués et al., 2016; Mancini-Texeira et al., 2018). Perception can operate, for example, as a factor of LUC or non-LUC.

The discourse of the SMN peasants reflected a less negative perception of avocado orchards than of the SFU peasants.

"Avocado cultivation is very noble and very profitable" (*Ejidatario* SMN, 45-years-old)

3.3.3. Community social organization and decision-making

This driver refers to the community organization of SFU and SMN and, therefore, also operates at the local level. In these communities, the main local authorities are the *ejido* board (commissariat, secretary, treasurer), and the head of the sub-municipal territory. The latter calls for assemblies to deal with matters or problems of the village. In addition, the *ejidatarios* gather in assemblies every month or when there is an issue to discuss, and they see to matters of the *ejido*, agriculture, and the forest. Decisions regarding the *ejido* are made by voting in these assemblies, and only the *ejidatarios* participate in that decision-making. There are also mechanisms to act collectively in case of events such as fires.

Some peasants know and declare that the organization and unity of the *ejidatarios* is a determining factor in the arrival (or not) of avocado orchards of outsiders in each community. Community social organization and decision-making present co-occurrence with LUC.

"Where they have not come from outside to buy, it is because their assembly is very solid, and they respect their rules of not selling to outsiders. And that is something very nice, very good" (Peasant SMN, 53-years-old)

They also mention, as determinants, that there is a good leader and regulations. According to SMN regulations, *ejido* land could not be sold to outsiders; however, it was not applied and they sold anyway.

"They have respect for their assembly. And when there is a good leader, he manages to be very clear, to say to them, not to sell, that is, they put good regulations. So, the regulations help them to abide by those rules and not sell, not do things that harm the *ejido*" (Peasant SMN, 53-years-old)

The most important difference between the determining drivers of change in both communities is that, in SFU, the *ejidatarios* have organized themselves and have decided not to sell land to outsiders. So far, they have complied, although they have received offers to buy *ejido* land from them, and they have not sold. Figure 4 shows that there are almost no avocado orchards in SFU *ejido*.

"The same assembly of *ejidatarios* is who approves the sale or dispossession of the land. And here the regulation has been very clear, not to sell land to outsiders, only to members of the same assembly of *ejidatarios*. That has been what has not allowed here in Uricho that they have not entered" (Peasant SFU, 36-years-old)

The fact that, in SMN, the *ejidatarios* have opted in the second decade of this century to experiment with planting avocado rather than to sell their lands, was due to an agreement of the *ejido* assembly.

3.3.4. Other change drivers

All the drivers presented below occur and operate in SFU and SMN, i.e., at the local level. Material desires have increased in the inhabitants of these communities, especially the youth, related to more modern and urban culture and lifestyle, raising the living costs of peasant families.

"There are many products that we do not require, for example, a newer screen, newer cell phone, more sophisticated sneakers, and well here we go" (Peasant SFU, 36-years-old)

Also, the attachment (or not) to traditional agriculture and the local lifestyle. In SMN, some interviewees express that they must modernize and technify their traditional agriculture, and must move away from that to improve the quality of life and economy of their families.

"If the peasant continues with ancestral agriculture, it is a problem … traditionalism is nice, but for self-consumption, to get ahead, no … At school, they ask for things, and you don´t have how to buy them, there is the result of sticking with traditionalism" (*Ejidatario* SMN, 45-years-old)

"The world has modernized and technified ... we have to turn the traditionalism of cultivation, we have to technify" (*Ejidatario* SMN, 45-years-old)

Other drivers for the arrival (or not) of industrial PUs have been that young people from peasant families value the land less, which favors the sale of *ejido* land, agricultural abandonment, or stops working in traditional agriculture; also, pressure, threats, and deception from outsider avocado growers.

"Our ancestors, who were the ones who acquired the *ejido*, valued it as such, with the emotion and pleasure of having land, cultivating the land. I don't know what happened, that today, this generation that we are living in, is no longer valuing the land as such, and it is not being valued because times have also changed, the economy has also been a factor, and technology has reached our communities, today you don't even buy a cell phone with a sack of maize" (*Ejidatario* SMN, 45-years-old)

See Supplementary Material: Table "Main changes and drivers associated, related to agricultural industrialization and its expansion, in the SFU and SMN communities in the PLB".

3.4. Peasant trajectories facing agricultural industrialization and its expansion

With few exceptions, peasants in these communities have adopted industrial agriculture traits, resulting in hybrid PUs (Subercaseaux et al., 2021). The main trajectories of SFU and SMN peasants facing agricultural industrialization and its expansion have been: increase in non-agricultural sources of income, including masonry and other trades, in their community and others; continuing with traditional agriculture (*milpa*, rotational plots, livestock); working as day laborers in industrial agriculture PUs (avocado orchards or berry greenhouses), in the same community and others; peasants plant avocado in their PUs; peasants sell their land to outsiders for avocado orchards; community social organization and decision-making regarding selling land to outsiders. The last four trajectories had not occurred before in these communities, implying novelty in a historical context.

In both communities, peasant families have modified their livelihoods by increasing their non-agricultural sources of income. In SFU, the trajectories have included community-level decision-making not to sell land to outsiders, with most peasants continuing with traditional agriculture. Less commonly, another trajectory has been that young people from peasant families work as day laborers in industrial PUs. In SMN, the path followed is similar in the latter but considerably different in the former. The community's main trajectory has been selling *ejido* land to outsiders for avocado orchards, later opting to plant avocados themselves.

"As the assembly began to stop the sale, they decided better to plant directly, and that is why they are experimenting, but it was like an assembly agreement" (Peasant SMN, 53-years-old)

In addition to social organization, other factors that determined that SFU *ejidatarios* have decided not to sell land to outsiders are the preference to produce their food rather than receive money and buy it, they want to maintain their lifestyle and manage their livestock as before, and the historical awareness, especially among older peasants. Furthermore, in SFU, there is a clearer perception of avocado orchards as more negative than positive than in SMN.

Another difference in the peasants' trajectories of both communities is that, in SMN, many young people from peasant families are working as day laborers in avocado orchards in the same community. In SFU, young people working as day laborers in industrial agriculture are less and do it in the berry greenhouses in the neighboring community (Arocutin).

4. Discussion

4.1. Interrelationships between the changes described

The described change processes do not occur independently but interact in each community. Changes in livelihoods are related to the LUC, as the new avocado orchards and berry greenhouses of outsiders, and the orchards of local peasants, mainly in SMN, correspond to new labor possibilities for peasants. The decrease in profitability and commercialization possibilities of traditional agriculture and the deterioration of peasant agroecosystem encourages change in livelihoods since it becomes convenient to look for other labor and economic options. This deterioration of the peasant agroecosystem leads, in turn, to a change in the management of peasant PUs, applying industrial elements, and increasing the production costs of traditional agriculture. LUC, migrations, changes in livelihoods, and the management of peasant PUs led to a deterioration of community life. The changes with the greatest rootedness (more presences in the interview quotes) are livelihoods (69), management of peasant PUs (61), and LUC (46). The co-occurrences (when two codes match in the same quote) between the changes are between the deterioration of the peasant agroecosystem and the management of peasant PUs (match in 4 citations), and between livelihoods and LUC (match in 2 quotes). Regarding the differences between both communities, there are specifically in the LUC, livelihoods, and the situation in hills and forests. LUC has been greater in SMN, due to outsiders and peasants planting avocado. This has resulted in changes in livelihoods, which is also greater in SMN. The change in the situation in hills and forests has occurred only in SMN due to the danger associated with the sale of peasant land to unknown people.

4.2. Livelihoods, deagrarianization, and economic sustainability

With industrial agriculture development in SFU and SMN, there are more and new labor opportunities for young people; therefore, they do not migrate to urban centers as much. In general, the interviewees do not see major economic problems in their community; however, this is possible by replacing traditional agriculture with other sources of income. That includes selling land to outsiders for industrial agriculture, working as day laborers there, and experimenting with industrial agriculture crops (avocado), technologies, and commercialization (see subsection 3.2.2, in Results).

The above is in line with the deagrarianization of the Mexican countryside, i.e., the progressive decrease in the contribution of agricultural activities to income generation in rural households (Escalante et al., 2008). In response to the low prices of their agricultural products and the increase in production costs (see subsection 3.2.4, in Results), peasant families try to counteract this with strategies to diversify their activities, replacing agricultural activity with wage labor. The diversification of their livelihoods corresponds to a survival strategy in response to economic, political, climatic, and demographic changes (Ribeiro Palacios et al., 2013). This complex combination of agricultural and salaried activity is known as peasant pluriactivity, which has

increased, becoming generalized in peasant families (Carton de Grammont, 2009). Diversification and pluriactivity is a survival strategy for poor peasant households, but it seems to be an unfavorable strategy for escaping poverty (Carton de Grammont, 2009). Frequently, the increase in wage-earning activities of the peasant family transformed its organizational logic. From a systemic organization ordered by agricultural production complemented by other activities, to a pluriactivity systemic organization in which the most lucrative activity determines family work dynamics and livelihoods strategies. Earlier, agriculture ordered and gave meaning to the peasant household and community life (Carton de Grammont, 2009).

4.3. Peasant heritage: land, knowledge, and community life

Traditional agroecosystems and landscapes have value as a source of knowledge and cultural heritage (Berkes et al., 2000). They are vital for the protection and regeneration of biocultural heritage through traditional knowledge and practices. RAMI processes have drastically modified the relationship between peasant communities and their environments (González-Jácome, 2004). Neoliberal policies and the domination strategies of the avocado agribusiness have impacted the peasant community lifestyle (Toribio et al., 2019). The above implies their immersion in the logic of capitalist reproduction, facing an unprecedented lifestyle and new values of coexistence, transforming and deteriorating essential elements of communality (Toribio et al., 2019).

One of the greatest heritages of peasant communities in Mexico, in the PLB, SFU, and SMN, is peasant land. The land is not only a productive heritage but also a social and cultural one, especially in the peasant and indigenous world. The agrarian society of a few decades ago, unlike today's rural society, saw land and the agrarian struggle as the main means of improving their living conditions. The archetypes of rural life were the plot and the *milpa*, which are now partially replaced by migration and precarious wage labor (Carton de Grammont, 2009). SMN and other communities in the region have lost part of their heritage by selling their land to outsiders; this is the first time this has occurred since these communities' peasants have land, after the Mexican Revolution[5] (see subsection 3.2.3, in Results). This also weakens their self-sufficiency and food security. This commodification of peasant lands occurs in a hostile productive and commercial context due to State policies, and with the presence not only of large avocado producers and entrepreneurs but also of organized crime that invades profitable lands in the Mexican countryside.

Traditional knowledge, another element of high-value peasant heritage, is being weakened. This knowledge is cumulative and adaptively built based on local transgenerational experiences (Hunn, 2002, 2007; Toledo and Barrera-Bassols, 2008). The prevailing notion of progress in industrial civilization has deliberately rejected traditional knowledge and practices generated throughout human history (Toledo and Barrera-Bassols, 2008). Various authors have shown the value of traditional peasant knowledge for the study and management of the soil, climate, vegetation, animals, and ecosystems, for food self-sufficiency, agroecological science (Norgaard, 1991), and also for sustainable rural development in developing countries (Toledo, 1990; Altieri, 1992; Pulido and Bocco, 2003). The *corpus* of traditional knowledge is associated with the *praxis* of traditional agriculture (Hernández, 1971; Toledo and Barrera-Bassols, 2008). One of the differentiating characteristics between traditional and industrial agriculture is the knowledge: the peasant has a wealth of knowledge of the local environment that allows him to dispense with external technical expertise in his production process (Toledo, 1999; Toledo et al., 2002). Traditional peasant knowledge is being weakened in the youth of SMN and SFU, and even in some older *ejidatarios*. Many

[5] Originally, *ejido* land could not be sold, land and land-rights could not be separated, and were transferred from the father to one of his sons (de Ita, 2006). In 1992, article 27 of the constitution was modified, authorizing the use of *ejido* and communal lands by third parties, the transfer of plot rights, and the acquisition of full ownership and alienation of plots (Gómez de Silva, 2016). The access of foreigners to Mexican rural lands was designed (Chávez-Padrón, 1999).

young people are no longer interested in the countryside and agriculture, so this weakening of peasant knowledge will likely continue if nothing is done about it (see subsection 3.2.2, in Results). This situation is observed with greater force in SMN, which is associated with the presence of avocado orchards, both by outsiders and local peasants.

The loss of peasant lands, the weakening of traditional knowledge, and the deterioration of traditional community life, although in different ways, have occurred in different rural regions worldwide in the framework of depeasantization processes.

4.4. Community social organization and decision-making

The differences between the current situations in both communities have been determined mainly by social organization. That determines their differences in the livelihoods and LUC. The main determining factors of the LUC in both *ejidos* have been the replacement by the arrival and expansion of industrial agriculture, ecological succession, agricultural abandonment, and community social organization and decision-making (or not) regarding selling *ejido* land to outsider. When the possibility of selling land to outsider avocado growers arose in the first decade of this century, SFU made a decision and position in this regard at the community level, collectively agreeing in the *ejidatarios*' assembly to not sell *ejido* land to outsiders. On the other hand, in SMN, in the first years, no decision or position was taken on this issue, which resulted in many *ejidatarios* selling *ejido* lands to outsider avocado growers, losing part of an important heritage, peasant land (see subsection 3.3.3, in Results). This is the first time that these communities face outsiders who want to buy their lands, making economic offers and also using unethical commercial practices. That difference in organization and decision-making explains that, while SMN avocado orchards correspond to 20.2% of the *ejido* area, they only correspond to 1.63% in SFU, which corresponds to local peasants' orchards. That also explains that while in SMN the area of traditional agriculture decreased 51.74%, in SFU it only decreased 0.86% (see subsection 3.2.3, in Results). This more extensive presence of avocado orchards in SMN is consistent with the peasant discourse there, where there is a less negative perception of the orchards than in the peasants of SFU (see subsection 3.3.2, in Results).

The sale of land to foreign avocado producers in the SMN has decreased due to: (1) many *ejidatarios* chose to experiment by planting avocado in their PUs, thus maintaining their land and implementing environmental care and profit-driven actions; this was discussed in the *ejidatarios*' assembly and was promoted mainly by young people from peasant families; (2) it was agreed, in the *ejidatarios*' assembly, that if any external avocado grower wanted to buy *ejido* land, he should attend a session so that they could meet him; this is due to worrying security issues that were occurring in association with the many outsider avocado orchards.

At the most general level, the common resources' problem is organizing: moving from independent actions to coordinated strategies (Ostrom, 1990), requiring collective rules agreed upon by the users of said resources (Merino, 2006). Other determining variables in the self-organization of such users are leadership, knowledge of the socio-environmental system and its importance for users (Ostrom 1990, 2014). Strengthening communality and social cohesion is key to facing the challenges imposed by neoliberal reform, the expansion of industrial agriculture, and organized crime (Toribio et al., 2019); on the contrary, as community life weakens, self-organization becomes more difficult. By defending a community resource or heritage, as has occurred in SFU with peasant land, becomes a source of unity and strengthens the sense of community (Velázquez, 2019). Such organized action facing the arrival of foreign avocado growers shows social cohesion (Speelman et al., 2014). On the other hand, the development of local groups also can improve social cohesion (Speelman et al., 2014), which has occurred in SMN, with the formation of a local avocado growers' group in the last years.

The key reason why, in SFU, peasants did not sell their *ejido* land to outsiders while in SMN they did sell was not an agroecological one, but rather because of social cohesion and the position and agreement in the *ejido* assembly. A sufficiently sound social organization is necessary to decide and position at the community level when a new problem arises, as the arrival of outsiders to buy peasant land and keep part of the community's heritage and resources. Sound social organizational structures are essential to deal with land dispossession (Velázquez, 2019), and to improve adaptability and the development of long-term adaptations in different systems and regions worldwide (Ostrom, 1990).

4.5. Traditionalism

Peasant organization has become a brake on capitalist expansion. The Mexican State has tried to turn peasant PUs into capitalist enterprises, with depeasantization being one of the paths for this (Carton de Grammont, 2009). Depeasantization deepened legally from 1992 with the end of the agrarian distribution, but in practice from the second half of the '70s and neoliberal policies from the '80s (Carton de Grammont, 2009). Quantitative (decrease in peasants and peasant PUs) and qualitative (change in the type of agriculture) depeasantization has occurred in the PLB (van der Ploeg, 2018). For some decades, peasants have been incorporating characteristic elements of industrial agriculture, such as agrochemicals, tractors, and improved seeds (qualitative depeasantization) (Subercaseaux et al., 2021). The above corresponds to the gradual industrialization of traditional agriculture. In addition, industrial PUs have arrived in the basin (quantitative depeasantization) (Astier et al., 2011; Orozco-Ramírez and Astier, 2017). In SMN, there has been greater depeasantization than in SFU due to the LUC towards industrial agriculture, both by selling peasant lands and by peasants planting avocado.

In SFU, most peasants have continued with traditional agriculture, showing more attachment to that, which is probably strengthened by greater social cohesion. In addition to experiences within the framework of the agroecological movement with support from academic actors, such as fairs of local peasant products and tortilla-makers networks, which seek to contribute to local sustainability. In SMN, there are other visions and peasants have taken other paths looking for the best option for their families, within their possibilities in the existing contextual and structural conditions. According to some of the peasants interviewed there, if the peasant continues to engage in the same old agriculture, it is a problem. In this vision, for peasants' well-being, they must change their style of agriculture by technifying it, and move away from traditionalism because the world has changed, modernized, and globalized (see subsection 3.3.4, in Results). This is consistent with the LUC in SMN. It is a speech that is becoming more like that of an agricultural entrepreneur than that of a peasant while showing innovation. The rationality underlying is economical and productivist; there is no comprehensive vision that allows adequately perceiving the value of traditional agriculture and the associated knowledge. If that deteriorates, the lifestyle of the communities where this agriculture has been developed and practiced also deteriorates. Economic rationality is a prevailing feature in our epoch (Naredo, 2004) and is associated with prioritizing the economic-monetary dimension by social actors (Naredo, 1987; Naredo and Parra, 1993). The dominance of economic rationality leads to the dominance and expansion of landscapes with a primarily economic functionality (Subercaseaux, 2013).

4.6. Peasant trajectories facing agricultural industrialization, adaptive capacity, and resilience

Both communities have shown different trajectories facing agricultural industrialization and its expansion (Table 3). Such trajectories are described and analyzed below using the concepts and considerations presented in subsection 2.1.

Table 3. Peasant trajectories facing agricultural industrialization and its expansion, in SFU and SMN communities in the Lake Pátzcuaro Basin. It indicates which trajectories each community has taken, and whether they correspond to adaptive strategies or not.

Peasant trajectories	Communities	Adaptive strategy or not?
Increase non-agricultural income sources	SFU SMN	Not an adaptive strategy
Continue with traditional agriculture: *milpa*, rotational plots, livestock	SFU, high SMN, low	Not an adaptive strategy
Work as a day laborer in industrial agriculture PUs (avocado orchards or berry greenhouses)	SFU SMN, high	Not an adaptive strategy
Peasants plant avocado and *milpa* in their PUs	SFU, very low SMN, high	Adaptive strategy
Peasants sell land to outsiders for avocado orchards	SMN, high	Not an adaptive strategy
Comunity social organization and decisión-making regarding the sale of land to outsiders	SFU SMN, weak, late	Adaptive strategy

In both communities, families have modified their livelihoods by increasing their non-agricultural sources of income. They have made changes, seeking other sources of income for financing family needs. With this, the system (family/community) has more bases and alternatives to sustain itself economically, as long as there is no loss of their own land or traditional knowledge. On the other hand, this is a trajectory that does not include adjustments considering future disturbances, being effective mainly in the short term. Consequently, although there is a response, there is no anticipation or adaptive strategy.

Also in both communities, young people from peasant families have responded by working as day laborers in industrial PUs, especially in SMN. This trajectory decreases the degree to which the system is affected only if the young peasants distribute their working time between day labor in industrial agriculture (they learn to work avocado) and in traditional agriculture in their PU, but not if they only work as a day laborer and begin to lose traditional knowledge. In turn, this in itself does not prepare the system for future disturbances; consequently, it is not an anticipatory trajectory but a coping facing the disturbance, not corresponding to an adaptive strategy. But, if young people acquire new knowledge by learning to work avocado and then plant it in their PUs, they would be anticipating a way to cushion and/or take advantage of the continuity of agricultural industrialization.

In SFU, the main trajectory has been the decision-making and position at the community level not to sell *ejido* land to outsiders and, moreover, most peasants have continued with traditional agriculture. The former implies strong and/or reinforced social networks and local organizational structures. By improving social organization and position at the community level, the system is better prepared for both current situations and future disturbances; therefore, this would be effective in the long term (as long as the agreement is maintained and complied with). Thus, this

trajectory is anticipatory and corresponds to an adaptive strategy. On the other hand, almost all the peasants in SFU remain with traditional agriculture despite contextual changes, nor anticipating or preparing the system for future disturbances.

In contrast, in SMN, the main trajectory has been the sale of *ejido* land to outsiders for avocado orchards and, in later years, peasants planting avocado in some of their plots. With the former, the system loses a valuable part of its heritage, the land, which has important negative consequences. This is a trajectory that does not consider future factors or prepare the system for future disturbances, but rather weakens it and, therefore, is mainly effective in the short term. Thus, it is not anticipatory nor is it an adaptive strategy.

Regarding the peasants who have planted avocado in their PUs (considerably more in SMN than in SFU), they usually plant avocado in one or two of their plots and maintain *milpa* in the others, which implies diversification and reorientation of production systems, and in some cases the improvement of agricultural infrastructure. Diversification of production and income has frequently been shown to reduce vulnerability to external factors and improve adaptive capacity (Ribeiro Palacios et al., 2013; Speelman et al., 2014). In addition, peasants in SMN are trained, incorporating new information and skills, i.e., they learn, something valuable for resilience (Speranza et al., 2014). Consequently, they make changes facing current situations and also anticipate and strengthen the community for future disturbances. Therefore, it would be effective in the long term, anticipatory, and correspond to an adaptive strategy. However, diversification may not be able to guarantee adaptive capacity in the absence of effective community decision-making structures (Speelman et al., 2014).

5. Concluding remarks

The changes related to agricultural industrialization and its expansion most important to explain the current situation of SFU and SMN have been the LUC, changes in livelihoods, migrations to urban centers and the United States, changes in the management of the peasant PUs, and the deterioration of the peasant heritage. Some drivers have promoted agricultural industrialization while others have hindered it. These change processes and their drivers operate at different interrelated scales, at community, regional, state, national and global levels, constituting a multi-scale network with local impacts.

The LUC is how RAMI is reflected in the rural landscape. SFU's LUC differs regarding SMN and the analyzed sub-basin as well as from the prevailing pattern in the region. The SFU *ejido* is an "island" with practically no avocado orchards, and the few there are owned by local peasants. This is explained by the decision and position in SFU not to sell land to outsiders.

The main peasant trajectories in SFU and SMN facing agricultural industrialization and its expansion have been: increase in non-agricultural sources of income; continuing with traditional agriculture (*milpa*, rotational plots, livestock); working as a day laborer in industrial agriculture PUs (avocado orchards or berry greenhouses); planting avocado in their PUs; peasants selling land to outsiders for avocado orchards; community social organization and decision-making regarding selling land to outsiders. The only adaptive strategies are: in SFU, the social organization and decision-making not to sell land to outsiders; in SMN, the peasants who plant avocado and *milpa* in their PUs. The latter implies diversification and reorientation of production systems, and in some cases improvement of agricultural infrastructure. In addition, peasants learn. However, diversification may not improve adaptability in the absence of effective community decision-making structures (Speelman et al., 2014). Thus, the peasant's trajectories in SFU have contributed to building and strengthening adaptive capacity more than in SMN.

The visions and attitudes of SFU and SMN facing agriculture industrialization have been different. SFU has taken a path mainly of continuity with traditional agriculture and taking care of community lifestyle and practices, a more traditionalist path. SMN has let in outsider actors and several peasants have experimented with more modern agriculture. Tradition and identity are valuable, as is innovation. That balance is important.

Social organization and self-organization (or not) are partially conditioned by social and political systems on a larger scale. This research shows that a sound social organization is crucial to the future of the peasant communities and to improve their adaptability. In addition to the social organization, elements such as diversification, reorientation of production, and learning, can allow an adaptive trajectory.

To build adaptability and long-term resilience, actors must collectively develop a vision regarding desired development. This is in line with resilience as the passage to the desired state. To establish where we want the system to go and manage it consciously and intentionally along that path, social organization, and the capacity to collectively deliberate are key. This corresponds to a process of collective construction of adaptive strategies according to own identity and potential, which is key to sustainability.

The reflections achieved here would not have been possible without the work in the peasant communities and the crossing among theoretical frameworks with observations and information from that fieldwork. This research problematizes peasant trajectories facing agricultural industrialization and approaches it from a complex approach. We show the value and potential of approaching such a problem from said approach, what tends not to be adequately perceived by part of the academic research sector.

6. Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

7. Author Contributions

The original idea for the article, D.S.; direction A.I.M.C.; conceptualization, D.S. and A.I.M.-C.; field visits to PLB and communities, D.S., A.I.M.-C., M.A. and G.B.; writing—original draft preparation, D.S.; critically reviewed and discussed the first draft, D.S., A.I.M.-C., M.A. and G.B.; writing—review and editing, D.S., A.I.M.-C., M.A. and G.B. All authors worked closely in further review, discussed, and editing leading to the final manuscript. All authors have read and agreed to the published version of the manuscript.

8. Funding

This research was made possible thanks to a doctoral fellowship granted by the Mexican National Science and Technology Council (Consejo Nacional de Ciencia y Tecnología/CONACyT) to Diego Subercaseaux. The publication of this article was funded by DGAPA PAPIIT IG200720, project titled "Agricultura y agroforestería familiar y social en contextos de cambios locales y globales".

9. Acknowledgments

We would like to show our gratitude to the members of the Laboratory of Transdisciplinary Studies on the environment at the National School of Higher Studies at Universidad Nacional Autónoma de Mexico (UNAM). Also, we want to thank Antonio Navarrete (CIGA-UNAM) and Ivan Cumana for their contributions to the quantitative analysis of land-use change. Finally, we thank the Postgraduate in Sustainability Science of UNAM.

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11. Supplementary Material

Table: Main changes and drivers associated, related to agricultural industrialization and its expansion, in the SFU and SMN communities in the Lake Pátzcuaro Basin.

Supplementary Table 1. Main changes and drivers associated, related to agricultural industrialization and its expansion, in the SFU and SMN communities in the Lake Pátzcuaro Basin, Michoacán, Mexico.

Changes	**Specific change**	**Community**	**Drivers of change**									
			International, national and local policies (multi-scale: international, national-Mexico, Michoacán state)	Perception (local scale)	Community social organization and decision-making (local scale)	Nuevos deseos materiales, especialmente de jóvenes (local scale)	Young peasants value the land and the countryside less (local scale)	Deterioration of peasant agroecosystem (local scale)	Profitability and commercialization of traditional agricultura (local and regional scale)	Attachment (or not) to traditional agriculture and local lifestyle (local scale)	Economic needs and lack of work (local scale)	Pressure from outsider avocado growers (local scale)
Management of peasant PUs	Incorporation of elements of industrial agriculture in peasants' PUs, resulting in hybrid PUs	SFU SMN	X					X				
Livelihoods	Increased non-agricultural income sources, as masonry, in their community and in other	SFU SMN				X	X	X	X			
	Day laborer in industrial agriculture (avocado orchards or berry greenhouses), in other communities	SFU (mainly in berry greenhouses) SMN, low				X	X	X	X			
	Day laborer in industrial	SMN,				X	X	X	X			

Changes	Specific change	Community	Drivers of change									
			International, national and local policies (multi-scale: international, national-Mexico, Michoacán state)	Perception (local scale)	Community social organization and decision-making (local scale)	Nuevos deseos materiales, especialmente de jóvenes (local scale)	Young peasants value the land and the countryside less (local scale)	Deterioration of peasant agroecosystem (local scale)	Profitability and commercialization of traditional agricultura (local and regional scale)	Attachment (or not) to traditional agriculture and local lifestyle (local scale)	Economic needs and lack of work (local scale)	Pressure from outsider avocado growers (local scale)
	agriculture (avocado orchards), in the same community	high										
Land Use Change (Avocado orchards and berry greenhouses)	Plant avocado in peasant PUs	SFU, very low SMN, high		X		X	X		X	X	X	
	Sale peasant land for avocado orchards	SMN, high	X	X	X	X	X		X	X	X	X
Migration	Members of peasant families, especially young people, migrating	SFU SMN		X		X	X	X	X	X	X	
Deterioration of peasant agroecosystem	Decrease in agricultural productivity and need for agrochemicals	SFU SMN	X									
Profitability and commercializatio	Lower profitability of	SFU	X					X				

Changes	Specific change	Community	Drivers of change									
			International, national and local policies (multi-scale: international, national-Mexico, Michoacán state)	Perception (local scale)	Community social organization and decision-making (local scale)	Nuevos deseos materiales, especialmente de jóvenes (local scale)	Young peasants value the land and the countryside less (local scale)	Deterioration of peasant agroecosystem (local scale)	Profitability and commercialization of traditional agricultura (local and regional scale)	Attachment (or not) to traditional agriculture and local lifestyle (local scale)	Economic needs and lack of work (local scale)	Pressure from outsider avocado growers (local scale)
n of traditional agriculture	traditional agriculture, fewer commercialization possibilities	SMN										
Dangerous hill and forest	Insecurity and dispossession of land in ejido hill	SMN			X		X			X		
Traditional knowledge and community life	Loss or weakening of traditional agricultural knowledge (soil recognition, milpa management) in some peasants. Deterioration and loss of traditions, festivals, and practices related to traditional agriculture	SFU, very low SMN, more					X			X		

CAPÍTULO 5

Reflexiones Finales

Las actividades humanas surgieron como conversaciones, redes de coordinaciones de coordinaciones conductuales consensuales entrelazadas con el emocionar

HUMBERTO MATURANA - BIÓLOGO Y EPISTEMÓLOGO CHILENO

No camines delante de mí, puede que no te siga. No camines detrás de mí, puede que no te guíe. Camina junto a mí y sé mi amigo

ALBERT CAMUS - LITERATO FRANCÉS

Hay un lugar
donde vive todo lo olvidado

MARGARET RANDALL - POETA ESTADOUNIDENSE

REFLEXIONES FINALES

1. Imposición de la Modernización e Industrialización Rural y Agrícola, el "Progreso" Moderno e Implicaciones

En este trabajo se ha abordado, desde la CS y la transdisciplinariedad y mediante un acercamiento complejo, el proyecto civilizatorio de la modernización en la sociedad industrial y, más precisamente, la modernización de las áreas rurales y la industrialización agrícola y su expansión e implicaciones. Ha ocurrido una imposición coactiva del modelo agrícola industrial, el cual ha ido transformando y/o sustituyendo a las formas tradicionales vinculadas a las culturas rurales locales (Guzmán *et al*., 1999). Esta problemática de naturaleza multidimensional incluye diferentes procesos e impulsores de cambio interrelacionados en un complejo multiescalar anidado, desde la UP a lo nacional y global. El paisaje rural va reconfigurándose hacia el modelo industrial y el agronegocio. Se requiere un paradigma de modernización rural y agrícola suficientemente abarcativo y flexible para dar cabida a una diversidad de visiones y modelos (García, 2002).

En el marco de la modernización industrial, el "progreso" de las áreas rurales se definió exógenamente, desde los centros urbanos y el pensamiento científico convencional, implicando una fuerte homogenización cultural y erosión del conocimiento local generado mediante la interacción humano-naturaleza en cada lugar y agroecosistema específicos. Con el desarrollo tecnológico y sus aplicaciones en las sociedades modernas surge la racionalidad científico-tecnológica. La agricultura industrial podría, pues, artificializar la naturaleza reproduciéndola a través de la ciencia y tecnología, y el humano podría separarse de la naturaleza y dominarla (Guzmán *et al*., 1999). La naturaleza pasó de ser el espacio-vida al cual pertenecemos, para convertirse en una mercancía que se transa en el mercado económico (Leff, 2004). La crisis civilizatoria y socioambiental es también una crisis epistémica (González-Márquez y Toledo, 2020). Esta crisis presenta varios símbolos dicotómicos modernos, como la separación sujeto y objeto y la percepción del resto del mundo como objeto, naturaleza y sociedad, individuo y comunidad, mente y cuerpo, razón y emoción. De estos símbolos dicotómicos se derivan percepciones, concepciones y comportamientos por los cuales concebimos las urdimbres de la vida como recursos disponibles para nuestros afanes explotadores (Giraldo, 2018). El sistema alimentario industrial es un potenciador de las crisis climática, ambiental, alimentaria, de salud pública y otras (Giraldo, 2018).

Con la MIRA ha ocurrido una divergencia y disociación entre la agricultura y la prosperidad de las regiones rurales (Gastó *et al*., 2012; Koopmans *et al*., 2018; Rivera *et al*., 2018; Huttunen, 2019). El modelo y manejo industrial es incompatible con la sustentabilidad

socioambiental (Guzmán *et al*., 1999). Además, cuando elementos de la agricultura industrial atraviesan los contextos y sistemas propios de la agricultura tradicional, lo cual ha sido impulsado por la acción del Estado, estos resultan alterados, lo que subsume y coopta al campesinado que habita esas tierras (Giraldo, 2018). Sin embargo, en muchos casos la voracidad de la acumulación de tierras por el modelo industrial imperante también ha provocado el fortalecimiento de los pueblos y comunidades campesinas y organizarse para defender sus territorios (Giraldo, 2018).

2. Aproximación y Posicionamiento Epistemológico y Trayectorias Campesinas

Para el abordaje integral de la MIRA y sus efectos en la CLP y otras regiones rurales, más que acumular información es crucial una aproximación adecuada. Nuestros actuales modelos de conocimiento construyen muros epistémicos. El posicionamiento epistemológico tiene implicaciones en nuestros procesos cognitivos y en la ética de la *praxis*. La negación de otros mundos y visiones nos afecta a todos (Giraldo, 2022); todas las miradas aportan para entender integralmente un problema. La transdisciplinariedad y el paradigma de la complejidad se orientan a lidiar con la complejidad. Conjuntamente proveen elementos para abordar la sostenibilidad y sus problemáticas integralmente, pudiéndose incluir y articular variadas dimensiones como la cultural, social, económica, territorial, ecológica, entre otras, además de manifestaciones o aspectos que dan cuenta de la bioculturalidad y la cuestión socioambiental, como las emociones, la afectividad o la espiritualidad. En esta investigación hemos planteado una aproximación y posicionamiento epistemológico para el abordaje integral de la MIRA, mediante la integración del axioma ontológico o de los niveles de realidad y percepción, el axioma lógico o del tercero incluido (Nicolescu, 2014_a), y la dialéctica (Morin, 1990). Tal aproximación abre posibilidades de observación, análisis, reflexión, argumentación y manejo respecto a la MIRA y sus implicaciones. Posibilita complementar diferentes campos y disciplinas científicas, con sus diferentes enfoques y conocimientos, así como conocimientos tradicionales no científicos,

Actualmente, en muchas regiones rurales las agriculturas tradicional e industrial, sus combinaciones o hibridaciones y otros estilos de agricultura, coexisten en el paisaje. Pero es una coexistencia tensa, conflictiva e inestable. Por un lado, están los afanes expansivos sin límites autoimpuestos del modelo industrial, acaparando tierras sin más consideraciones que la propia conveniencia económica; por el otro, la respuesta que aquello provoca en las comunidades rurales, incluyendo autoorganización y defensa del territorio y la vida comunitaria tradicional, y también comunidades que incorporan elementos del modelo industrial, permeando en el sistema sociocultural comunitario. Percibiendo diferentes niveles de realidad interactuantes y desde la confrontación dialéctica entre opuestos, la coexistencia e interacción entre agricultura tradicional y agricultura industrial puede abordarse no como meramente dicotómica y antagónica sino a la

vez como complementarias en el sistema total; los opuestos coexistiendo e interactuando sin perder sus identidades (Max-Neef, 2005). Así, la descampesinización y recampesinización, las agriculturas tradicional e industrial, los saberes tradicionales y científicos, actores con culturas y percepciones diferentes, entre otros, coexisten y pueden complementarse, con probables tensiones. Podemos pasar de un nivel a otro, de la perspectiva y percepción de un actor a otro, e integrando opuestos. Lo que surge con esa coexistencia no es sólo un estado intermedio o un tercero incluido, sino una "complejidad emergente". Con una mirada cercana, fina y situada, pueden percibirse no tres situaciones sino una mayor variedad de situaciones que tienden a interrelacionarse entre sí, y que pueden ser o mostrar opciones ante problemáticas enrevesadas y en procesos de transición. Esta aproximación y posicionamiento epistemológico posibilita percibir, considerar e incorporar en los análisis y reflexiones, las complejidades emergentes desde los procesos de la MIRA, correspondiendo a una aproximación y posicionamiento de la investigación transdisciplinaria de sostenibilidad (Lang *et al*., 2012).

La propuesta epistemológica permite percibir heterogeneidades y diferencias y, a la vez, vincularlas, concibiendo la coexistencia complementaria de elementos y procesos antagónicos como parte de la constitución identitaria de un territorio, paisaje o región. Aporta al diálogo y encuentro entre culturas, para generar procesos de co-construcción. Tal aproximación transdisciplinaria y compleja permite también trascender la supuesta dicotomía naturaleza-sociedad, ya que nos conduce a una visión abarcativa e integradora de diferentes dimensiones y manifestaciones de los sistemas, procesos y problemas socioambientales complejos. Se enmarca en las epistemologías de vanguardia, las que incluyen a la epistemología de la complejidad y transdisciplinaria, además de las epistemologías de la decolonialidad y del Sur (Haidar, 2020, 2021). Estas presentan una recursividad, dialogo y complementariedades entre sí, con posturas críticas frente a las epistemologías hegemónicas, reconocen todos los procesos cognitivos que se desarrollan en todas las culturas, aceptan varios tipos de conocimiento, y abren caminos de diálogo (Haidar, 2020 y 2021).

Las comunidades tradicionales tienen diferentes visiones y actitudes, y toman diferentes trayectorias, ante la MIRA. En los casos abordados hemos observado que algunas toman un camino de apego a la agricultura tradicional y la vida comunitaria, una trayectoria más tradicionalista, y otras en cambio experimentan con nuevos cultivos y tecnologías más industriales, y se abren a la entrada de otros actores y costumbres. La tradición y la identidad son valiosas, al igual que la innovación. Ese balance es importante.

Actualmente, en parte debido al contexto internacional y las políticas internas, las cuales han fomentado la MIRA, frecuentemente la agricultura tradicional por sí sola no sostiene económicamente al hogar campesino mexicano, lo que ha llevado a una diversificación de sus

medios de vida (desagrarización) (Carton de Grammont, 2009). Su sostenibilidad económica suele requerir de otras actividades, incluyendo la agricultura industrial, a través del trabajo jornalero en UPs industriales, experimentación con cultivos, tecnologías y comercialización industriales, o la venta de tierras a foráneos, buscando la mejor opción para sus familias dentro de sus posibilidades. Con esa venta de tierras o reemplazo de cultivos tradicionales por otros más industriales, ocurre un CUS, como ha ocurrido en la CLP (Orozco-Ramírez y Astier, 2017).

El CUS es como la MIRA se plasma en el paisaje rural. Tal CUS está determinado por la interacción de procesos y factores externos e internos. Entre los últimos está la (auto)organización social de las comunidades rurales. Esa organización comunitaria está parcialmente condicionada por los sistemas sociales y políticos a mayor escala. Nuestros hallazgos muestran que para las comunidades es fundamental una sólida organización social para tomar decisiones y posturas para proteger su patrimonio frente a nuevos problemas, como forasteros que quieran comprar sus tierras, así como para construir adaptabilidad comunitaria.

En un contexto de alto nivel de cambio e incertidumbre, como en la época actual, desarrollar la capacidad de respuesta de los sistemas rurales y agrícolas debiera ser un eje central en su "modernización" (García, 2002). Además de la organización social, la diversificación y reorientación de los sistemas productivos, mejorar la infraestructura agrícola y adquirir nuevos conocimientos y habilidades, también pueden conducir a trayectorias y estrategias adaptativas ante la MIRA (Speelman *et al*., 2014; Speranza *et al*., 2014). Sin embargo, es posible que la diversificación no mejore la adaptabilidad en ausencia de estructuras comunitarias eficaces para la toma de decisiones (Speelman *et al*., 2014).

Con base en los casos estudiados, hemos discutido que para construir adaptabilidad y resiliencia a largo plazo, los actores y comunidades locales deben desarrollar colectivamente una visión sobre el desarrollo que desean. Para manejar al sistema consciente e intencionadamente por ese camino deseado, son claves la organización social y la capacidad de deliberar colectivamente. Esa búsqueda del interés general de la comunidad es coherente con un conocimiento de tipo inherentemente comunitario, el cual tiende a justificarse intersubjetivamente por todos los sujetos de la comunidad epistémica pertinente (Villoro, 2008). La academia puede hacerse participe de esa comunidad epistémica pertinente en un proceso de co-construcción de la misma y, así, participar en el proceso de deliberación colectiva. Lo indispensable es que, mediante el diálogo, la comunidad local construya una visión del desarrollo deseado, pudiendo ser participe en aquello la academia, en el marco de procesos colaborativos y una epistemología abarcativa e inclusiva. Este proceso deliberativo, de diálogo, y eventualmente colaborativo, corresponde a un proceso de construcción colectiva de estrategias adaptativas, construyendo así adaptabilidad y resiliencia, ambas claves para la sostenibilidad.

A continuación, se presentan de manera concisa los principales resultados, reflexiones y planteamientos que emergieron en esta investigación:

- Aproximación y posicionamiento epistemológico, para abordar la MIRA integralmente, con base en elementos de la transdisciplinariedad y del paradigma de la complejidad: axioma de niveles de realidad y percepción; axioma del tercero incluido; dialéctica en el marco del paradigma de la complejidad.
- Las complejidades emergentes al abordar la CLP respecto a la MIRA desde la aproximación epistemológica referida en el punto anterior. A nivel de UPs: hibridaciones entre las agriculturas tradicional e industrial. A nivel de cuenca: coexistencias, heterogeneidades y mosaicos, con el surgimiento de neo campesinos, la llegada de nuevos actores de la agricultura industrial, nuevas tecnologías y manejos, y descampesinización. Finalmente, el surgimiento de nuevos problemas y tensiones (como acaparamiento y despojo de tierras, y exclusión e inseguridad), y de posibilidades (como empleo y posibles complementaciones y diálogos entre diferentes tipos de agricultura y actores) para el desarrollo rural y la sostenibilidad. Todo lo anterior como procesos y situaciones dinámicas interrelacionadas, multidireccionales y multiescalares.
- Las comunidades campesinas SFU y SMN presentan una diversidad de trayectorias ante la industrialización agrícola y su expansión. Tales trayectorias han sido: aumento de fuentes de ingresos no agrícolas; continuar con agricultura tradicional: milpa, parcelas en rotación, ganado; trabajar como jornal en UPs de agricultura industrial (huertas de aguacate o invernaderos de *berries)*; plantar aguacate y milpa en diferentes parcelas de sus UPs; vender sus tierras campesinas a foráneos para huertas de aguacate; organización social comunitaria y toma de decisión respecto a venta de tierras a foráneos.
- Los cambios cuantitativos en el uso del suelo en SFU y SMN, desde el año 1995 al 2021, ante la industrialización agrícola y su expansión. En los ejidos de ambas comunidades no había huertas de aguacate en 1995; en 2021, en el ejido de SFU ese uso del suelo aumentó en solo 1.63%, en cambio en SMN aumentó en 20.2%.
- El elemento por el cual en SMN han llegado y se han expandido las huertas de aguacate y en SFU no, es el acuerdo y postura que tomaron en la asamblea ejidal en SFU de no vender tierras a foráneos cuando llegaron, por primera vez en la historia de estas comunidades, actores foráneos queriendo comprarles tierras. En SMN, en cambio, no tomaron un acuerdo y postura ante aquella situación.
- Por lo anterior, la organización social comunitaria ha sido el principal factor determinante de las diferencias actuales entre SFU y SMN, por ejemplo, sus diferencias actuales en

medios de vida y usos del suelo. La solidez de la organización social comunitaria ha sido el factor crucial.

- Por lo anterior, las trayectorias campesinas ante la industrialización agrícola y su expansión en SFU han aportado más a construir adaptabilidad que las trayectorias en SMN.

3. Diálogos, (Auto)organización Social y Movimientos Campesinos

Frecuentemente, en la coexistencia tensa, conflictiva e inestable entre las agriculturas tradicional e industrial, y sus hibridaciones, estamos ante conflictos entre mundos. Frente a intervenciones en torno a la idea moderna de progreso, las comunidades rurales frecuentemente intentan defender sus territorios materiales e inmateriales y sostener sus mundos (Giraldo, 2022). Ha sido usual negar otros mundos, ocupar sus tierras, irrumpir en sus entramados simbólicos e imponer la visión hegemónica del modelo industrial imperante. Se requieren, en cambio, aproximaciones y actitudes para abordar los procesos de construcción del mundo y la sostenibilidad rural considerando la interacción entre diferentes actores y sus perspectivas, percepciones y culturas, no imponiendo visiones e intereses excluyentes ni que resultan deteriorantes de los sistemas de soporte de vida. Una actitud y paradigma que no pretenda ser el único posible ni verdadero, sino que sea incluyente y pluralista en lo epistemológico y metodológico (Guzmán *et al*., 1999), propiciando un dialogo con otros paradigmas y visiones en la teoría y en la *praxis*.

Varias iniciativas y movimientos campesinos que han crecido exponencialmente en diferentes países (México, Nicaragua, Cuba, India, Mozambique, Nepal, etc.), muestran la importancia de la organización social y las metodologías horizontales basadas en el protagonismo de los agricultores y campesinos para desarrollar procesos colectivos de base. Un aspecto común y crucial ha sido que las organizaciones campesinas hayan tomado el proceso, no dependiendo de actores externos (Giraldo, 2018; Rosset y Altieri, 2018). Se deben identificar los potenciales que hay en la comunidad y "acompañar" los procesos de transformación en una dinámica colaborativa (Guzmán *et al*., 1999). Si un actor o fuerza externa interviene un sistema adaptativo, debe realizarlo sin deteriorar la adaptabilidad de tal sistema, requiriéndose identificar los elementos que generan y sustentan esa capacidad adaptativa. Lo endógeno no debe visualizarse como algo estático que rechace lo externo; cuando lo externo no agrede la identidad local y la autodefinición de calidad de vida, aquello puede incorporarse y activar el potencial local (Guzmán *et al*., 1999).

Esos movimientos campesinos horizontales han mostrado gran éxito respecto a la soberanía alimentaria (Giraldo, 2018). Los aprendizajes mediante el diálogo de saberes, además de abrir posibilidades de más autonomía, rescatan aspectos comunitarios debilitados, liberando potenciales individuales y colectivos inhibidos por el modelo industrial imperante, reavivan y/o

fortalecen el capital relacional, así como la capacidad de las comunidades de encontrar soluciones concretas ajustadas a sus particularidades culturales y ecológicas locales, desarrollan o rescatan saberes situados y la creatividad e invención social, y el sentimiento de pertenencia (Giraldo, 2018). Además, sirven para incorporar sistemáticamente las lecciones aprendidas en las experiencias exitosas, y así concebir nuevos proyectos colectivos (Rosset y Altieri, 2018).

Similarmente a como lo observamos en las comunidades participantes en esta investigación, un elemento clave son los procesos autoorganizativos. Por un lado, en las experiencias referidas en los párrafos anteriores fueron imprescindibles estructuras organizativas de base campesina para que el proceso pudiera desarrollarse; por otro lado, los campesinos no estuvieron aislados. La autoorganización horizontal debe combinarse, al menos en etapas iniciales, con elementos de planificación más centralizada (Giraldo, 2018). Sobre esa arquitectura en red pueden circular saberes comunes y producirse nuevo conocimiento a través de la hibridación, diálogo, recombinación de la información y aprendizaje colectivo (Escobar, 2005). La autonomía debe buscarse, pero sin aislamiento, sino que en red y en dialogo.

4. Colapso Civilizatorio y Socioambiental, Co-construcción de Alternativas y Sostenibilidad

La modernidad industrial se halla en un laberinto generado por ella misma, sin encontrar las posibles salidas. Inmersa en esta situación, se mantiene menospreciativa respecto al acervo experiencial histórico que radica en los conocimientos, creencias y prácticas tradicionales (Toledo y Barrera-Bassols, 2008). Esto confiere especial valor a los pueblos y comunidades tradicionales y a la agricultura tradicional.

Para la CS también ha resultado desafiante abordar la problemática socioambiental. Existe una percepción de insuficiencia general respecto al paradigma de la CS (González-Márquez y Toledo, 2020). Aunque implican un colapso, las crisis y revoluciones científicas son esenciales para la ciencia, ya que hay una ruptura del orden, un cuestionamiento de las reglas y generan un proceso de reconstrucción que puede crear nuevos postulados epistemológicos y ontológicos, estructuras conceptuales y caminos (González-Márquez y Toledo, 2020).

La articulación e integración que el abordaje desde la CS y la transdisciplinariedad permite, puede y debe generar un campo de interacción bidireccional entre la academia y los actores no académicos, a veces ya existente y que debe ser reconocido, visibilizado y valorado por la academia, y a veces aún no existente y que debe construirse. Ante el desafío socioambiental y de la sostenibilidad, se requiere una articulación e integración profunda de diferentes conocimientos, campos y disciplinas científicas y también más allá de la ciencia, incluyendo al arte, filosofía, conocimientos tradicionales, culturas y espiritualidades. Transcender esas fronteras, como se ha planteado desde la transdisciplinariedad (Nicolescu, 2014_b y 2020), replanteando el

conocimiento desde un *continuum* complejo (Haidar, 2020 y 2021). No una mera interacción entre diferentes formas de conocimientos, innovación tecnológica, tratados políticos y coherencia ambiental. Para la co-construcción de salidas ante la situación socioambiental, se requiere un dialogo entre culturas o cosmovisiones (Toledo, 2022), entre conceptos surgidos desde la ciencia y la política como la sostenibilidad y conceptos desde los pueblos originarios como el "buen vivir".

La transición civilizatoria hacia trayectorias diferentes a la expansiva industrialización tecnologista requerirá no sólo un cambio en la plataforma técnica y político-económica, sino un profundo cambio cultural y ético (Giraldo, 2018). Actualmente existen campos y aproximaciones científicas integradoras, con potencial de injerencia social y política, que muestran posibles alternativas ante la actual problemática socioambiental, rural y agrícola. Las agroecologías, por ejemplo, pueden activar y poner en práctica diálogos intersectoriales e interculturales entre ciencia y campesinado, generándose eventualmente una co-construcción de saberes. Conforman también un movimiento social y proyecto político con propuestas concretas para la soberanía alimentaria y la autonomía territorial. Tales agroecologías muestran el tránsito hacia un ser humano que actúa en comunalidad, e implican un pensamiento crítico, cuestionando injusticias sociales e impactos ambientales, pudiendo operar como una herramienta para la defensa de los territorios, estilos de vida y patrimonios bioculturales (Giraldo, 2022). Varias prácticas y procesos sociales campesinos y agroecológicos ya están dando pautas aproximadas para una transición civilizatoria (Giraldo, 2018), autoorganizándose a nivel local, construyendo estrategias adaptativas y así adaptabilidad, y de esta manera preparándose para futuros cambios, amenazas o problemas. La evidencia, hasta ahora, muestra que la esperanza ante la crisis socioambiental radica en iniciativas de actores locales que han tomado un camino hacia la sostenibilidad y el bienestar colectivo actual y futuro, más que en iniciativas y acuerdos globales o instituciones nacionales e internacionales.

Un problema de alta trascendencia en el devenir humano, y que ha sido abordado desde hace siglos desde diferentes perspectivas, es el hecho de que cada quien vive, transcurre y está inmerso en su propio mundo; los mundos de cada persona difieren, inherentemente, unos de otros. ¿Cómo lidiar y manejar aquello? Los procesos de dialogo y aprendizaje mutuo son un elemento clave para eso y, consiguientemente, las aproximaciones y marcos epistemológicos y también metodológicos que se encausan e iluminan ese camino son de valía. Ante la MIRA y para la sostenibilidad rural, se requiere asumir el desafío de co-construir, en el marco de procesos colaborativos de articulación e integración de conocimientos y saberes, sistemas socioambientales adecuadamente adaptativos y paradigmas dinámicos acoplados con el contexto de nuestra época y sus particularidades.

5. Proyección de la Investigación

A continuación, se presentan varios temas y preguntas que han surgido durante el transcurso de este proceso investigativo y que muestran su proyección, hacia donde mirar en la continuidad de esta línea de investigación. Además, son temas y preguntas respecto a los cuales este trabajo aporta luces, orientación o elementos, tanto por las aproximaciones epistemológica y metodológica aquí planteadas e implementadas, como por las discusiones y reflexiones desarrolladas. En algunos casos, los temas y preguntas se presentan agrupados en temas más amplios que los engloban y vinculan.

(1) Sostenibilidad y trayectorias campesinas.

- Relacionando la MIRA, las trayectorias campesinas que resultan de la interacción multiescalar entre lo endógeno (comunidades campesinas o CLP) y exógeno (Michoacán, México o contexto global), la organización comunitaria, y la sostenibilidad local, ¿las trayectorias campesinas ante la MIRA han propiciado y están propiciando la continuidad y sostenibilidad del sistema campesino comunitario, del cual la agricultura y tradicional es parte central?, ¿se han desarrollado y están desarrollándose a nivel local operaciones colectivas colaborativas y estrategias coordinadas que propicien tal continuidad y sostenibilidad?
- Respecto a la evaluación de sostenibilidad, ¿cómo puede realizarse una evaluación de sostenibilidad de áreas rurales que se base en el conocimiento local, que sea altamente participativa y colaborativa y se incorporen los temas importantes desde la perspectiva de los campesinos locales, y que permita que salgan a luz dimensiones como la afectiva, estética y la espiritualidad?, ¿cómo podrían la CS y la transdisciplinariedad aportar en aquello?

(2) Construcción colectiva, (auto)organización comunitaria y coexistencias rurales.

- ¿Cómo ocurre la circulación de conocimientos y la generación de nuevos conocimientos en el marco de procesos (auto)organizativos campesinos en red en áreas rurales?, ¿cómo lograr procesos sociales agroecológicos efectivos para territorializar, escalar y difundir la agroecología y sus prácticas?
- ¿Como podrían equipos investigadores académicos contribuir a fortalecer la capacidad de dialogo y deliberación colectiva en las comunidades campesinas, de manera de construir y/o potenciar la organización social y así estar en mejor condición ante la MIRA, la expansión de la agricultura industrial, las políticas neoliberales y la globalización?
- Respecto a la coexistencia de procesos y elementos rurales antagónicos, ¿cómo ocurre la coexistencia, interacciones y potenciales complementaciones y tensiones entre procesos y

elementos rurales antagónicos, como diferentes tipos, proyectos e iniciativas agrícolas, como parte de la constitución identitaria de un territorio, paisaje o región rural?, ¿cómo se desarrollan esos entramados?, ¿cómo puede usarse aquella coexistencia para co-construir alternativas al modelo agroindustrial imperante y caminos hacia la sostenibilidad?, ¿cómo desarrollar e incorporar procesos de dialogo y de aprendizaje mutuo que sirvan al respecto?

(3) Políticas públicas, CS y transdisciplinariedad.

- ¿Qué elementos de la CS y la transdisciplinariedad podrían incorporarse en la elaboración de políticas públicas para el desarrollo rural sostenible?, ¿cómo pueden la CS y la transdisciplinariedad propiciar la circulación de conocimientos de una manera que permita y facilite el empoderamiento y la autonomía de las comunidades rurales, a diferencia del extensionismo clásico?, ¿cómo la CS y la transdisciplinariedad pueden proveer bases y elementos para una política pública que proteja las condiciones de vida campesinas y sus posibilidades ante los cambios contextuales y en sus entornos y territorios?
- Respecto al cambio de uso del suelo, ¿cómo manejar y regular, de manera diferenciada y en el marco de procesos participativos y colaborativos, el cambio de uso del suelo de acuerdo para que se adecue a las necesidades, aptitudes y potenciales de cada comunidad dentro de cada región, cuenca u otra unidad territorial rural?, ¿cómo manejar y regular la coexistencia, distribución y balance entre los diferentes tipos de agricultura en las diferentes regiones, cuencas u otras unidades territoriales rurales?
- Respecto a la soberanía y seguridad alimentaria, ¿cómo podría manejarse y regularse el balance entre los diferentes tipos de agricultura en cada región, cuenca u otra unidad territorial rural, de manera de propiciar la soberanía y seguridad alimentaria?, ¿cómo podrían la CS y la transdisciplinariedad aportar al respecto y al desarrollo de políticas públicas?
- Respecto a la justicia social, ¿cómo pueden contribuir los procesos de la MIRA y de construcciones de alternativas al modelo agroindustrial imperante, y especialmente su abordaje integral, en la reducción de la brecha de pobreza y en condiciones de vida más equitativas?

(4) MIRA y complejidades emergentes.

- ¿Cómo continuar profundizando en las complejidades emergentes que surgen desde la MIRA, es decir respecto a toda la diversidad de situaciones y tipos de agriculturas y otras actividades rurales que surgen con dicho proceso modernizador, así como las tensiones, problemas y nuevas posibilidades?, ¿cómo abordar y manejar las tensiones y problemas

que surgen desde la MIRA?, ¿cómo desarrollar e incorporar procesos de dialogo y aprendizaje mutuo que sirvan al respecto y para la sostenibilidad rural?

(6) Ontología de agricultura y modelo agroindustrial.

- ¿Corresponde considerar como "agricultura" al tipo industrial, un estilo y modelo profundamente industrializado, orientado prioritariamente al (agro)negocio e inherentemente deteriorante de los sistemas y procesos base de la agricultura, o más bien corresponde considerarlo como un negocio relacionado con lo agrícola?

(7) Agroecología y transdisciplinariedad.

- ¿Puede una agroecología transdisciplinaria proveer un marco adecuado para abordar las complejidades emergentes desde la MIRA de manera integral, y para construir alternativas al modelo agroindustrial imperante?

(5) Academia y ciencia.

- ¿Cómo generamos investigación científica acorde y sensible a las inquietudes y problemas de las comunidades campesinas que habitan las áreas rurales, una investigación situada, desarrollando procesos participativos y colaborativos y que incluyan a los diferentes sectores de la sociedad (multisectorial: política, comunidades locales, ONGs, mundo privado, academia, etc.)?

(6) Adaptabilidad y tradicionalismo

- ¿Cómo, a nivel de las comunidades rurales, puede buscarse y lograrse un balance entre adecuarse adaptativamente ante los cambios del entorno (económicos, sociales, políticos, climáticos, etc.) y a la vez no perder la identidad propia ni los acervos construidos experiencial e intergeneracionalmente?

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