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To cite this article: Elvis Parraguez-Vergara, Beatriz Contreras, Neidy Clavijo, Vivian Villegas, Nelly Paucar & Francisco Ther (2018): Does indigenous and *campesino* traditional agriculture have anything to contribute to food sovereignty in Latin America? Evidence from Chile, Peru, Ecuador, Colombia, Guatemala and Mexico, International Journal of Agricultural Sustainability, DOI: [10.1080/14735903.2018.1489361](https://doi.org/10.1080/14735903.2018.1489361)

To link to this article: <https://doi.org/10.1080/14735903.2018.1489361>



Published online: 27 Jun 2018.



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Does indigenous and *campesino* traditional agriculture have anything to contribute to food sovereignty in Latin America? Evidence from Chile, Peru, Ecuador, Colombia, Guatemala and Mexico

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ABSTRACT

The current challenge for world agriculture is to provide food for a growing population, within a context of environmental degradation and economic inequality. The challenge is how to produce accessible, healthy, diverse, nutritious, safe and abundant food in a way that is sustainable, allowing farmers to exert food sovereignty while at the same time addressing ecosystem conservation. The aim of this study is to explore the potential contribution of traditional agriculture to food sovereignty and also to understand the challenges that indigenous communities are facing today. Our case studies are from six Latin-American countries: Chile, Peru, Ecuador, Colombia, Guatemala and Mexico, where we carried out semi-structured, guided visits and field observations. Our results shed light on how traditional agricultural knowledge, techniques and practices can contribute to these issues, but also to the need of protecting and recovering the cultural and ecological heritage. There is a need to resolve public management issues, related to development investment, technological packages, cultural loss and gender. If these are not addressed, the potential contribution of ancient agricultural knowledge will fail to contribute to strengthen food sovereignty and maintain the local markets, which are also places for seed exchange, knowledge sharing and social networking.

KEYWORDS

Traditional agriculture; food sovereignty; food; Latin America; indigenous people; *campesinos*

The complex scenario of family-based traditional agriculture at present. Challenges for indigenous people and *campesinos*

The current challenge for agriculture at a global level, under a 30% population increase scenario by 2050 (9.1 billion people), is how to produce enough food for everyone; a challenge more apparent on highly populated developing countries. At the same time, contrasting health issues like malnutrition, micronutrient deficiency and obesity need also to be addressed (Acuña, 2015; Fanzo, 2015; FAO, 2015a). From these arises the question: How can we produce food that is healthy, diverse, nutritious, innocuous, abundant

and accessible? Can this be done sustainably, strengthening food sovereignty and promoting the conservation of natural resources? According to the literature, food sovereignty is one alternative.

Food sovereignty is a policy proposal, presented by the Via Campesina during the World Food Summit in 1996, stating that it is the 'right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems'¹ (Declaration of Nyéléni, 2007). It is also the right of each state to maintain and develop its own capacity for food production, respecting local cultural and produce diversity

(Comité de Seguridad Alimentaria Mundial, 2015; Peoples Food Sovereignty Network, 2002; Via Campesina, 1996). This universal right requires the recognition of existing sustainable agriculture systems. These include (a) sustainable access and control of resources, respecting the right of use by indigenous people, with emphasis in women; (b) increase diversified local models of production by recovering, validating and spreading sustainable practices, for example, the use of endogenous potential; (c) transformation and commercialization of produce in local markets, reducing the role of middlemen; (d) the right to have daily access to healthy and culturally appropriated nutritious food, produced locally and sustainably; (e) and the right of indigenous people and *campesinos* to be aware, participate and influence in policies, strategies, programmes and agricultural incentives (Agüero, 2015; Chirinos, Leal, & Montilla, 2006; Figueroa-Helland, Thomas, & Aguilera, 2018; Gumucio & Tafur, 2015; Ortega-Cerda & Rivera-Ferre, 2010). It is necessary to work at various levels, with different actors to achieve these goals aiming that all participants have a dignified life in harmony with nature. Currently, historical processes, economical interest, lack of and constant division of land, unemployment, limited access to health care and education, limited investment in infrastructure and now climate change, are all synergic factors that promote poverty and environmental degradation as part of the rural context in Latin America (Duru et al., 2015; Monsalve, 2018; Parraguez-Vergara & Barton, 2013; Parraguez-Vergara, Barton, & Raposo-Quintana, 2016; Tendall et al., 2015; Westra, 2008). Paradoxically, small-scale indigenous and *campesino* producers play a major role in food production, and subsistence economies (FAO, 2015b), making a significant contribution to the dynamism of local and regional markets, and supporting the wellbeing of the other local actors.

Two main food production systems are coexisting today, the modern-agricultural system and indigenous and *campesino* traditional agriculture. The former, supported by political and economic powers and with a stronger negotiation capacity, has displaced family-based traditional agriculture to marginal lands and out of the main markets. However, this technified production, using hybrid or genetically modified varieties, has a high demand of agrochemicals and is ill-adapted to each local ecosystem, which apart from conferring a higher vulnerability to climate change, has impacted negatively on ecosystems. These social, economic

and environmental impacts have produced, amongst other things, an increase in migration rates, unemployment and ecosystem pollution (Alders, Ratana-wongprasat, Schönfeldt, & Stellmach, 2018; Gordillo, 2004; GRAIN, 2015; Khoury et al., 2014; McGuire & Sperling, 2016; Peredo & Barrera, 2005). Additionally, a substantial portion of the food produced by the modern agricultural system is either exported, used as fodder for cattle or as biofuel, further reducing the access by rural people to food produced locally (Azadia et al., 2011; Pérez, 2005). The main aim of big producers, under the current modern agricultural system, is to maximize profits relying heavily on technological improvements generating a bigger demand of natural resources. This economy, based on only a few plant species/varieties, is usually promoted and subsidized by governments globally and is one of the main causes of useful biodiversity loss. Varieties that took thousands of years to be domesticated and adapted locally are no longer being grown, even the indigenous people and *campesinos* are shifting to subsidized varieties. At a global scale, 60% of agricultural lands are used to grow only five monocultures (wheat 22%, maize 13%, rice 11%, barley 9% and soy 5%), an additional 21% of land is dedicated to 24 other species, 7 of which (9% of the area) are for sugar, fibre and seed oil. Only the remaining 19% of land is used to grow legumes, vegetables, fruits, species, etc. (Leff, Ramankutty, & Foley, 2004). Major crops are certainly nutritious and can provide most if not all required nutrients in most situations.

On the other hand, indigenous and *campesino*² family-based agriculture is a diverse and extensive system whose main aim is self-consumption (although any surplus can be sold). Hereafter, we will refer to the agricultural systems of indigenous people and *campesinos* as family-based traditional agriculture, as the majority of *campesinos* are small-holder *mestizos* which agricultural practices mostly derive from the indigenous agricultural systems used locally long before the Spanish arrival. Their systems are nested within the ecosystem, as many of the species used occur naturally in the surrounding areas. Their traditional ecological knowledge comprises experiences, practical skills and techniques about the use of hundreds of species of plants, animals and fungi that can be used for food, medicine and building material (Altieri & Nicholls, 2010; Battiste & Henderson, 2000; FAO, 2009, 2011). This knowledge is related to a specific cultural and ecological context, which can be of great relevance in current global issues like

food sovereignty, water and ecosystem management, soil conservation and biological control of plagues³ and diseases (Agüero, 2014; Altieri & Toledo, 2011; Menzies, 2006; Via Campesina & GRAIN, 2015). Nevertheless, along with biodiversity, traditional knowledge and practices are being eroded by globalization processes (Contreras, Silva, Parraguez-Vergara, & Barton, 2015; FAO, 2015c; Henderson, 2018; Turner, Gregory, Brooks, Failing, & Satterfield, 2008).

Within the Latin-American context, there are still 826 Native Peoples recognized today and whose interaction for hundreds of years with the great richness and diversity of their region has produced two of the eight globally recognized centres of origin: Mexico and Central America, and the Andes (CEPAL, 2014; Vavilov, 1992). However, cultural change and migration to big cities are threatening the survival of these groups; by 2010 there were 45 million indigenous people representing only 7.8% of the total population in Latin America (CEPAL, 2014). The countries with the higher proportions are Bolivia (62.2%), Guatemala (41.0%), Peru (24.0%) and Mexico (15.1%). Brazil is the country with the biggest number of native groups (305), followed by Colombia (102), Peru (85), Mexico (78) and Bolivia (39). However, as mentioned before, many of these groups are on the verge of disappearing. Brazil (70 endangered groups), Colombia (35 groups) and Bolivia (13 groups) are the countries with the biggest problems. Despite their lower numbers with respect to the total population, family-based traditional agriculture contributes between 30% and 40% of the regional gross domestic product (FAO, 2015b). These figures show that there are strong and highly dependent links between food production at a country level and the rural indigenous livelihoods (Deaton & Lipka, 2015; Ford, 2012; Hendricks, 2015), which could be a great asset for securing food sovereignty if their importance was to be recognized and supported.

In summary, it is increasingly recognized that traditional agricultural systems, once forgotten and marginalized by governments, can play a leading role in food sovereignty at local and regional levels, as they are diverse integrated systems adapted to local conditions, which are able to provide the necessary nutrition for people. This paper compared the rural context of family-based traditional agriculture of six Latin-American countries, aimed at identifying the agricultural practices used by local actors as part of their traditional agricultural system. These practices were analysed in order to determine: Which practices are

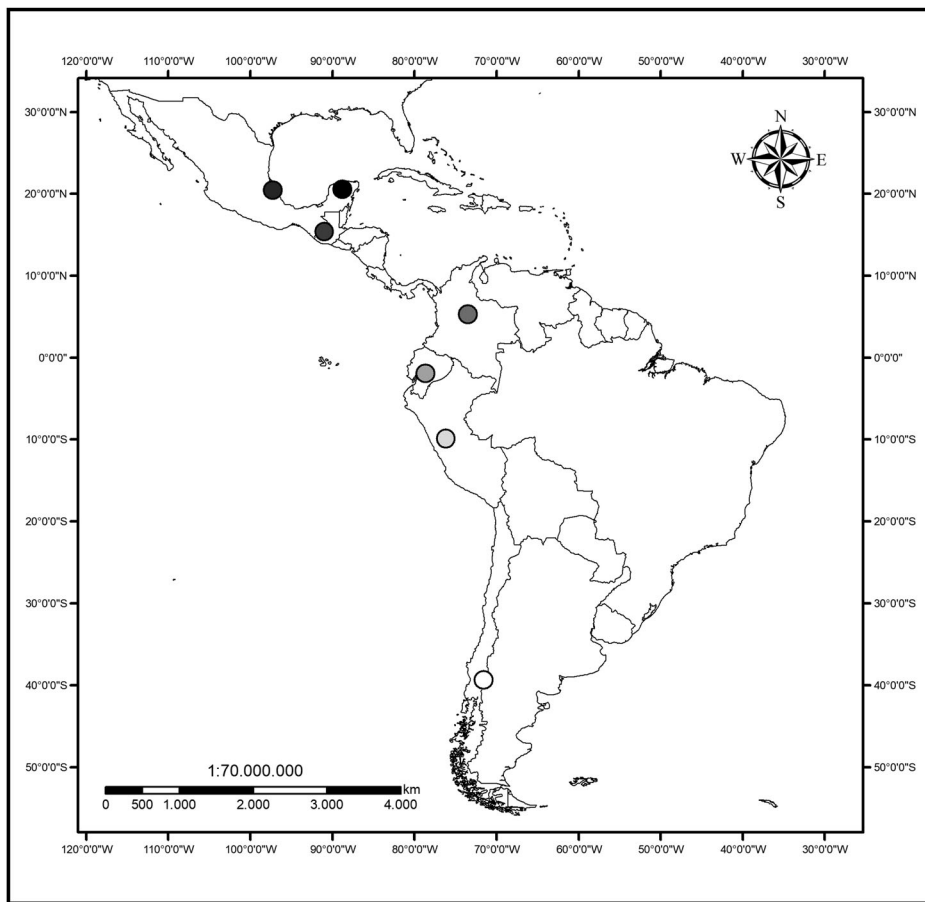
still being used? Why are they still used? What benefits are provided for local actors? How biodiverse are their systems? What is the impact, in the rural context, from the point of view of food sovereignty and ecosystem conservation?

Analysis scope

The information was compiled from the rural context of the following areas of Latin America: (a) Curarrehue Commune, Araucania Region, Chile; (b) San Pedro de Macha and Alto Quera communities, Santa María del Valle District, Huánuco Region, Peru; (c) Las Huaconas Community, Chimborazo Province, Ecuador; (d) Turmequé and Ventaquemada Municipalities, Boyacá Department, Colombia; (e) San Juan Cotzal, Los Pinos and Cunén, Quiché Department; and La Concepción, Quetzaltenango Department, Guatemala; (f) El Tajín, Papan-tla Municipality, Veracruz and Yaxcabá Municipality, Yucatán, Mexico (see Figure 1). All these communities differ amongst themselves in terms of climate and other physical variables (see Table 1). Nevertheless, they share similarities in terms of productive economic activities and demographics, as there is a high proportion of indigenous and *campesino* populations dedicated to agriculture. Their economy is mostly informal, with temporal jobs and a variable income, as they usually seek employment when the agricultural season is over; however, their access to food is mostly directly through local production (see Table 1).

Methods

We used a set of ethnographic research methods. For Chile, Peru and Guatemala methods included guided visits, semi-structured interviews and field observations. The information obtained for Chile at Curarrehue Commune was compiled during a technical training campaign aimed at small indigenous producers and *campesinos*, covering issues related to ecosystem conservation and sustainable food production. Regarding Peru and Guatemala cases, the information was gathered by a Chilean group supported by the Agricultural Innovation Foundation. This is an initiative of the Chilean Ministry of Agriculture promoting technical and academic exchange between small producers, entrepreneurs and researchers with Parties from other countries. This group, comprising small and medium Mapuche producers and Mapuche entrepreneurs from the Araucania region and researchers, visited projects related to



Context of Study

- Curarrehue, Región de la Araucanía, Chile.
- San Pedro de Macha y Alto Quera, distrito de Santa María del Valle, Región de Huánuco, Perú
- Comunidad de las Huaconas, Provincia de Chimborazo, Ecuador
- Turmequé y Ventaquemada, Departamento de Boyacá, Colombia
- San Juan Cotzal, Los Pinos y Cunén, departamento de Quetzaltenango, Guatemala.
- Totonacas de Papantla, Estado de Veracruz, México.
- Mayas de Yaxunah, Estado de Yucatán, México.

Figure 1. Context of study in Latin America. Source: Salinas Riveros Pablo, based on the cartography ESRI DATUM WGS 84 (2017).

‘sustainable agriculture, food sovereignty and local markets’ under the umbrella of the National Agricultural Confederation of Peru and ‘rural value chains’ projects promoted by the Guatemalan Association of Exporters.

Data for Ecuador and Colombia are from a comparative study between indigenous producers from Las Huaconas Community at Ecuador and from

Turmeque y Ventaquemada Municipalities at Colombia, assessing their local agricultural knowledge about use and conservation practices of three Andean tubers: ruba (*Ullucus tuberosum* C.), ibia (*Oxalis tuberosa* M.) and cubio (*Tropaeolum tuberosum* R. & P.). Research methods were semi-structured interviews, life stories, participative observation and workshops with focal groups. For Mexico, we included two

Table 1. Characterization context of study in Latin America.

Country	Chile	Peru	Ecuador	Colombia	Guatemala	Mexico Totonacas Papantla	Mexico Mayas Yucatán
Study site	Curarrehue Commune, La Araucanía Region	San Pedro de Macha and Alto Quera communities, Santa María del Valle District, Huanuco Region	Las Huaconas, Canton of Colta, Chimborazo Province	Ventaquemada and Turmequé Municipalities, Bocayá Department	San Juan Cotzal, Los Pinos and Cunén, Quiché Department; La Concepción, Quetzaltenango Department	El Tajin, Papantla Municipality, Veracruz State	Yaxunah, Yaxcabá Municipality, Yucatán State
Distance from the country capital	677 km SE of Santiago	410 km NE of Lima	216 km S of Quito	Between 98 and 120 km NE of Bogotá	Between 150 and 350 km N of Guatemala City	270 km NE Mexico City	1,450 km. SE Mexico City
Climate	Cfb , Warm and temperate climate, summer rains	Bsh , local steppe climate, winter rains	Aw , Cold and dry	Cfb , Temperate climate, summer rains	Cfb , Temperate climate, summer rains	Af , Tropical wet, summer rains	Aw , Tropical wet and dry, summer and autumn rains
Annual rainfall	1.500–2.500 mm	388 mm	500–1.000 mm	Turmequé 856.5 mm; Ventaquemada 1.092 mm	900–2.300 mm	1187 mm	1141 mm
Temperature	Winter: –0°C; Summer +30°C	Winter: 17°C; Summer +30°C	10–13°C	Turmequé 15°C and Ventaquemada 14°C	Winter: 18°C; Summer 32°C	Winter: –6°C; Summer +35°C	Winter: 10°C; Summer 37°C
Altitude (data from a nearby city)	Curarrehue, 400 m.s.n.m.	Huánuco, 1.800 m.s.n.m.	Cantón Colta, 3180 m.s.n.m.; Ciudad de Riobamba, 2750 m.s.n.m.	Tunja, 2810 m.s.n.m.	Quetzaltenango, 2.000 m.s.n.m.	Papantla, 180 m.s.n.m.	Pisté, 30 m.s.n.m.
Type of habitat	Temperate rainforest	Mountain forest	Mountain forest	Mountain forest	Mountain Forest, Cloud Forest and Dry valleys	Tropical rainforest	Tropical deciduous forest
Ethnicity	Mapuche indigenous and Campesinos	Indigenous campesinos	Indigenous	Campesinos	Indigenous campesinos (90%)	Totonacas campesinos and Mestizos	Mayas campesinos
Employment type	Informal	Informal	Informal	Informal	Informal	Informal	Informal
Source of income	Variable + State subsidies	Variable	Variable + State subsidies	Variable	Variable	Variable + State subsidies	Variable + State subsidies
Economic and productive activities	Agriculture, forestry, tourism and services	Agriculture	Agriculture, livestock, commerce, transport, masonry	Agriculture, livestock, commerce, transport, masonry	Agriculture, handcrafts and commerce	Commercial and subsistence agriculture, handcrafts, masonry, touristic services	Wood crafts, honey production, subsistence agriculture, touristic services
Working as merchants in food markets	Local, community markets	Local and regional	Local, regional through middlemen	Local, regional through middlemen	Local, regional	Local, regional through middlemen	Local, regional through middlemen

Source: Ministry of Environment (2017).

different case studies, one performed in El Tajin Community, Veracruz and the other in Ejido Yaxunah, Yucatan. In the first case, semi-structured interviews were initially performed and after a structured questionnaire was designed using that information. This was part of a bigger project of Grass-roots Sustainable Development from the Center of Tropical Research at the University of Veracruz. The Yaxunah case incorporated lessons learned at El Tajin, but in this case, the focus of the project was out of school education and training for local children and young people. Nevertheless, we performed semi-structured interviews and collected life stories; we also participated directly in the agricultural practices.

Every one of these projects is either directly or indirectly associated with the several aspects of food sovereignty previously described. At the local level, the traditional knowledge and practices of indigenous and *campesinos* livelihoods are highly heterogeneous. For example, Andean tuber crops are important for food security of farmer and native communities of Colombia and Ecuador. However, these crops are not economically important for their urban markets, thus not a priority for their public policies. On the other hand, Andean tuber crops for these rural communities are of not only economic relevance, but also represent their identity and culture. This is demonstrated through the variety of ways on how to use and consume these products. These tubers are cultivated in a variety of traditional production systems, which apply sustainable practices for the management, use and conservation of the soil, while maintaining monetary and non-monetary trade exchange that facilitates family and local food sovereignty. This context is similar to case studies on traditional agriculture in Peru, Guatemala and Mexico, where the first two countries received knowledge exchange and economic support from of the National Agricultural Confederation of Peru and by the Guatemalan Association of Exporters. The focus of the investment of the Chilean government has been on transformation and commercialization of the local agricultural production; therefore, local actors are the one responsible for covering the remaining areas of food sovereignty. In that way, projects can be interpreted and addressed as case studies covering all the aspects of food sovereignty and considering all the relevant stakeholders. In other words, these case studies would consider stakeholders involved in all the steps in the process, including production, distribution and consumption of food products, according to the cultural

and sustainable perspective of traditional knowledge and practices relevant to food sovereignty.

Results and discussion

In total, we assessed 54 practices related to the family-based traditional agriculture. Seven of these practices were related to their worldview (13%), important for cultural recovery and cultural appreciation; 38 practices were related to conservation, protection and enhancement of the agricultural lands (70%), including preparation of land (14.8%), seed conservation (14.8%), crops (11.1%), natural fertilizers (18.5%) and pesticides (11.1%); and nine practices (17%) were related to the efficient use of water and other natural resources (Table 2). While all study cases were restricted to a specific area, there is a general tendency in our results that very likely represents what is currently occurring within the wider Latin-American context, as many practices. However, the geographical and cultural diversity included in this study implies that some practices are related to a specific culture and area (Table 2).

Our results also show that indigenous producers and *campesinos* have incorporated innovative technologies to their traditional practices, principally in relation to fertilizing the soil (earthworm composts, organic liquid fertilizers, etc.) and water management (Table 2). This is because NGOs and governments are providing training and running workshops to increase production and to contribute to the conservation of local species and varieties. A good example of this kind of initiative is the programme for the conservation of Andean tubers shared by Ecuador and Colombia (Clavijo & Pérez, 2014; Clavijo, Barón, & Combariza, 2014). Notwithstanding, most of the communities included in our study still observe traditional practices related to their connection to the Earth, like offerings to Gods and Nature or planting the seeds (natural capital) at specific phases of the lunar cycle.

Cultural recovery and revaluation

Worldview

The family-based traditional agriculture of Latin-American peoples is underpinned by their Worldview, which synthesizes centuries of accumulated empirical knowledge of the ecosystems and climates they live in. This knowledge, which has practical applications, also informs their belief system from which people

Table 2. Traditional practices according to context of study in Latin America.

Rural livelihoods	General considerations	Practices	Chile	Peru	Ecuador	Colombia	Guatemala	Mexico Totonacas Papantla	Mexico Mayas Yucatan
Cultural practices and values	Worldview	Season	X	X	X	X	X	X	X
		Lunar phase	X	X	X	X	X		
		Month	X	X	X	X	X	X	X
		Time of the day	X	X			X	X	X
		Emotional state	X	X	X		X		
		Woman (fertility phase)			X		X	X	X
		Offerings to nature (gods)	X	X	X		X	X	X
Conservation, protection and enhancement of ecosystems	Preparing land for sowing	Hoes and spades	X	X	X	X	X	X	X
		Animal yoke	X	X	X	X	X	X	
		Fallows	X	X	X	X	X	X	X
		Resting lands	X					X	X
		Rotation system (cattle and agriculture)	X	X	X	X	X		
		Terraces		X			X		
		Rised beds	X						
	Seeds	Green houses	X	X			X		
		Native seeds conservation (saving seeds for the next season)	X	X	X	X	X	X	X
		Seed adaptation to critical environmental conditions					X	X	X
		Seed exchange with other producers. Local or regional (<i>trafkintu</i> mapuche)	X	X	X	X	X	X	X
		Exchanging seeds for other produce (<i>trueque</i> mapuche)	X	X	X	X	X		
		Family seed banks		X	X	X	X	X	X
		Community seed banks				X	X	X	X
		Seed storing practices (hay, baskets, trojes, silos, wooden sheds)		X	X	X	X	X	X
	Crops	Seed purchase	X	X	X	X	X	X	X
		Mixed cropping	X	X	X	X	X	X	X
		Mixed cropping with fodder crops		X			X		
		Intercropped polyculture	X	X	X			X	X
		Crop rotation	X	X	X	X	X	X	X
		Crops using allelopathic plants				X			
		Crops associated with trees	X	X	X	X	X	X	X
	Natural fertilizers	Leaf compost (<i>broza</i> , Guatemala)	X	X		X	X		
		Animal manure	X	X					
		Worm compost	X	X		X	X		
		Bacteria					X		
		Mixtures	X	X		X	X		
		Organic layer	X	X	X		X	X	X

(Continued)

Table 2. Continued.

Rural livelihoods	General considerations	Practices	Chile	Peru	Ecuador	Colombia	Guatemala	Mexico Totonacas Papantla	Mexico Mayas Yucatan
Efficient use of resources	Natural pesticides and crop management	Green manure			X	X	X		
		Organic liquid fertilizers	X				X		
		Slash and burn					X	X	X
		Ashes	X	X		X	X	X	X
		Macerated plants (rue, tobacco, eucalyptus, etc.)	X	X			X		
		Biol		X		X	X		
		Plant mixture	X	X	X	X	X	X	X
		Medicinal herbs	X	X	X	X			
		Changing planting season (before pest appearance)					X		
		Ashes	X	X			X		
	Water management	Cloud harvesting		X			X		
		Ponds	X	X		X	X		
		Drip and sprinkler irrigation	X	X			X		
		Rows	X	X	X	X		X	X
		Watershed protection		X			X	X	
	Other management practices	Grafting		X			X	X	
		Fruit thinning	X				X	X	
		Hedges		X	X	X	X	X	X
		Weeding	X	X	X	X	X	X	X

Source: Parraguez-Vergara, Elvis; Contreras, Beatriz; Clavijo, Neidy; Villegas, Vivian; Paucar, Nelly; Ther, Francisco (2017).

derive their 'Belief Knowledge' (Woodley, 2006). Practices related to performing activities at a certain time of the year or the month and thanksgiving practices for Nature or Gods are strongly linked to this Worldview. The use of the Belief Knowledge is a shared practice between Chile, Peru Ecuador, Guatemala and Mexico. People seek answers to issues related to the success or failure of their crops in their Worldview, for example, the time of the day, lunar phase or their emotional state when sowing seeds (Louwagie & Langohr, 2007; Tavhare, Nishteswar, & Shukla, 2015). However, we found very little use of the Belief Knowledge in Colombia, which could be related with the rapid decline of indigenous peoples (35 ethnic groups surviving out of 102 still existing at the beginning of twenty-first century), and the consequent loss of traditional knowledge and practices associated with food production. This loss is one of the main challenges that must be resolved in relation to food sovereignty.

Within the Peruvian and Guatemalan contexts, there are processes helping to regain cultural identity and revaluing the traditional knowledge and agricultural practices thanks to the help received from the National Agrarian Confederation of Peru and the

Guatemalan Association of Exporters, generating a certain degree of autonomy about what and how to produce food. The local actors – especially indigenous people – recognize that poverty and ecosystem degradation are problems affecting them, while also acknowledging that they are undervaluing or not using the traditional knowledge and practices for food production. Once they perceive themselves as poor, people stop regarding their traditional knowledge as human capital (in text cultural capital) with an intrinsic value; conversely, they overvalue the external education and training received through programmes and subsidies. This may help to explain in part, why they imitate the modern agriculture system of monocultures, using synthetic agrochemicals, aggravating or perpetuating the degradation of the rural socio-economical and socio-ecological systems. In this process of undervaluing local knowledge, the state has played a key role, through their policies, programmes, plans and agricultural interventionist projects, which mostly fail to consider the endogenous potential as a valuable asset (Jacobi, Mathez-Stiefel, Gambon, Rist, & Altieri, 2017; Jenkins, 2000; Pereira, López, & Dal Soglio, 2017).

Conservation, protection and enhancement of ecosystems

Soil preparation

The main deciding factor for selecting a specific practice for soil preparation is, not surprisingly, the knowledge about local environmental characteristics. In addition to it, land tenure, land extension, labour costs, accessibility and costs of implements and supplies are also considered. In general, in mountainous areas, where steep slopes prevent the use of tractors, hoes, spades and animal yokes are the main tools used. In most areas, resting the lands is allowed by letting it go fallow after 3–5 years of use.

Land extension has promoted the implementation of certain practices using locally available materials. Such is the case of terraces, which are a response of indigenous people to limited land availability and steep slopes; using rocks, dirt and sand, they build walls that prevent soil erosion and retain water. Steep slopes also need different irrigation practices, like channels and small reservoirs. Land rotation between agriculture and livestock is a common practice in most of the study areas, which allows soil resting and manure fertilization. In Guatemala, Peru, Colombia, Ecuador and Mexico, shepherding is carried out mostly by women and children. These complementary systems allow larger numbers of animals for sale or self-consumption (mostly ovine due to limited land) and for traction (horses and oxen). In Peru, the production of guinea pigs in confined spaces is recovering a traditional practice that was getting lost, allowing people to generate income by selling their meat or cooked following traditional recipes, and in addition, faeces and urine are used as a fertilizer. These practices follow a cyclic pattern according to seasons, which allows the social and economic aspects of their livelihoods to be articulated with environmental factors, and which are therefore less disruptive to ecosystems. The complementarity between plant and animal resources would allow alleviating the problems of malnutrition and mineral deficiency in children, one of the challenges of food sovereignty.

Seeds

We found that using native seeds represents a great challenge in our study cases, in terms of seed storage, acclimatization (see also Peters, Breitsameter,

& Gerowitt, 2014) and seed exchange as opposed to buying introduced or hybrid seeds. Seed conservation and direct seed exchange between producers during local or regional market days are a common and extended practice, receiving particular names in different regions (example: *trafkintu* in Chile). One of the challenges for native seed exchange or purchase in regional markets is that they may not be totally adapted to the local climatic conditions, particularly in steep mountainous regions where the altitude between villages can differ by the hundreds of metres or where the seeds had been acclimatized to wet side of the slope, for example. For that reason, the acclimatization of certain species to extreme conditions, particularly drought, plays a key role in the process of strengthening the family-based traditional agriculture under a climate change scenario. In Guatemala, seed acclimatization is technically supervised by the Guatemalan Association of Exporters, but the farmers are the ones sowing the seeds and maintaining the plant characteristic that allows survival under critical conditions (drought, floods, scorching sun, soil salinity, thin and poor soils, etc.). These practices are applied for different regional and productive contexts, for example, for coffee, maize, beans and some grass varieties. Except Chile, seed banks and other seed storing practices, either family-based or communal, are an extended practice across our study cases, using a great diversity of techniques and objects. These include baskets or clay pots for bean and maize grains, *trojes* (a simple construction consisting of a thatched roof and raised platforms) to stack maize ears or burying potatoes and yuca in holes. Herbs with plaguicide properties are sometimes added to the seeds stored in baskets or pots (e.g. Epazote, *Dysphania ambrosioides* in México).

The opposite practice is buying the introduced or hybrid seeds in the market, either with their own resources or with subsidies, which is the main factor for seed diversity loss. One of the main problems with these seeds is that they are mostly designed to increase high yields, whereas the native seeds have been selected for a variety of factors that can threaten food security. For example, for maize, Mexican *campesinos* select ears from plants resisting drought, heavy storms, good sized seeds, nutritious content, water/dry weight ratio, resistant to plagues while stored for example. As one man shared: 'You won't believe me, but one kilo of hybrid maize does not convert into one kilo of tortillas, and those seeds are easily eaten by weevils'. In Yucatan, seeds from maize plants that

are still standing after a hurricane are also carefully selected and stored. In general, hybrid seeds create a bigger demand for water, fertilizers, pesticides and the accompanying infrastructure, and they are highly vulnerable to plagues and climatic variations. The problem is the cost associated with the modern agricultural system. The indigenous and *campesinos* rural livelihoods are characterized by high poverty and degradation of ecosystems, making food sovereignty one of the best alternatives.

Native, introduced and improved varieties for commercial purposes

In all our study cases, there is a high diversity of native species, adapted to different climates and in some cases to extreme environmental conditions (e.g. high temperatures and drought in Yucatán, or high altitudes and freezing conditions in the Andes). Several of these species had been adopted and adapted to other continents centuries ago (e.g. maize, tomato, potatoes and cocoa) and have a high commercial value. Other species, introduced to the international market during the last decades like quinoa or avocado, have a good economic potential due to their high yields and high nutrient content. In our study sites, approximately 94 native species are cultivated; many of them are little known to mainstream agriculture and are now endangered like some Andean tubers and Centro American *qualities* (nutritious herbs). Even though there are a lot of state initiatives and NGO's working *in situ* trying to address these problems, at the same time the same governments are implementing national programmes that incentivize commercial monocultures.

In the whole of Latin America, the same 10 species are being promoted by governmental programmes and subsidized (avocado, rice, banana, coffee, sugar cane, beans, maize, mangoes, potatoes and wheat), with coffee and sugar cane being commodities with little nutritional content. The great danger of these initiatives is that immediately indigenous people and *campesinos* become connected and therefore vulnerable to the global market fluctuations, while having little knowledge of economics at that level. Additionally, as all the countries are promoting the production of the same species, the market becomes saturated resulting in the subsequent collapse of prices. In addition, monocultures have high economic and ecological costs; they need in general high quantities of fertilizers and insecticides, and naturally promote

plagues. Likewise, the degradation of ecosystems entails the difficulty of obtaining natural seeds. Culturally, monocultures have also a negative effect, as by converting vast areas of land into a single crop, all the traditional knowledge and practices related to the other species are no longer used and get forgotten. This shows that the loss of traditional knowledge and practices is synonymous with the loss of natural capital when it is associated to indigenous and *campesino* traditional agriculture. It also shows that food sovereignty represents a process of different areas of action, which necessarily requires integral and gradual mechanisms.

Agroecosystems

The most used crop practices were mixed cultivation, crops associated with trees and crop rotation. Peruvian traditional producers were proud of showing the recovery of knowledge and practices about mixed crops (two or more species are planted at the same area, and their interaction is mutually beneficial, for example, maize and beans); and intercropping (alternate rows of different species, for example, rows of tomatoes and rows of onions). Such practices provide several benefits like soil fertilization (i.e. beans fix the nitrogen needed by maize), pest resistance and water retention. Thus, this can reduce production and maintenance costs, and also reduce the dependency of indigenous people and *campesinos* on climatic conditions, and at the same time increases their access to fresh, nutritious and balanced food (Adhikari et al., 2018; Powell et al., 2015). Surplus produce was sold in the regional markets, and the resources were used for house improvement or reinvested in agriculture, particularly in irrigation systems. Conversely, in Guatemala, even though producers had knowledge about mixed crops, they were organized and associated to produce commercial monocultures to be exported to the US and Europe. These producers also bought improved seeds according to market demands. In Colombia, what is relevant to highlight is the use of allelopathy plants, which are plants that produce biochemical compounds capable of influencing positively or negatively the growth, survival or reproduction of other plant species. In Mexico, the *milpa* crop system is highly diverse, where three main species: maize, beans and squash, are key components for nitrogen fixation, protection against erosion and water retention. Food produced in the *milpa*, is complemented with produce from the home garden, where spices,

fruits and animal protein are obtained. Nevertheless, commercial monocultures like citric and bonnet pepper are becoming more common. An additional benefit from mixed crops, as well as providing a more balanced nutrition, is that in most cases medicinal plants are also interspersed. Although some are used to cure illness, others are used regularly to maintain health and prevent illness. Thus, *agroecosystems* show that food sovereignty is a process of different areas that requires integral work approach in association how the different capitals are mobilized within the livelihoods.

Natural fertilizers

The key features of using organic fertilizers are their low cost of raw materials, labour and implements. Using a specific raw material mostly depends on its availability, namely leaf litter, animal faeces and urine, organic matter, grass, legumes, etc. Another factor is also the knowledge and practices that belong to the local culture. Both factors may help to explain the great variability in our case studies (see also Aziez, Indradewa, Yudono, & Hanudin, 2018; Giomi, Runhaar, & Runhaar, 2018; He, Zheng, Chen, He, & Zhang, 2008; Melero, Madejón, Ruiz, & Herencia, 2007). Other practices like using earthworm composts and foliar fertilizers require a bigger economic investment; therefore, they are mostly implemented for economic crops. Slash-and-burn practices, although used in Mexico and Guatemala, are not used in Andean study cases, as people are aware that such practice would imply a massive soil loss from the mountainous steep slopes. In Chilean case studies, such activity is restricted by the government as the indigenous communities lie within two Protected Natural Areas. In general, with the exception of slash-and-burn, all practices recorded have positive impacts on ecosystems as mostly easily degradable organic matter is added to the soil (Planes-Leyva et al., 2004).

Natural pesticides

The knowledge about the use of natural pesticides is based on detailed observations of plant responses to plagues and of the links between plague events and climatic factors. Given the specificity of such knowledge, it is important that it is constantly implemented and updated, to prevent that this knowledge becomes forgotten and the practices replaced with non-natural pesticides. The danger is not only that the practices fall into disuse, but also that some natural pesticide

plants, specific to a certain ecosystem, can become extinct or lost locally. Such is the case of the macerated compounds used in Chile, Peru and Guatemala. Using a mixture of edible and medicinal plants in crops is an extended and low-cost practice that necessarily requires traditional knowledge and practices. A practice differing from the above is the use of biol (macerated leaves of local plants with pesticide activity, diluted in water and stored in bottles), which are sold amongst the small-scale producers, even at regional markets, providing additional income to local actors. In Guatemala, broad beans are planted earlier in the season, and this decision is based on traditional knowledge, as broad beans can grow under low temperatures, but cold deters the growth of weevils. This simple practice leads to economic savings, as there is no need of pesticides and the produce is available in the market early in the season (Strange & Scott, 2005). Similarly, adding ash to the soil has a double function as a natural fertilizer and pesticide (Altieri & Nicholls, 2007; Chávez-Dulanto et al., 2018; Girvan, Bullimore, Ball, Pretty, & Osborn, 2004). An important characteristic of natural pesticides is their zero or very minimal impact on insect pollinators (bees, bumble bees, butterflies). This fact has allowed honey production to be an additional asset, with high economic value, for the family-based traditional agriculture. Nevertheless, honey production is practised at a small scale. The use of natural fertilizers and pesticides represents an alternative of foods production free of agrochemical. Its trend has been increasing for reasons of human health and ecosystems protection, in direct relation with challenge food sovereignty.

Efficient use of resources

Water

The big limiting factor in all our study areas was water availability and access to water (Dinesh Kumar & Singh, 2005; Domènech, 2015; Fereres, Orgaz, & Gonzalez-Dugo, 2011; Field & Michalak, 2015). These are further aggravated by uncertainty related to climate change, which brings back the issue of the importance of traditional agricultural practices, water management and native seeds. Water management in these regions is also highly related to geographic location and degree of slope. Protecting the slopes from erosion is a practice that is becoming increasingly important, reviving traditional knowledge and

practices. Slope protection includes the benefit of clean water, as runoff water does not have chemical pollutants, like the chlorine in drinking water, which may decrease or prevent agricultural production at a small scale. In Peru, slope protection and the use of wooden watercourses reduce water loss and make its use more efficient. Currently, wood in watercourses is being replaced by plastic pipes and water tanks. These factors also influence governmental and other agencies interventions, especially in Chile, Peru and Guatemala, as they provide resources, infrastructure and training about irrigation techniques. However, the concept of food sovereignty is unclear when it points about sustainable access and control resources, specifically, the water. It is necessary to specify explicitly the key role that will have the water availability and access for strengthening of food sovereignty. For example, what additional and complementary measures are necessary to ensure water availability and access, articulating the traditional knowledge and practices?

Other management practices

There are other practices that not only are linked to the traditional knowledge and practices, but that also shows the great plasticity, adaptation and learning capacity of the local people to adopt new practices and productive species, strengthening the food sovereignty. For example, weeding allows the crop to grow stronger and the weeds can be composted and used as fertilizer. Living fences – except in Chile – are particularly useful in mountainous areas, as they provide wind shelter, reduce erosion, replenish soil nutrients and provide shade. However, living fences are being slowly replaced by wire fences and barbed wire which implies a bigger investment for building and maintenance. In Peru, grafting was used to respond to market demands while using resources already in place; there was a market demand for *hass* avocado and the producers grafted their avocado trees with this variety instead of replacing them, to take advantage of the resistance characteristics of the local native trees. Such a strategy allowed the producers to supply the market with *hass* avocado within 2–4 years, selling it at a higher price than the local avocado. This variety was also commercialized in Lima – the capital – along with other new fruits that were either obtained by grafting different varieties of the same tree species, or two different species, like lime and orange. Thinning fruits is a simple technique, but

it has an associated uncertainty due to the changing weather conditions up in the mountains. Unexpected climatic events and changing rainy seasons were the major reasons for discouraging this practice, as there is no guarantee of a good production or even to have any produce at the end of the season. These practices mean benefits monetary and cultural, being other useful mechanisms to advance in food sovereignty.

Conclusions

This research concludes that in all the reviewed case studied (54) already existing traditional knowledge and practices, that direct or indirect benefit at local actors. Firstly, we concluded that indigenous people and *campesinos* traditional agriculture could contribute to strengthen in a fair and equitable way food sovereignty in Latin America, while respecting the natural and cultural endogenous potential of these groups. Secondly, food sovereignty should be understood as an integral process, where work is carried out in a series of steps covering all aspects of food sovereignty, while focusing on the local actors being supported by the external ones. Gradualness and integrity of the process could help local actors by providing them with autonomy on decisions and opinions; therefore becoming the basis for future policy development aiming to strengthen food sovereignty in Latin America. This would mean changes in the already existing tools created by the countries to strengthen food and agriculture. Traditionally, their focus has been a vertical integration that includes economic indicators and fixed deadlines, without considering the heterogeneity of local stakeholders. In fact, interrelatedness and gradualness were unique of the National Agricultural Confederation of Peru and by the Guatemalan Association of Exporters, where there was a clear empowerment of local actors by working in food sovereignty using a comprehensive approach, 42 and 47 practices. To achieve that, training in local cultural knowledge, as well as in external marketing and commercialization, focuses on rescuing and valuing the endogenous potential of the capital natural and cultural like essential.

Our results show that the contribution of family-based traditional agriculture represents at the same time the challenges to strengthen food sovereignty in Latin America. This complexity arises from the transversally and interrelation of the several components of food sovereignty that in this study were divided into: (a) cultural valuing and recovery: worldview, and

traditional knowledge and practices; (b) conservation, protection and improvement of ecosystems: soil preparation, seeds, sowing and natural fertilizers and pesticides; (c) efficient use of resources: water management and other agricultural practices. That information was obtained by assessing the number of agricultural practices found in this study: Chile 37, Peru 42, Ecuador 27, Colombia 30, Guatemala 47, Totonacas of Paplanta 30 and Mayas of Yucatan 26. Although there is disparity between the practices analysed, the difference between the cultural valuing and recovery and conservation, protection and improvement of ecosystems, 13% vs 70% of practices, is meaningful. This could be the consequence of poverty, degradation of ecosystems and marginalization, which have relegated even more the ethnic character and as a result increasing the loss of cultural of traditional knowledge and practices over management, use and conservation of ecosystems. This complexity explains why policies, programmes, plans and projects on locals agriculture and food systems must have an integral and gradual character, without prejudice to other relevant matters such as women rights, child labour, cultural education and climate change amongst others.

Even more, the focus on current contributions of the traditional agricultural practices to food sovereignty is growing. For example, several practices recorded in this study are similar to newly developed techniques for permaculture and organic production. The use of these methods can give answers to the need of producing healthy, diverse, nutritious, safe, available and accessible food. Several species domesticated in these areas, such as quinoa and amaranth, have a high nutritional value on high-quality proteins, iron, magnesium and phosphorous (United States Department of Agriculture, 2016) and also can achieve high yield (AgMRC, 2017). On the other hand, Andean tubers are a source of carbohydrates. Most of these crops are planted in an associative or co-operative form, maximizing the use of the soil and reducing the need on external inputs and helping to retain soil moisture. The fact that these practices are linked to their worldview confers a sense of respect and gratefulness to the environment that provides for them, therefore setting a higher baseline, an intrinsic value for conservation as opposed to a commercial or utilitarian value, which can be more easily challenged and compromised.

However, as the cultural capital has been widely relegated, the survival of traditional agricultural practices is threatened. Thus, valuing and strengthening

of cultural practices and knowledge is compulsory in order to achieve food sovereignty. How to value these, not only inside the communities but externally, is challenging. This was a complex path, as pointed out by indigenous people and *campesinos* of Alto Quera, Peru. They only accepted their own responsibility for not using their traditional knowledge in agricultural practices only after training delivered by National Agricultural Confederation of Peru. Through these training activities, they also learnt that through conservation of the ecosystems they were also preserving their culture, as the natural and cultural capital is closely linked to their livelihoods. At the same time, inclusive planning on mechanisms to intervene agriculture and local food systems is required. This should be able to articulate technology, infrastructure and commercialization with traditional knowledge and practices, while avoiding the concepts of substitution and replacement, which are often seen when interventions measures are put in place. We conclude that traditional agricultural systems developed by indigenous people and *campesinos* in Latin America can make an important contribution to food sovereignty, providing it is respected and supported. Otherwise, they will degrade and possibly vanish alongside the ecosystems they thrived in.

Acknowledgements

The authors gratefully acknowledge the collaboration of the members of the Curarrehue Commune, Chile; San Pedro de Macha and Alto Quera communities, Perú; Huaconas Community, Ecuador; Turmequé and Ventaquemada Municipalities, Colombia; San Juan Cotzal, Los Pinos, Cunen and La Concepción, Guatemala; CommunitiesTajin and Yaxunah, México.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The authors gratefully acknowledge the support of Agricultural Innovation Foundation (FIA, Chile), Grant number GIT 2014 - 0043; Centro de Investigaciones Tropicales and Grace Bascopé Fund, Grant number P - 00134; Vicerrectoría de Investigación, Pontificia Universidad Javeriana, Colombia, Grant number P - 004445; Asociación Guatemalteca de Exportadores (AGEXPORT), Guatemala, Grant number GIT 2016 - 0336; Confederación Nacional Agraria del Perú (CNA Perú), Perú, Grant number F - 000235.

Notes

1. Food production also includes produce from aquaculture and fisheries.
2. Non-indigenous person who lives and works regularly in the field. Also called mestizos in some areas of Latin America.
3. Massive and sudden appearance of living beings, for example, aphids, mites, that cause serious damage to plants and animals populations.

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