

What do we talk about when we talk about milpa? A conceptual approach to the significance, topics of research and impact of the mayan milpa system

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ABSTRACT

The Maya milpa is an ancient agrarian system extended along Mesoamerica, widely known for the slash and burn practices and the polyculture of maize, beans and squashes. Although the Maya milpa has more than three centuries of history, there are several challenges that must be tackled in order to promote the preservation of the system. The aim of this paper is to settle a new starting point in Maya milpa research through a synthesis around the analysis Maya milpa concept, its main lines of research, and its environmental, social, and economic effects in the Yucatan Peninsula. Our research methodology consisted of two different phases: a) the review and analysis of secondary information (169 documents) by means of automated-curation of information (text mining methods) and manual inspection, and b) the design, application, and analysis of 12 interviews using Yucatan Maya milpa researchers as informants. Based on the results we propose some basic elements to consider for an integrative definition of the Maya milpa, we highlight the information gaps described by researchers and checked by wordclouds, and we reveal the most positive and negative impacts of the Maya milpa in terms of environmental, socio-cultural, and economic aspects.

1. Introduction

Mesoamerica is a large territory extended from mid-Mexico through Guatemala, El Salvador, Belice, and western Honduras and Nicaragua. This large region is considered one of the primary plant domestication centers where agriculture originated. Furthermore, all pre-Hispanic civilizations utilized the milpa as the basis for their crop-growing activities (Vavilov, 2009).

The word milpa comes from the Nahuatl *milli*, which means planted plot, and *pan*, which means upon (CONABIO, 2013) and is widely used in the current Castilian vocabulary of Mexico.

In Mexico, as in some other parts of Mesoamerica, the agrifood system is based on a type of rotational “shifting cultivation” slash and burn agriculture with a traditional low-intensity practice in which staples of maize, beans, and squashes are produced (Toledo et al., 2003).

The Maya milpa or *Kool* (milpa in mayan language) leads to an increase in landscape diversity due to the use of multi-stage and successional pathways of native secondary growth vegetation (Terán, 2010). It is an ancient agrarian practice and is regarded as an agro-system immersed in a matrix of polycultures, family gardens, milpa in

different stages of fallow, fragments of natural vegetation, among other elements that complement and interact with each other (Zizumbo-Villarreal and Colunga-García, 2017).

The Maya milpa partially supports the household economy and the food security and sovereignty of families where it has been established (Ford and Nigh, 2009; Martínez et al., 2017; Salazar-Barrimentos et al., 2016). Despite the significance and permanence of the milpa system across time, there is no precise statistics around the number of Maya milpa farmers and surface area used for milpa system.

On the other hand, the excessive use of agrochemicals, climate pattern changes, rural migration, among other factors, seem to be affecting the stability of the milpa system in the Yucatan Peninsula (Arias, 1994; Poole et al., 2007; Zizumbo-Villarreal and Colunga-García, 2017).

Maya milpa research has an important decades-long trajectory, there are relevant findings and knowledge. Nevertheless, there are difficulties which have not yet been addressed. In order to design proposals to solve the complex problems facing the Maya milpa, it is necessary to break down conceptual, theoretical and methodological barriers. Therefore, transdisciplinary approaches, such as the Socio-ecological system framework, offer a key tool for reaching this goal

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(McGinnis and Ostrom, 2014; Herrero-Jáuregui et al., 2018).

Moreover, it is important to synthesize the research efforts and main discussions developed around Maya milpa. A first step towards an effective analysis of the Maya milpa is to establish a well-defined corresponding concept, since the adopted definition will surely guide the analysis performed and will also facilitate a more effective communication among specialists in different domains.

The aim of this paper is to settle a new starting point in Maya milpa research through a synthesis around the analysis of the Maya milpa concept, its main lines of research, and its environmental, social, and economic effects in the region of the Yucatan Peninsula.

2. Methodology

Our research methodology involved two phases, we first reviewed and analyzed secondary information such as scientific papers and books, we then designed and conducted interviews in order to understand how different researchers conceptualize and understand the Maya milpa.

2.1. Phase I. Secondary information

The first phase of our investigation involved three different stages: definition of the secondary information web search strategy, selection of literature to be reviewed and, finally, automated-curation of information through text mining methods.

During the first stage we searched for Maya milpa researchers and their publications, as well as articles that contained the following key words: ethnobotany, *Zea mays*, maya forest, milpa, maize, slash and burn agriculture, and Yucatan Peninsula. This web search was conducted using the following databases: Science Direct; Scopus; Directory of Open Access Journals (DOAJ), Network of Scientific Journals from Latin America and the Caribbean, Spain, and Portugal (REDALyC), Web of Knowledge, Wiley Online Library, BioOne, Google scholar, CONRICyT, ResearchGate, and Annual Reviews.

The second stage involved the creation of a database in order to organize the following secondary information data: author, year, title, key words, first author institutional affiliation, type of document (scientific article, chapter, other), topic of research, and the region of the study area.

The third step involved the automated-curation of information through advanced methods of text mining. Text mining is the process of identifying, extracting, and managing words in order to retrieve specific information from a text (Ananiadou and McNaught, 2006). It allows the automation of time-consuming tasks in order to optimize bibliography curation. We preprocessed all the selected literature using part of the software of “The Text Mining Library for Biodiversity Literature in Spanish” described in Barrios et al. (2015).

The automated tasks were:

a) Extraction of the definitions of milpa: the definition extraction method we used was based on the method proposed by Molina-Villegas (2009) and Sierra et al. (2009); which uses lexical patterns, such as definitional verbs, combined with terms and cue words in order to generate regular expressions that allow the extraction of definitions in a fully automatic fashion. Two automatic definition extraction processes were conducted separately for English and Spanish documents. Appendix 1 lists the regular expressions¹ used for each language. The definitions we extracted were manually reviewed and grouped in five different categories which emphasize different concepts: 1. Milpa system exclusively as an agricultural activity, 2. Milpa system as an agricultural activity and related socio-cultural aspects, 3. Milpa system as an agricultural activity and related environmental aspects, 4. Milpa system as an agricultural activity and related economic aspects, and 5.

¹ Regular expressions are sets of strings or sets of ordered pairs of strings (Mitkov, 2003).

Milpa system as an agricultural activity and two or three related aspects (socio-cultural, environmental, or economic).

Therefore, the extracted definitions were organized by year in order to analyze the change in the definitions in the two following periods: 1993–2012 and 2013–2017.

b) Topic modelling around the milpa concept: this process was performed using a probabilistic method called Latent Dirichlet allocation (Blei et al., 2003) and enhanced with a parallel version of the original algorithm. Probabilistic topic modelling is based upon the idea that documents are mixtures of topics, where a topic is a probability distribution of Dirichlet over the words. One important feature of this method is the assumption that the only observable variable is the word frequency in each document as well its co-occurrence with other words. Therefore, the results are not biased by human interpretation. As a result of the process, each individual topic is represented as a probability distribution of words. The distributions we obtained were presented through word clouds and were later reviewed and categorized. The resulting information and the final proposed topics were complemented with a manual inspection of the selected papers, which consisted in the analysis of titles, keywords, and abstracts, therefore, publications were organized by year in order to analyze the variation in the research topics in the last decades.

c) Automatic Extraction of Reported Impacts: two automatic extraction processes were performed separately for English and Spanish documents. In order to perform the word-search we used the program Treetaggerwrapper version 2.0.6, utilizing adjective-noun lexical patterns such as: “environmental impact”, “economic impact”, “social impact”, “environmental implications”, among others. For the documents in the Spanish language, we performed the extraction using the same cue terms translated to the corresponding language: “*impacto ambiental*”, “*impacto económico*”, “*impacto social*”, “*implicaciones ambientales*”, etc. The complete list consists of 49 cue terms overall.

We found 169 documents (Appendix 2), of which 79% were articles, 9% were book chapters, and 13% were other types of documents (theses, conference proceedings, etc.). In terms of the language, 53% were in the Spanish language and 47% in English. With regard to the region, 72% of the documents pertained to the “Peninsula de Yucatan (Campeche, Quintana Roo and Yucatan)”, 17% to other areas of Mexico, and the remaining 11% to other countries in Mesoamerica.

In terms of the first author affiliation, 77% were from Mexican institutions, 13% from United States Universities and the remaining 10% from other international institutions.

All the documents were published during the 1953–2018 period; 12% were published prior to 2000, 44% during the 2001–2010 period, and 44% throughout the 2011–2018 period.

2.2. Phase II. Interviews with experts

The second phase of the investigation consisted of three different stages: interview design, conducting of the interviews, and analysis of gathered data through the interviews.

The first stage was the design of the interviews, the objectives of which were to inquire about the three elements described above: definition of milpa, topics of research, and the impacts of the milpa system.

The interview format included 24 open questions distributed in four different parts: academic information (institution, time spent working at said institution), experience in milpa research (topic of research in milpa, study area, main contributions to the topic), conceptualization of milpa (definitions, evolution of the definition) and milpa impacts (environmental, social, and economic impacts of the milpa system).

The second stage involved contacting and conducting interviews with expert researchers on milpa. The interviews were recorded in order to facilitate information analysis. The third and final stage involved the creation of an answer matrix and the analysis of the data collected.

During this phase, we conducted 12 interviews within the period of April to October 2018, each interview lasted an average of 60 min. We interviewed milpa researchers from institutions such as El Colegio de la Frontera Sur (ECOSUR), Centro de Investigaciones Científicas de Yucatán (CICY), Universidad Autónoma de Yucatán (UADY), Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV), Instituto Nacional de Antropología e Historia (INAH), Secretaría de Desarrollo y Cultura del Estado de Yucatán (SEDECULTA), Universidad de Oriente (UNO), and Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP).

3. Results

3.1. Definition of the maya milpa system

Based on the automated-curation and analysis of the information, we identified 56 different definitions from the reviewed literature, and 12 definitions expressed by the researchers during the interviews (Appendix 3). We organized these definitions in five different groups (Table 1). The first group corresponds to those definitions focused on agricultural and technical aspects of milpa crop (maize, squash and beans; slash and burn, etc.). This was the most frequent type of definition contained in the literature (42,9%), but not in interviews (16,7%). The second group of definitions contains those that relate the milpa system with cultural elements such as traditional knowledge (21,4% in the literature review and 16,7% from interviews conducted with researchers). The third group (17,9%) corresponds to those definitions which emphasize the environmental aspects, such as the milpa's ecosystem services. Only one of the interviewees provided a definition with this characteristic (8,3%). The fourth and smallest group, contains the definitions of the milpa that describe it as an economic system (3,6% from the literature review and 8,3% from interviews). Finally, the fifth group contains those definitions which describe the milpa in terms of multiple aspects (environmental, socio-cultural, and economic), 14,3% of the reviewed documents offered a holistic approach to milpa, as opposed to the definitions provided by the interviews, where 50% of the interviewees agreed that the milpa system definition includes economic, environmental, and socio-cultural aspects related to agricultural activity.

In addition, in terms of the number of milpa definitions, we organized them in two periods (1993–2012 and 2013–2017), in the first group there were 27 definitions and 29 in the second one (Fig. 1.). In the first period the most frequent definition was associated to Agricultural activity (59,3%), followed by Agricultural activity complemented with socio-cultural aspects (29,6%), whereas there were no definitions related to environmental aspects.

In contrast, in the second period, the most frequent definition was related to Agricultural activity and environmental aspects (33,3%), followed by Agricultural activity (26,7%), and Agricultural activity integrated with two or three dimensions (23,3%).

Table 1
Types of milpa definitions.

Definition group	Computer analysis		Interviews with experts	
	Nº	%	Nº	%
1. Agricultural activity (Production system, subsistence, corn, bean, squash, chili, polyculture, slash and burn practices, native seeds)	24	42,9	2	16,7
2. Agricultural activity and socio-cultural aspects (Agricultural activity description and indigenous worldview, culture, spirituality, traditional knowledge)	12	21,4	2	16,7
3. Agricultural activity and environmental aspects (Agricultural activity and agroecosystem, environmental/ecosystem services, biodiversity, climate, soil, vegetation)	10	17,9	1	8,3
4. Agricultural activity and economic aspects (Agricultural activity and income, economic axes)	2	3,6	1	8,3
5. Agricultural activity integrated with two or three aspects (Agricultural activity and environmental, socio-cultural or economic aspects).	8	14,3	6	50,0
Total	56	100	12	100

3.2. Topics of research in milpa

The manual inspection of information (MII) allowed us to reveal that 45% of the reviewed documents were environmental publications, 33% socio-cultural, and 22% had an economic emphasis. Similar values were found through the automated-curation of information (ACI) for socio-cultural and economic areas (Fig. 2.)

The ACI in the English documents identified six research topics in milpa, and eight research topics in the Spanish documents. The results are presented in word clouds (Appendix 4). Table 2 summarizes a comparison between the results obtained through the MII, the ACI in Spanish and English, and mentions of the most addressed topics in the milpa research according to the opinion of the milpa researchers who were interviewed.

We found that 44% of the documents analyzed through MII and 61% of the documents analyzed through ACI pertain to four topics of research: milpa and food production, milpa and natural resources, milpa and agrodiversity conservation, and productive management of milpa (Table 2).

Fig. 3 describes the number of publications with environmental, socio-cultural and economic emphasis in the three periods: 1990–2000, 2001–2010, 2011–2018, showing a significant increase in environmental publications from 1990 to 2018.

Table 3, breaks down the number of publications in the three periods concerning the 11 topics described in Table 2.

Finally, the interviewees emphasized some important topics for future research that have not been addressed, such as: technology transfer, milpa impacts, governance (land tenure, organization, power structures), milpa and governmental transfers, milpa and human health, human rights, and legal aspects of milpa.

3.3. Impacts of milpa

This section outlines the data drawn from the interviews in terms of the perceived impact of the milpa system. The outcomes of Automated Detection of Impacts were not favorable since the sentences extracted were not related to the real impact of the system.

Twelve researchers with expertise in Maya milpa were inquired about how the milpa system has environmental, socio-cultural, and economic effects and impacts where milpa has been developed. Table 4 presents the positive and negative impacts mentioned by the research experts.

According to the researchers, the aspect which has been affected on a more positive way is the socio-cultural aspect; researchers mentioned that the Maya milpa promotes the preservation of customs, traditions, and environmental knowledge. According to the researchers, the milpa is also conceived as a way to promote social cohesion and as a system that reduces the risk of food insecurity and population malnutrition.

On the other hand, the negative perceived effects of the Maya milpa by researchers are mostly concerned with environmental and economic

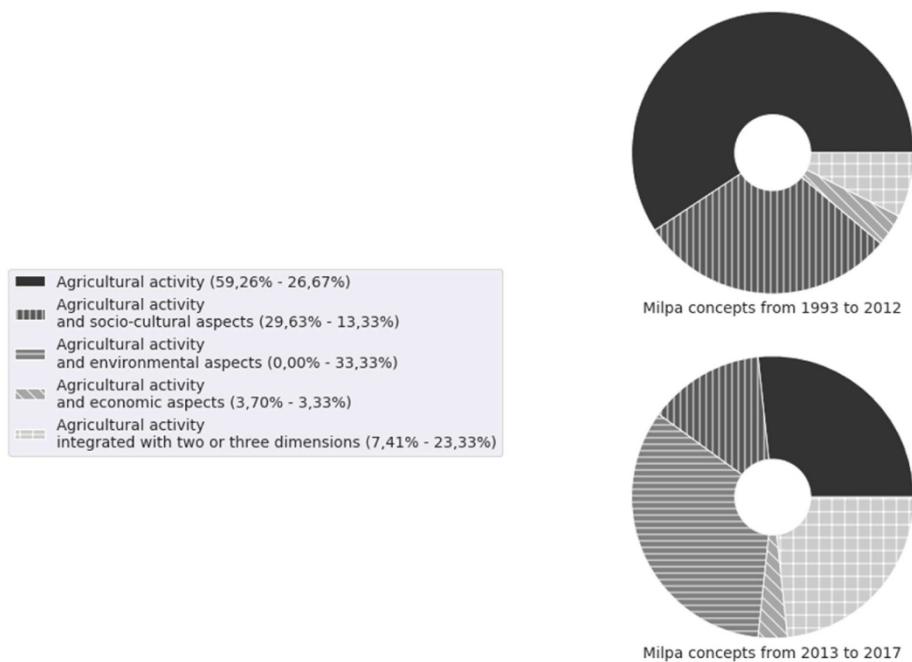


Fig. 1. Milpa concepts in 1993–2012 and 2013–2017.

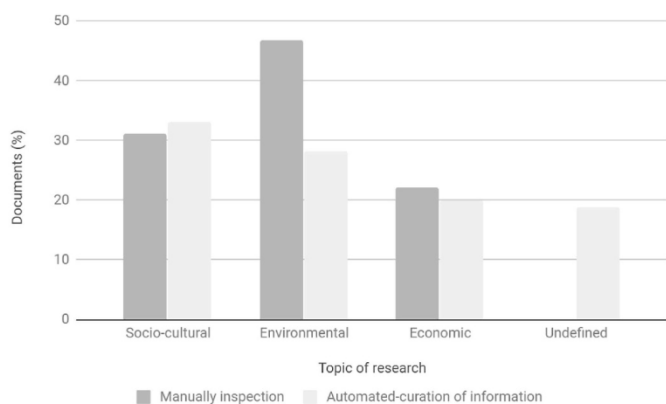


Fig. 2. General areas in milpa research.

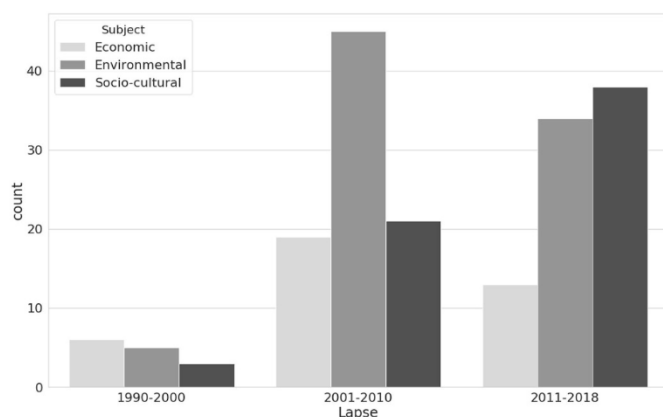


Fig. 3. Milpa publications emphasis in the period 1990–2018.

aspects. In terms of environmental effects there are two main concerns: a) burning can cause forest fires if this activity is not adequately managed, and b) the increased use of agrochemicals can have a negative effect on soil and water bodies. In terms of economic aspects, one negative perceived effect is that the milpa system is not profitable for families, since most of the production is consumed by the families and

the limited surplus is difficult to sell. Furthermore, some activities related to the milpa system are criminalized, such as the hunting of wild animals which can help provide families with a source of protein and protect the integrity of the milpa.

Table 2

Topics of research. Fields with a hyphen indicate a lack of reported data.

Research topics	MII (%)	ACI in Spanish (%)	ACI in English (%)	Interviews with experts (N = 12)	
Socio-cultural	a) Milpa and food production (including food safety)	9,4	13,1	–	1
	b) Milpa and cultural issues	9,4	6,3	–	5
	c) Milpa and public policy	2,1	2,5	–	–
	d) Other issues	12,5	1,3	10,0	–
Environmental	e) Milpa and natural resources	10,4	9,4	2,5	–
	f) Milpa and agrodiversity conservation	12,5	8,1	7,5	1
	g) Environmental management of the milpa	16,1	–	–	2
	h) Other issues	6,3	–	–	–
Economic	i) Productive management of milpa	12,0	8,8	11,3	6
	j) Economic activities associated to milpa system	6,8	–	–	–
	k) Other issues (%)	2,6	–	–	–
Undefined	–	3,1	15,6	–	
Total (%)	100	53	47	–	

Table 3
Number of milpa publications by topic in the period 1990–2018.

Specific research topic	Time periods		
	1990–2000	2001–2010	2011–2018
Economic activities and the milpa system	1	5	6
Productive management of milpa	4	11	5
Others economic topics around milpa	0	3	2
Milpa and natural resources	2	11	8
Milpa and agrobiodiversity conservation	2	15	7
Environmental management of the milpa	2	13	16
Others environmental topics around milpa	3	6	3
Milpa and food production	0	5	13
Milpa and cultural issues	4	7	7
Milpa and public policy	0	3	1
Others socio-cultural topics around milpa	0	6	17

4. Discussion

4.1. Milpa definition

The concepts that have been used to define the milpa system are as diverse as the elements that make it up. According to our results, the Maya milpa is conceived through a range of definitions that range from conceptualizations based on the milpa's most basic elements, such as maize, beans and squash, which are the main means of subsistence for rural families (Aguilar et al., 2003; Arias et al., 2007; Cálix de Dios et al., 2014; Duch-Gar, 1993; Rodríguez et al., 2016); through definitions that include cultural elements that have evolved and persisted since the origins of the system, such as rituals (Bonfil, 1987; Carrera-García et al., 2012; Gómez, 1997; De Frece and Poole, 2008; Méndez, 2012, Vázquez, 2012). On the other hand, there are authors who conceive the milpa system as a recipient and provider of environmental services, and the definitions they propose focus on the milpa's interactions with the surrounding ecosystems (Almaguer et al., 2016; D'Alesandro and González Cabañas, 2017; Pérez, 2013).

The smallest group of definitions (3.6%) describe the milpa as a complex system integrated by other economic activities such as hunting, beekeeping, and crops in family-owned backyard gardens which represent the economic backbone of many families (Dzib-Aguilar et al., 2016; Mariaca, 2015; Martínez et al., 2017). Otherwise, most of the definitions provided by the interviewees take into account social, cultural, environmental, and economic aspects of the milpa.

The milpa system has been adapting to the environmental, political and cultural changes. This adaptation has blurred the limits needed to define when a crop system is a traditional milpa (or Maya milpa), and when it is not. Deep questions arise, such as; Could a corn monoculture

practiced by some Maya farmers be considered as a milpa? Could a milpa without shifting cultivation can still be considered a milpa?

The answers to these questions are still unresolved, but it is worth mentioning that they could vary depending on the context of each region. As it has been explained throughout the text, in the case of the Yucatan Peninsula, the concept of Maya milpa contains elements associated with agro-diversity, culture and local knowledge. However, increasing requirements to improve yield crop are even influencing the meaning of this rural livelihood. Therefore, these unresolved questions could be corroborated in future studies with surveys directed at Maya farmers.

On the other hand, as a result of the document analysis, we detected an evolution of the concept through time. Although the milpa definition concerning it as an “Agricultural activity” has been the most used definition from 1990 to 2018; in the period 2013–2017, 56,6% of the definitions were integrative or related to Environmental aspects.

Nevertheless, the most cited references in the first period (1990–2012) had an agricultural or socio-cultural emphasis; whereas in the second period (2013–2017) the most cited references addressed socio-cultural or environmental aspects.

As we have explained throughout the discussion section, there is an increasing interest to include environmental concepts in the milpa definition. Our hypothesis around this pattern is that there is a recent international trend to establish a linkage between environmental and social problems. Particularly, the generalized climate change concern has influenced the research on milpa.

Our hypothesis could be supported by the incidence of the international tendencies to address socio-environmental problems promoting new conceptual approaches to analyze social and ecological systems (Berkes and Folke, 1998). Moreover, recent efforts to address

Table 4
Environmental, social, and economic impacts of the milpa system.

Aspect	Positive	Negative
Environmental	<ul style="list-style-type: none"> - The slash and burn practice has been stigmatized - There are very well-preserved areas near milpa landscapes - The germplasm of the milpa has become the solution to drought and flooding periods 	<ul style="list-style-type: none"> - The burning practices can have a negative impact if there is not an adequate management - There is an uninformed use of agrochemicals - The milpa system has ceased to be itinerant leading to soil erosion and agrochemical use
Socio-cultural	<ul style="list-style-type: none"> - Preservation of customs, traditions, knowledge, and native language - Boosts social cohesion and cooperation - High levels of milpa dependence generates better nutritional levels and reduces the likelihood of malnutrition and obesity - Diversity of milpa reduces the risk of food insecurity 	<ul style="list-style-type: none"> - System for older people. Disinterest in land work
Economic	<ul style="list-style-type: none"> - Milpa represents a pension in old age, it is a refuge in the economic crisis - There are regions in which milpas provide 80% of household food 	<ul style="list-style-type: none"> - No demand for surplus - Milpa derivatives, such as coal, firewood, and hunted animals are criminalized - The milpa is not profitable, it is only for subsistence - The milpa does not satisfy the changing needs of young people

climate change were institutionalized in the period 2010–2018, by the advances in the COPs (Conference of the Parties), with the discussion around reducing carbon emissions and promotion of the sustainable development goals. It seems very likely that the integration of socio-environmental concepts in the milpa definition will become part of the standard way of conceiving this rural livelihood.

4.2. Topics of research in milpa

The approaches to Maya milpa study have been very diverse. There is a certain overlapping between the results obtained through the Automated curation of information (ACI), the Manual inspection of information (MII), and the interviews with the Maya milpa researchers. This overlapping corroborates that the research efforts have been focused mostly on environmental and socio-cultural aspects and to a lesser extent on economic matters.

The chronological analysis of research topics yielded interesting results. For example, there has been a gradual increase in the number of studies in relation to environmental aspects since 1990, while the number of studies concerning socio-cultural aspects has been fairly constant in the last two decades. Finally, economic-related research has received much less attention in milpa studies. A relationship between these results and the findings related to the chronological analysis of the definitions can be perceived, since both analysis suggest an increasing emphasis on environmental aspects related to the milpa.

The advantage of complementing the automated curation of information with interviews with researchers was to be able to identify information gaps in the form of lack of data and new research proposals.

In terms of socio-cultural aspects, researchers identified a lack of data on issues of governance, human rights, human health and legal aspects related to the Maya milpa. These gaps were also evident in the analyzed literature, since the existing research on socio-cultural aspects is focused mainly on the symbolic representation of the Maya milpa (worldview).

In terms of economic aspects, interviewees mentioned an information gap in the analysis of milpa governmental transfers, an issue that is not mentioned in the analyzed literature.

Another aspect emphasized by researchers is the absence of integrative research, an example of this is the controversy around the slash and burn system, because burning is seen by some experts as an element that favors the regeneration of the tropical forest (Faust, 2001), while for others, it is a factor that contributes to climate change (Márdero et al., 2014). We propose that an integrative approach to research on milpa would allow for the understanding of the environmental, economic, and social advantages and disadvantages of the activity of burning.

4.3. Impacts of milpa

The data on perceived impacts obtained from the interviews with researchers coincide with the data obtained in the literature review. In terms of environmental aspects, there are opposed opinions. For instance, some authors point out that the slash and burn system has promoted tropical forest degradation and deforestation, whereas according to Aguilar et al. (2003), these statements reveal a lack of knowledge and a significant misunderstanding of how the system operates.

Granados et al. (1999) mention that slash and burn systems increase the annual average temperature of the air and soil and change the physical-chemical properties of the soil (pH, organic matter, loss of nutrients). Likewise, Ebel (2018) found that these practices reduce organic matter, magnesium, and exchangeable calcium in the soil.

In addition, according to some researchers, the fallow periods between agricultural cycles have been reduced, affecting the fertility of soils and biodiversity. This reduction can generate homogeneous secondary forests that are significantly different to the primary forests

(Ochoa-Gaona et al., 2007; Rodríguez et al., 2016).

On the other hand, some researchers claim there is positive relationship between the milpa system and the environment arguing, for example, that farmers (milperos) possess a deep knowledge of the forest, and that the reforestation processes begin with the cultivation of milpa crops in a milpa landscape (Illsley, 1984; Ford et al., 2012). Arias (1994), for example, emphasizes the rapid recovery of secondary forests and the maintenance of the vegetal composition in the most advanced successional phases in abandoned fields of milpa.

Two other positive environmental impacts of the milpa have been included the capture of carbon in well-managed milpas (Nigh and Stewart, 2013) and the lower impact of the system in comparison with modern agriculture which makes use of tractors, monocultures, and agrochemicals (Faust, 2001).

With regard to the sociocultural aspects, the literature emphasizes that the milpa is a space which promotes learning and family unity and strengthens social, cultural, and ecological values (Aguilar et al., 2003; Vázquez, 2012; Méndez, 2012, Almaguer et al., 2016).

However, factors such as population growth, labor migration, economic pressure for the acquisition of goods, technological changes, and little transmission of knowledge are leading people to abandon this production system (Aguilar et al., 2003; Moya et al., 2003; Birol et al., 2009; Pérez, 2013; Román; Licea, 2016).

One of the most important problems that the milpa system has faced is the low participation of young people, which implies a loss of information due to a generational change. This disinterest is due to young people looking for better alternatives for generating income by means of migrating to other regions or countries (Arias, 1994; Birol et al., 2009; Martín-Castillo, 2016; Salazar-Barrientos et al., 2016).

In terms of the economic aspects, the literature suggests that the milpa system has for decades faced different obstacles in order to subsist (Aguilar et al., 2003; Vázquez, 2012).

The economic sustainability of the milpa system has been questioned due to three different factors: a high variability of maize production, low profitability, and its relation with rural poverty.

The historical evidence of maize production under the slash and burn system highlights a highly variable average annual production per hectare (500–200Kg/Ha/Year).² This variability may be the result of the erratic climate characteristics in the region (Rodríguez et al., 2016).

Low profitability of the milpa and limited contributions to family income have been reported by different authors (Moya et al., 2003; Salazar-Barrientos et al., 2016). Nevertheless, a statistically significant relationship between greater agricultural diversity, better nutritional status, and higher poverty index has been demonstrated. On the one hand, this relationship results in an apparent paradox; the poorest households depend mainly on agriculture, and poverty itself prevents access to processed products, which in turn can lead to a higher nutritional and health status (Becerril et al., 2014).

On the other hand, although poverty has been associated with the low productivity of the milpa (Robles-Zavala and Fiechter-Russo, 2008); in Mexico, there is an inherent state of marginalization in rural areas (Salazar-Barrientos et al., 2016), partially associated to the structural changes of the Mexican economy (Becerril et al., 2014).

The positive economic impacts of milpa are related to feeding costs savings since feeding represents 40% of total family output (Cuanalao and Siniarska, 2006; Cáliz de Dios et al., 2014). The milpa system

²Rodríguez et al. (2016) compiled from different authors the maize production across the time in the region: 690 kg/Ha in 1938, 100 kg/Ha in 1940 and 880 kg/Ha in 1942 (Pérez, 1942), 800 kg/Ha in the mid-eighties (Humphries, 1989) and 590 kg/Ha in 2015. In addition, Arias (1995) reported for the decade of the nineties the relation of the yields according to the year of harvest (first and second year of milpa in the same plot) for the first harvest year 1500 kg/Ha and for the second year 750 kg/Ha. In the 2000s, Bautista-Zúñiga et al. (2005) reported yields of 1000 kg/Ha for the first year and 500 kg/Ha for the second year.

(milpa crops, forest, backyard plants and animals) provides on average 64% of the family's food needs (Salazar-Barrientos and Magaña-Magaña, 2016) and can provide 85% of the family's minor livestock diet (poultry, pigs and cattle) (Rosales et al., 2003).

In addition, there is a positive reported impact of this food system on health related to the local production and consumption of vegetables, protein, and carbohydrates (Carrera-García et al., 2012, Almaguer et al., 2016) which can in turn be translated into economic savings.

5. Conclusion

The analysis of the milpa concept, topics of research, and impacts on environmental, social, and economic issues resulted in some relevant findings.

There are different approaches towards a Maya milpa conceptualization, from the most basic, related to technical concerns, to the most complex that articulate it in terms of environmental, socio-cultural, or economic aspects. Nevertheless, there has been an increasing change towards the incorporation of environmental aspects and the establishing of an integrated definition. The three thousand-year history of the Maya milpa highlights the importance to recognize the different elements that integrate it, therefore, an interdisciplinary approach transcending institutions and research topics is needed.

We propose some basic elements to consider for an integrative definition of the Maya milpa. First, it is important to recognize the milpa as the axis of the Mayan culture. Second, Maya milpa is an adaptive and a complex socio-ecological system, it involves a great agricultural diversity based mainly on corn, squash and beans, with various environmental use strategies framed in the slash and burn system. And third, Maya milpa implies a specific worldview and traditional knowledge about the acquisition of food security.

Therefore, Maya milpa research is in need of more comprehensive approaches and new conceptual, theoretical and methodological perspectives that allow us to solve deep and permanent questions around its sustainability. In our paper, we have begun the process of highlighting the contrasting environmental, social and economic effects. Future research could be addressed around the sustainability of the Maya milpa recognizing the wide experience of the multiple actors around the study of the system such as researchers as well as local and governmental actors.

CRedit authorship contribution statement

Karla Juliana Rodríguez-Robayo: Conceptualization, Data curation, Methodology, Investigation, Writing - original draft, Supervision. **María Elena Méndez-López:** Data curation, Investigation, Writing - original draft. **Alejandro Molina-Villegas:** Methodology, Formal analysis. **Lilián Juárez:** Data curation, Investigation, Writing - original draft.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jrurstud.2020.04.029>.

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APPENDIX 1. Lexical patterns for definition extraction

Examples of regular expressions used for definition extraction of term "milpa" in Spanish and English. Each word is represented as three components: the word instance/the lemma of the word/the corresponding Part-of-Speech of the word.

The documents were labelled using Treetaggerwrapper version 2.0.6. and then processed according to Sierra et al. (2009)¹.

Lexical patterns for definition extraction
Spanish
'la/el/ART milpa/milpa/NC es/ser/V\$fin'
'la/el/ART milpa/milpa/NC se/se/SE define/definir/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE caracteriza/caracterizar/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE comprende/comprender/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE concibe/concebir/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE conoce/conocer/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE considera/considerar/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE comprende/comprender/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE denomina/denominar/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE describe/describir/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE entiende/entender/VLfin'
'la/el/ART milpa/milpa/NC se/se/SE identifica/identificar/VLfin'
English
'the/the/DT milpa/milpa/NC is/be/VBZ defined/define/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ characterized/characterize/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ comprehended/comprehend/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ conceived/conceive/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ known/know/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ considered/consider/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ described/describe/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ understood/understand/VBN'
'the/the/DT milpa/milpa/NC is/be/VBZ identified/identify/VBN'

¹ G. Sierra, R. Alarcon, A. Molina and E. Aldana, "Web Exploitation for Definition Extraction," 2009 Latin American Web Congress, Merida, Yucatan, 2009, pp. 217-223, doi: 10.1109/LA-WEB.2009.36.

APPENDIX 3. Conceptual definitions of milpa

N°	Definition Group	Original definition	Bibliography
1	1	La milpa es un lugar para el cultivo de maíz en asociación con diversas plantas (al menos frijol y calabaza), dentro de un ecosistema	Aguilar, J., Ilsley, C., Marielle, C. (2003). Los sistemas agrícolas de maíz y sus procesos técnicos. En: Esteva, G., Marielle, C. (eds.). <i>Sin maíz no hay país</i> . Ciudad de México: CONACULTA.
2	1	The milpa is an intercropping of maize (<i>Zea mays</i>), ib bean (<i>Phaseolus lunatus</i>), common bean (<i>P. vulgaris</i>) and squash (<i>Cucurbita</i> spp.), which farmers of Yucatan plant using the slash-and burn system.	Arias, L. et al. (2002). Diversidad de maíces de la Milpa en Yaxcabá, Yucatán. En Chavez-Servia, J.L., L.M. Arias-Reyes, D.I. Jarvis, J. Tuxill, D. Lope-Alzina, and C. Eyzaguirre (eds). <i>Proceedings of a symposium: Managing crop diversity in traditional agroecosystems</i> . Merida, Mexico. International Plant Genetic Resources Institute, Rome, Italy.
3	1	La milpa es un sistema de producción agrícola basado en la asociación de maíz (<i>Zea mays</i> L.), frijol (<i>Phaseolus</i> spp.), calabaza (<i>Cucurbita</i> spp.) y chile (<i>Capsicum</i> spp.)	Arias, L.M., Latournerie, L., Montiel, S., Sauri, E. (2007). Cambios recientes en la diversidad de maíces criollos de Yucatán, México. <i>Universidad y Ciencia</i> 23(1), 69-73.
4	1	The milpa is a polyculture based on maize that usually also includes bean, squash, semi-domesticated herbs, and other plant and animal species.	Benitez, M., Fornoni, J., García-Barrios, L., López, R. (2014). Dynamical networks in agroecology: the milpa as a model system. En: Benítez, M., Miramontes, O., Valiente-Banuet, A. <i>Frontiers in ecology, evolution and complexity</i> . Ciudad de México. Coplt-arXives
5	1	La milpa es un policultivo estructurado y manejado bajo el sistema denominado roza-tumba-quema.	Cálix de Dios, H., Kissman, S., Alvarado, D. S. H., Luckson, P. J., y Putnam, H. (2014). <i>Seguridad y Soberanía Alimentaria en la Zona Maya de Yucatán</i> . Quintana Roo, México: Universidad Intercultural Maya de Quintana Roo.
6	1	La milpa es el sistema agrícola más utilizado para producir maíz (Pérez Toro, 1945; Hernández X., 1958; 1991; Arias, 1980; Dzib, 1988; Cortina, 1991)	Duch-Gar, J. (1993). Racionalidad técnica y debilidad productiva de la agricultura milpera en el estado de Yucatán. <i>Revista de Geografía Agrícola</i> 18, 37-46.

7	1	La milpa consiste en el desmonte de un área arbolada, en la cual, después de transcurrido un tiempo conveniente, la vegetación ya seca se quema con el fin de limpiar y acondicionar el terreno, y sembrar el acostumbrado maíz y otros cultivos que los campesinos yucatecos requieren para procurarse los alimentos que conforman su dieta cotidiana.	Duch-Gar, J. (1993). Racionalidad técnica y debilidad productiva de la agricultura milpera en el estado de Yucatán. <i>Revista de Geografía Agrícola</i> 18, 37-47.
8	1	The milpa is a traditional Mesoamerican production system based on polycropping corn (<i>Zea mays</i> L.), squash (<i>Cucurbita</i> spp.), and bean (<i>Phaseolus vulgaris</i> L.). Milpa is characterized by synergetic interactions between these plants that favor the total output of this arrangement and increase resilience to perturbations of the entire agroecosystem.	Ebel, R., Pozas, J., Soria, F., Cruz, J. (2017). Manejo orgánico de la milpa: rendimientos de maíz, frijol y calabaza en monocultivo y policultivo. <i>Terra Latinoamericana</i> 35, 149-160.
9	1	La milpa es un sistema de subsistencia	Gurri, F., Vallejo, M. (2007). Vulnerabilidad en campesinos tradicionales y convencionales de Calakmul, Campeche, México. Secuelas del huracán Isidore. <i>Antropología biológica</i> 13, 449-470.
10	1	Para las familias de la comunidad de Santa Marta (región Altos), la milpa es el medio para asegurar los alimentos durante todo el año, ya que las plantas más representativas que se cultivan en la milpa son el (maíz y el frijol) que representan la base de la dieta cotidiana de los habitantes.	Méndez, J. (2012). <i>La importancia comunitaria del sistema milpa Tojol-ab'al: el caso de la colonia 20 de Noviembre, las Margaritas, Chiapas</i> (Tesis para obtener el título en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
11	1	La milpa es una forma de producción	Perez, M. (2013). Efraím H. Xolocotzi. Contribuciones al estudio de las familias milperas mayas milperas. <i>Etnobiología</i> 11(3), 14-27.
12	1	La milpa se define como un sistema de policultivos	Rodríguez, A., González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.

13	1	La milpa se define por el uso de semillas criollas de maíz, junto con la diversidad de cucurbitáceas (calabazas, leques y calabazos) y leguminosas (frijoles e ibes), así como hortalizas (chiles, jitomates, jícamas, sandías, melones, pepinos) y tubérculos (yuca, macal, malanga, camote), entre otras especies y variedades.	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
14	1	La milpa existe cuando en un espacio distinto al solar se usan semillas criollas	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
15	1	El concepto milpa se acota a tres criterios: uso de semillas criollas mayas, tiempo de barbecho (descanso) del monte y roturación del suelo utilizado.	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
16	1	La milpa es un sistema de producción vigente y central para la sociedad rural yucateca	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
17	1	La milpa es policultivo	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
18	1	La milpa es un sistema que forma parte de las estrategias de vida de las familias campesinas	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
19	1	La milpa como sistema productivo, eje organizador de la producción	Terán-Contreras, S. (2010). Milpa, biodiversidad y diversidad cultural. En: Durán, R., M. Méndez (Eds). <i>Biodiversidad y Desarrollo Humano en Yucatán</i> . CICY, PPD-FMAM, CONABIO, SEDUMA.

20	1	La milpa es el espacio que utilizan los agricultores mayas para realizar sus cultivos, su nombre en maya yucateco es kool.	Tuz-Chi, L. (2009). <i>Así es nuestro pensamiento: Cosmovisión e identidad en los rituales agrícolas de los mayas peninsulares</i> (tesis de Doctorado). Universidad de Salamanca, España.
21	1	La milpa es planta y plantación, la milpa es la planta que sostiene a la mazorca que hace que crezca el maíz, pero también de la milpa se saca la verdura, la calabaza, el frijol y animales que se cazan (Juan Vázquez Seku'm, 83 años, 2010).	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
22	1	La milpa es maíz (María Velasco Méndez, 49 años, 2010)	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
23	1	La milpa es el maíz para alimentarnos y a nuestros animales (Victorio Vázquez Pérez, 59 años, 2010).	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
24	1	La milpa es la planta de maíz	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
25	2	La milpa es el valor del cultivo de maíz, cosmovisión, medida del tiempo, ciclo de vida que se cumple año con año	Aguilar, J., Ilsley, C., Marielle, C. (2003). Los sistemas agrícolas de maíz y sus procesos técnicos. En: Esteva, G., Marielle, C. (eds.). <i>Sin maíz no hay país</i> . Ciudad de México: CONACULTA.
26	2	la milpa es el sistema de producción que mejor representa a los pueblos indígenas, puesto que el maíz que se produce forma parte fundamental de la alimentación de la familia campesina e indígena.	Aguilar, J., Ilsley, C., Marielle, C. (2003). Los sistemas agrícolas de maíz y sus procesos técnicos. En: Esteva, G., Marielle, C. (eds.). <i>Sin maíz no hay país</i> . Ciudad de México: CONACULTA.
27	2	The milpa is the production system that best represents indigenous peoples, in addition to maize other foods are produced like: bean, squash, quelites, in addition to other species cultivated or allowed.	Carrera-García, S., Navarro, H., Pérez, M.A., Mata, B. (2012). Calendario Agrícola Mazateco, Milpa y Estrategia Alimentaria Campesina En Territorio De Huauteppec, Oaxaca. <i>Agricultura, sociedad y desarrollo</i> 9(4), 455-475.

28	2	Para José, la milpa es “el primer alimento”, para Epifanio “es algo seguro, no como el dinero” y para María “significa muchas cosas, [pero] primero es la salud”.	Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., Vázquez, B. (2017). <i>Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable</i> . México: Centro Mexicano de Derecho Ambiental.
29	2	Para la cultura tojol-ab’al la milpa es un sistema viviente, por lo que se pone triste cuando no se visita	Méndez, J. (2012). <i>La importancia comunitaria del sistema milpa Tojol-ab’al: el caso de la colonia 20 de Noviembre, las Margaritas, Chiapas</i> (Tesis para obtener el título en Desarrollo Sustentable).Universidad Intercultural de Chiapas.
30	2	The milpa is ejido land, primarily for maize cultivation	Poole, N., Gauthier, R., Mizrahi, A. (2007). Rural poverty in Mexico: assets and livelihood strategies among the Mayas of Yucatán. <i>International Journal of agricultural sustainability</i> 5, 315–330.
31	2	Para los mayas la milpa es el centro de la gracia o lo divino	Rodríguez, A., Arias, L. (2014). La milpa y el maizal: retos al desarrollo rural en México y Perú. <i>Etnobiología</i> 12 (3), 76-89.
32	2	La milpa es un saber propio y autónomo al que se añan otros componentes de la etnia maya viviente del S XXI	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
33	2	La milpa es componente esencial de la cultura, está “vinculada a un acervo de conocimientos que son experiencias acumuladas y sistematizadas durante siglos y que son consistentes con maneras propias de ver el mundo y entender la naturaleza, con esquemas de valores profundamente arraigados, con formas particulares de organización social y con el universo correspondiente de la vida cotidiana” (Bonfil, 1987: 36)	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
34	2	The milpa is the sacred place in which the raw material of humans was created, and maize is the holy substance from which the Maya emerged, and as such is considered to be sacred and life-giving (De Frece and Poole 2008).	Schmook, B., Vliet, A., Radel, C., Manzón-Che, M., McCandless, S. (2013). Persistence of Swidden Cultivation in the Face of Globalization: A Case Study from Communities in Calakmul, Mexico. <i>Human Ecology</i> 41, 93–107.

35	2	Para el maya el hombre es la milpa y la milpa es el hombre, es una fusión sagrada en donde se dinamiza y se explica la existencia	Tuz-Chi, L. (2009). <i>Así es nuestro pensamiento: Cosmovisión e identidad en los rituales agrícolas de los mayas peninsulares</i> (tesis de Doctorado). Universidad de Salamanca, España.
36	2	La milpa es un espacio de interacción entre el humano y los dueños de la naturaleza donde hay que dar para recibir	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.
37	3	La milpa es un sistema productivo de autoconsumo que abarca el aprovechamiento eficiente de clima, suelo y trabajo humano.	Almaguer, J. A., García, H., Padilla, M., González, M. (2016). <i>La Dieta de la Milpa: Modelo de Alimentación Mesoamericana Biocompatible</i> . Ciudad de México. Secretaría de Salud.
38	3	La milpa es un espacio en donde se vive la experiencia del aprendizaje y se ejercita un proceso de reflexión y autoaprendizaje ligado al contacto con la naturaleza (Gómez, 1997),	D'Alesandro, R., González, A.A. (2017). La práctica de la milpa, el ch'ulel y el maíz como elementos articuladores de la cosmovisión sobre la naturaleza entre los tzeltales de tenejapa en los altos de chiapas. <i>Estudios De Cultura Maya</i> 50, 271.
39	3	La milpa es un agroecosistema donde se encuentra presente una gran cantidad de biodiversidad, que genera servicios ambientales a favor de la comunidad	Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., Vázquez, B. (2017). <i>Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable</i> . México: Centro Mexicano de Derecho Ambiental.
40	3	La milpa se concibió como un sistema de aprovechamiento integral de los recursos naturales, que bajo el sistema de la roza-tumba y quema, contempla diversos grados de perturbación-recuperación de la selva, formas intensivas y extensivas de producción; así como diversas formas de recolección y extracción.	Perez, M. (2013). Efraím H. Xolocotzi. Contribuciones al estudio de las familias milperas mayas milperas. <i>Etnobiología</i> 11(3), 14-27.
41	3	La milpa es una de las diversas formas de una estrategia integral para el uso del medio ambiente, basada en un conocimiento eficaz de las regularidades meteorológicas y de las características del paisaje, en función de la producción agrícola, que a su vez, se caracteriza por el manejo de una compleja diversidad de cultivos y de plantas no cultivadas.	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.

42	3	La milpa es sólo parte del proceso cíclico de uso-regeneración que realiza el campesino maya en el medio selvático, bajo una lógica de procurar la obtención de la mayor cantidad de bienes de la sustitución temporal del monte, y posteriormente propiciar la recuperación de éste en la perspectiva de su ulterior uso.	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
43	3	La milpa integra manejo y aprovechamiento de selva	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
44	3	La base de la milpa maya es el uso y aprovechamiento de la selva maya, el desmonte de pequeñas porciones que son sometidas a un uso de dos o tres años y después dejadas para que la sucesión vegetal permita su recuperación.	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
45	3	La milpa es un sistema de vida con bases agroecológicas, cuya principal función es la de proporcionar sustento a las familias campesinas mayas	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
46	3	La milpa es el sistema maya de producción agrícola bajo una agricultura de roza-tumba y quema (RTQ) en selvas secundarias, constituye el eje central que articula toda la estrategia productiva y reproductiva de aprovechamiento y manejo integral de la selva.	Santos-Fita, E., Naranjo, E., Bello, E., Estrada, E., Mariaca, R., Macario, P. (2013). La milpa comedero-trampa como una estrategia de cacería tradicional maya. <i>Estudios de cultura maya</i> 42, 87-118
47	4	La milpa es un sistema productivo amplio que incluye y ordena otras actividades como la cacería, la agricultura de otras especies, la recolección de otras plantas y frutos comestibles, medicinales e insectos, así como la ganadería de monte.	Almaguer, J. A., García, H., Padilla, M., González, M. (2016). La Dieta de la Milpa: Modelo de Alimentación Mesoamericana Biocompatible. Ciudad de México. Secretaría de Salud.

48	4	La milpa como eje de la economía	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
49	5	La milpa es el sistema de producción agrícola más importante, cuyo propósito es producir alimentos y otros satisfactores, como la leña, los cuales son la base material de la vida familiar y comunal, las que se caracterizan por su fuerte cohesión social y cultural.	Dzib-Aguilar, L.A., Ortega-Paczka, R., Segura-Correa, J.C. 2016. Conservación in situ y mejoramiento participativo de maíces criollos en la Península de Yucatán. <i>Tropical and Subtropical Agroecosystems</i> 19(1): 51-59
50	5	La milpa maya es un fenómeno cultural y tecnológico de aprovechamiento de los recursos naturales que tiene dos acepciones: a) la parcela, donde se cultivan especies anuales, donde el maíz es la principal; y b) el sistema de manejo y aprovechamiento de la selva.	Mariaca, R. (2015). La milpa maya yucateca en el siglo XVI: Evidencias etnohistóricas y conjeturas. <i>Etnobiología</i> 13(1),1-25.
51	5	La milpa es el agroecosistema más importante bioculturalmente hablando pues constituye el principal pilar para la alimentación de las familias campesinas e indígenas	Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., Vázquez, B. (2017). <i>Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable</i> . México: Centro Mexicano de Derecho Ambiental.
52	5	La milpa es un agroecosistema resultado de un largo proceso de coevolución de las sociedades y los ecosistemas (Gliessman, 2002), caracterizado por ser un policultivo que ha sido adaptado a condiciones edafológicas, ecológicas, sociales y culturales específicas de los territorios en donde se practica	Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., Vázquez, B. (2017). <i>Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable</i> . México: Centro Mexicano de Derecho Ambiental.
53	5	La milpa es el espacio donde se recrean las culturas, se construye autonomía, se conserva la biodiversidad, se satisfacen derechos humanos y se propicia la soberanía alimentaria	Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., Vázquez, B. (2017). <i>Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable</i> . México: Centro Mexicano de Derecho Ambiental.

54	5	La milpa es una compleja imbricación de actividades productivas y extractivas, para la obtención de bienes y servicios que han permitido por siglos la sobrevivencia y reproducción de las familias campesinas mediante un acervo de conocimientos eficaces, generados y perfeccionados en el mismo proceso, realizado acorde a una peculiar forma de ver y entender a la naturaleza y sus regulaciones que trasciende a lo ideológico-religioso	Rodríguez, A.,González, P., Flores, J., Nava, R., Dzib, L. A., Pérez, J. R., Thüerbeck, N., González, J. A. (2016). <i>Milpas de las comunidades mayas y dinámica de uso del suelo en la Península de Yucatán</i> . Mérida Yucatán: Centro Regional Universitario Península de Yucatán de la Universidad Autónoma Chapingo.
55	5	La milpa es más que el eje de la economía maya, es el eje de toda la vida material y espiritual de los mayas	Rosales, M., Solís, I., Ayala, A. (2003). <i>Memoria de trabajos y resultados del foro taller: Problemática campesina, retos y perspectivas de la investigación y el servicio para el mejoramiento de la milpa en Yucatán</i> . INIFAP, INAH, EDUCE.
56	5	La milpa como proceso económico, social, cultural y cosmogónico para obtener el maíz, representa para los pueblos indígenas, la base principal para el sustento de su alimentación	Vázquez, E.P. (2012). <i>Técnicas y estrategias tradicionales de conservación en la milpa de San Pedro Chenalhó, Chiapas, México</i> (tesis para obtener el título de Licenciada en Desarrollo Sustentable). Universidad Intercultural de Chiapas.

N°	Definition Group	Researcher definition
1	1	Sistema productivo representado por el maíz y enriquecido con variedades de calabazas, frijoles, hibes
2	1	Sistema agrícola de policultivo que está enfocado a la producción de alimentos primario
3	2	Es un sistema de producción tradicional que circula alrededor del maíz y es la producción básica de autoconsumo, y donde tenemos que enfocarnos para incrementar la productividad en el cultivo del maíz y los asociados con el fin de tener seguridad alimentaria. Es un sistema ancestral y tradicional que va a perdurar por siempre es la base de la producción de alimentos en la zona rural.
4	2	Es un sistema agroalimentario, nutricional complejo que ha sido la base de las culturas de mesoamérica y que en los últimos 25 años la hemos destrozado, a pesar de los estudios e el tema. Los milperos son la clave para rescatar sus prácticas y germoplasma.
5	3	Es un agroecosistema basado en una observación ecológica. Se basa en el mismo concepto del ecosistema. Cuando se tumba, se dejan algunos árboles para que el espacio se vuelva a recuperar.
6	4	Es un sistema de subsistencia cuyo objetivo no es el ganar dinero, es una forma de asegurar. Es una forma de asegurar el alimento de las familias, de hecho la consideran como la actividad de los pobres.
7	5	Sistema de producción múltiple, integrado a la naturaleza, aprovechando la agrobiodiversidad.

8	5	La milpa es el corazón del sistema productivo milpero, porque ha sido el eje de una estrategia diversa e integral de uso del medio ambiente y ofrece seguridad alimentaria. También, la milpa es el eje del sistema cultural porque en ella descansa la riqueza y diversidad culinaria; las múltiples prácticas tanto de manejo técnico como de manejo ritual que derivan de una cosmovisión basada en las premisas de que la naturaleza es sagrada y no le pertenece al hombre (los rituales son para pedir permiso para cultivar, para cazar, para ocupar un terreno o para agradecer el uso de los recursos naturales), todo lo cual apuntala la conservación de la selva y la sustentabilidad del sistema. Es decir, que la milpa es la base de la filosofía y de la cosmovisión.
9	5	Es un policultivo, pero también es un sistema económico complejo, en tanto que contempla una serie de tecnologías, pero además de eso, la milpa tiene un ciclo y en los periodos en los que disminuye el trabajo de la milpa, los campesinos mayas pueden ocuparse de ganado o de traspatio, pero también pueden ser peones, albañiles, este nuevo modelo económico de la milpa es un ajuste para una realidad más compleja que enfrentan los campesinos y también es un sistema cosmogónico, porque se asocia a una serie de ritos y creencias que dan muestra de su relación con la naturaleza.
10	5	Agroecosistema complejo. Alrededor del cultivo del maíz (alimento principal de mesoamérica) hay cultivos complementarios como frijol, calabaza, chiles, tubérculos y hortalizas. Este agroecosistema es complejo en términos de las entradas y salidas de energía, no solo implica relaciones ecológicas; sino relaciones sociales, económicas. Es un sistema dinámico, la milpa que manejaron los mayas, en esencia tiene similitud a la que actualmente se maneja, pero ha cambiado no solo en tecnología, sino en cultivos, formas de intensificarlo
11	5	La milpa es el eje de la cultura maya, aunque se transforma constantemente, los mayas emigran a la ciudad y se reestructura en contextos no agrarios. La milpa es el eje cultural de los mayas, es parte de la administración del ecosistema, implica el manejo del monte, los huertos, es la base de su seguridad alimentaria y económica. Políticamente la milpa favorece la unión entre milpero para proteger sus tierras
12	5	Es un sistema integral del manejo del entorno natural, social y cultural. Es un sistema mesoamericano de manejo medioambiental en su dimensión tecnológica y productiva, pero también tiene una dimensión cultural y cosmogónica.



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