Recognizing rural territorial heritage: characterization of Andean tuber production systems in Boyacá

Reconociendo el patrimonio territorial rural: caracterización de sistemas productivos de tubérculos andinos en Boyacá

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ABSTRACT

In the municipalities Ventaquemada and Turmequé (Boyacá-Colombia), we identified 20 small agricultures by their production systems including the following Andean tubers: *Ullucus tuberosus* Caldas (ulluco), *Oxalis tuberosa* Molina (oca), and *Tropaeolum tuberosum* R. & P. (Mashua), which were important in their family meals and culture, however, their use has declined and the area has not seen research and development processes that provide alternatives for handling, conservation, use and marketing, and now are at the risk of disappearing. This research conducted participatory assessment processes for the characterization of production systems and initiated reassessment processes of territorial heritage, identifying common sub-farm agrobiodiversity and projects for these traditional Andean tuber crops in order to enhance the special and know-how knowledge surrounding the production.

Key words: agrobiodiversity, participatory research, traditional crops, peasant culture.

RESUMEN

En los municipios de Turmequé y Ventaquemada (Boyacá-Colombia), se identificaron 20 pequeños agricultores que incluían en sus sistemas productivos los siguientes tubérculos andinos: *Ullucus tuberosus* Caldas (ruba), *Oxalis tuberosa* Molina (ibia) y *Tropaeolum tuberosum* R. & P. (cubio), los cuales eran importantes en su alimentación familiar y su cultura, sin embargo, su consumo ha disminuido y en la zona no se han llevado a cabo procesos de investigación y desarrollo que proporcionen alternativas para su manejo, conservación, uso y comercialización, corriendo el riesgo de que desaparezcan. Esta investigación realizó procesos de diagnóstico participativo para la caracterización de los sistemas productivos e inició procesos de revaloración del patrimonio territorial entorno a éstos, identificando subsistemas comunes en las fincas, la agrobiodiversidad presente y las labores tradicionales en los cultivos de tubérculos andinos, a fin de realzar las particularidades y el *saber hacer* que envuelve la actividad productiva.

Palabras clave: agrobiodiversidad, investigación participativa, cultivos tradicionales, cultura campesina.

Introduction

Among the wide agrobiodiversity of Andean tuber crops we see important cultivars, including the potato (*Solanum tuberosum* L.), widely recognized worldwide for being the fourth most consumed food in the world (FAO, 2008). In addition, three tubers from different botanical families, *Ullucus tuberosus* Caldas (ulluco), *Oxalis tuberosa* Molina (oca), and *Tropaeolum tuberosum* R. & P. (Mashua) (referred to hereafter as AT) are less known, but were also domesticated in South America (Tapia, 2000).

The AT have adaptive advantages to the Andean environment, producing at 2,400-4,000 m a.s.l. (Parra, 2001), where the growing conditions are unfavorable for many other crops. Besides that, they have a strategic character for food security as they provide a dietary diversification alternative for society in general, especially in rural and indigenous communities due to its tradition of consumption.

This research area is home to the comment by Casabianca and Linck (2008), defining it as "a social construction that comes from both an environmental heritage and cultural heritage", which according to the authors implies the equity component image of a complex resource, composed of interacting elements such as an artificialized ecosystem, infrastructure, social relationships, know-how, representations and values that give structure, so you can understand that heritage is a collective memory, of past events and experiences, but with a projection capability into the future, hence the importance of reassessment by the local inhabitants of the territory.

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In connection with these local production systems is the intangible and tangible part of cultural heritage of the territories, this fact becomes important, as the heritage "has a particular collective significance and estimated values and ties that make sense of belonging, identity and memory for a group or collective humanity" (Soto, 2006) that can be used as a strategy in the process of improving the quality of life of people in the territories.

Production systems typical of a particular territory, form part of local economic systems and know-how of the rural population, largely determine the culture of the inhabitants of these spaces and their identity. In the rural areas of Colombia, the above situation is easy to observe, and that's how crops such as coffee (*Coffea Arabica* L.), potato (*Solanum tuberosum* L.), sugarcane (*Saccharum officinarum* L.) and some fruit trees have built rural cultures that cling to traditions from generation to generation, and have had a huge impact on the country, through the physical transformation of the regions and setting up the food market, to name a few.

The AT and the culture around them can establish a territorial patrimony of the Colombian Andes, however, they are undergoing a strong process of deterioration, as a result of the above, the gene cluster that exists today is represented by retained native varieties maintained and managed by indigenous and ancestral Andean peasants, that due to market pressure and loss of traditional knowledge, are fading, leading to an irreversible decrease of genes, and loss of plant varieties, which "as a unique combination of genes may have a particular value and immediate use" (FAO, 1996) yet unexplored, linked to this loss of regional cultural are assets associated with cultivation and consumption, which play an important role around identity processes in the territories.

Parra (2001), reaffirmed the above work describing "farmers who kept ulluco germplasm and other species of AT, as preserving subsistence crops as cultural heritage".

In this context, this research sought through knowledge of production systems and farmers in Turmequé and Ventaquemada (Boyacá), to determine the importance and current presence of the AT in the system of home farm producers, as well as rescuing these local crops, through tools of participatory rural appraisal (PRA), which "allow communities to make their own diagnosis and then begin to self-manage their own planning and development" (Verdejo, 2003).

Materials and methods

In order to characterize rural production systems Turmequé and Ventaquemada (Boyacá), we used secondary sources of information to identify the social and economic features of the municipalities, then through participatory rural appraisal tools we took as a reporting unit, a local population, a group of 20 producers participating in the project "Participatory design of sustainable alternatives for management and conservation of agrobiodiversity of AT in the department of Boyacá" advanced by the Pontificia Universidad Javeriana and Corporación PBA.

The farms were characterized spatially and distributed in two municipalities in Boyacá: Turmequé (16 farms in the villages: Teguaneque, Juratá, Chiratá, Pozo negro, Rinchoque, Rosales, Joyagua, and Casco urbano) and Ventaquemada (4 farms in the villages: Parroquia Vieja, Supatá, El Hato, and Bojirque); characterization activities were conducted during August, 2008.

The characterization of production systems includes five exercises, three workshops with the entire group of farmers on: sowing, harvesting, pests and diseases of AT in the territory and two years on each farm and family, and the following activities: the mental mapping of the farm and a transect tour of the site, in order to sample the agrobiodiversity in each production unit and identify subsystems.

Results and discussion

General features of the municipalities

Turmequé is located in the department of Boyacá, at an altitude of 2,389 m a.s.l. and belongs to the Province of Marquez, has an average temperature of 14°C. According to the DANE census in 2005, the municipality had 7,583 inhabitants of which 2,434 (32.1%) lived in the county seat and 5,148 (67.9%) in rural areas (Alcaldía Municipal de Turmequé, 1999).

The Turmequé township is characterized as being economically dependent on the agricultural sector. Traditionally, the municipality has made a smallholder distribution of property from republican times to modern times, a feature that has been pronounced due to the further breaking down of estates through inheritance from fathers to sons. The calculation of the family farm unit (FFU) for the municipality of Turmequé is 3.5 ha, however, according to calculations of IGAC in 1999 there were 5,869 farms with an average size of 1.13 ha, where 86.5% of the properties correspond

to between 0 and 2 ha, smaller than that calculated by FFU through unfavorable economic and social implications for farmers (Alcaldía Municipal de Turmequé, 1999).

The Ventaquemada township is located in the central province of Boyacá, 98 km away from Bogota DC at an altitude of 2,630 meters; its temperature varies between 8°C and 14°C (Alcaldía Municipal de Ventaquemada, 2001).

According to DANE (2005), the population projections based on the 2005 census indicate that by the year 2009, the municipality would have 14,866 inhabitants, of whom 86% live in rural areas and 14% in urban areas (Alcaldía Municipal de Ventaquemada, 2001). The economy of the municipality of Ventaquemada depends largely on the development of agriculture, mostly on potatoes. "The soil structure is characterized by the existence of small farms, where most land has an area greater than one hectare and less than three, to a lesser proportion with estates larger than 5 ha and less than 10 ha. With minimal involvement of properties over 100 ha and less than 500 ha" (Alcaldía Municipal de Ventaquemada, 2001).

General features of the production systems characterized

Farm size was found to be categorized either as smallholder or microfundio (Tab. 1) and a large percentage (80%) have a smaller area than calculated by FFA Turmequé, which is characteristic of the agricultural structure in the municipalities of Turmequé and Ventaquemada as discussed above. A characteristic feature is the farms were owned by farmers or were in process of succession, making the producers owners of small production units.

TABLE 1. Characterized farm size.

Municipality	Farm size (ha)			
	< 1	1 - 3	3.1 - 6.0	6.1 – 8.0
Turmequé	7	4	3	2
Ventaquemada	1	2	1	0
Total	8	6	4	2

Other important features of the farms corresponding to the trend in the production systems in Andean Boyacá is the high use of family labor and the fate of production, which is mainly for home consumption and surplus for sale on the market local.

According to a mind map of the farms and the transects carried out, the analyzed farms have the elements and interactions presented in Fig. 1. We identified four subsystems: agriculture, livestock, native forest and home.

In the agricultural subsystems were the presence of urban gardens where they cultivated the AT of interest as well as some vegetables and plants used daily in food preparation. An important feature of the cultivation techniques used in this space, was the absence of pesticide use, low fertilizer application of chemical synthesis, the low mechanization of farming and the wide variety of species planted, we also found that care of the garden is shared among household heads, but most of their care was done by the wives.

This subsystem also highlights the presence of one or two cash crops, whose production is destined for the local market and some for personal consumption, among the highlights are the potato and pea (*Pisum sativum* L.), fruit in some production systems is the main cash crop and in others is only for home consumption; their presence is common in most of the farms, for these crops, the use of outside labor is common for some tasks, as well as the use of pesticides and fertilizers and organic chemical synthesis, usually the seed used in these crops is of external origin.

A final element of the agricultural subsystem was the presence of pasture crops to feed livestock, which in the larger farms served as a rotation crop with potatoes, and in the smallest was limited in space by rearing calves or was non-existent.

In the livestock sub-system the presence of small animals in all the farms was observed, principally chickens (*Gallus gallus* L.) and rabbits (*Oryctolagus* cuniculus L.), larger sized animals such as cattle (*Bos taurus* L.) and pigs (*Sus scrofa domestica* L.) are limited to estates of more than 1 ha. The animals were fed a small part of the agricultural production subsystem, using some crop residues and weeds associated with traditional farming systems, the chicken feed was supplemented with commercial concentrate formulations. To feed the cows, they used pasture crops, crop residues and concentrated feed, pigs were raised in the same way as cows but rarely is feed supplemented with supplements but instead with waste from the kitchens.

Some small farms still had remnants of forests, which were in great danger because it was found that each year producers have been increasing planted areas at the expense of clearing of this subsystem, in addition many families use firewood for cooking or for fencing, without reforestation.

A home subsystem attributed several functions within the farm system, one of which was to manage land resources through the farmer and his family, and also as recipient of many of the outputs of the subsystems, as part of the

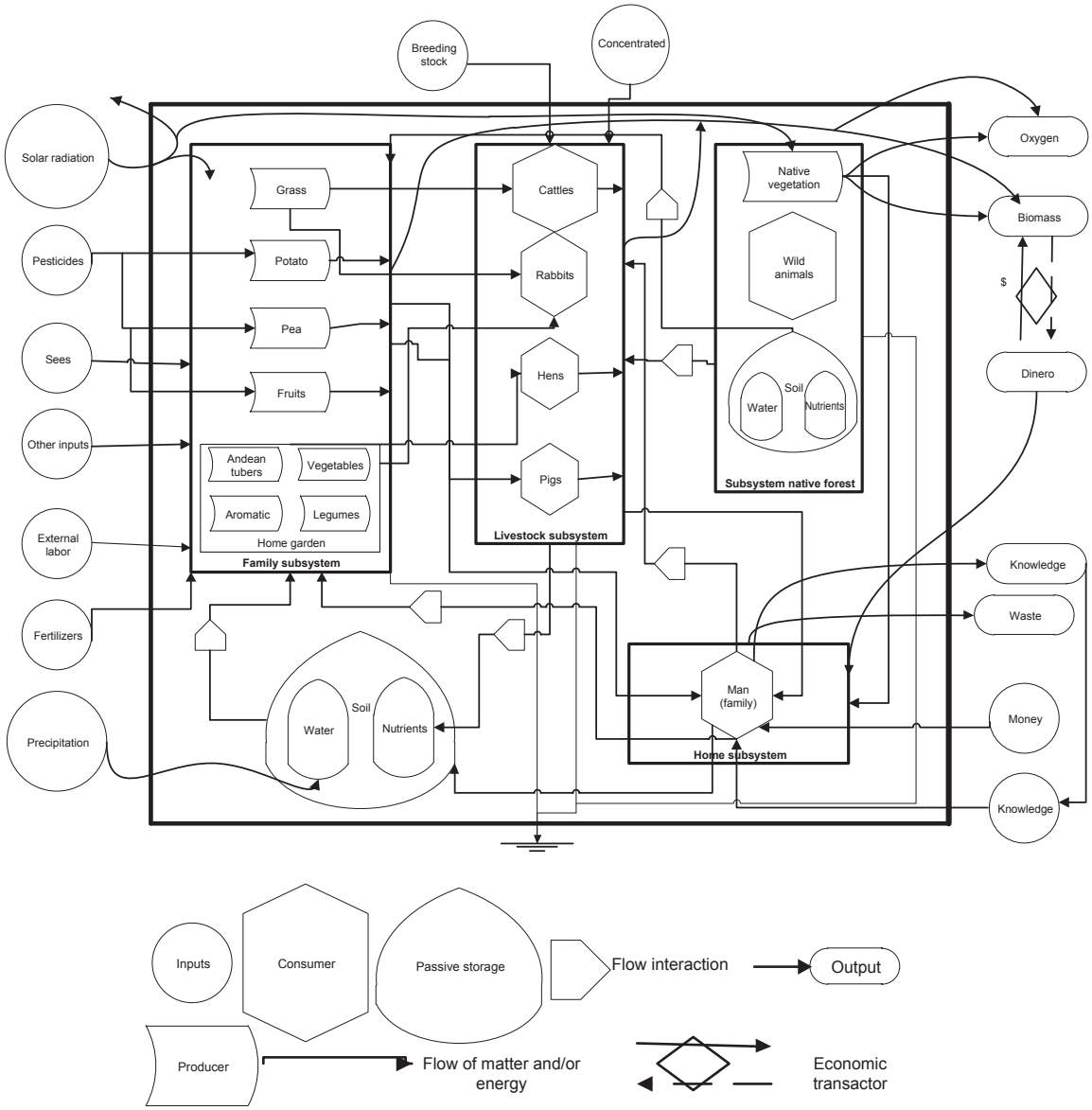

FIGURE 1. Farm system model, designed based on the characterizatio.

crops and the animals were destined for consumption. The man (farmer and family) was the driver of the farm activities, therefore their contribution to the flow of matter and energy within the system is crucial to organize some of its structure.

Agrobiodiversity

We performed this sampling of agrobiodiversity on-farm inventory in the municipalities of Ventaquemada and Turmequé.

As a result of this sampling, we achieved an inventory of plant and animal species of economic importance (Tab. 2), as shown in the large diversity present on the farms and reaffirms the importance of indigenous Andean farming in Andean diversity preservation.

In Fig. 2 shows the diversity of economically useful species for the rural family, for each of the productive systems characterized, showing the wide heterogeneity of farms with respect to the species retained by the families.

By relating the size of fields with the number of species a direct relationship is not observed between these two variables (r^2 = 0.03), i.e. the size of the premises does not directly affect agrobiodiversity present for this event, however since most of the farms are small farms one would have to compare these results with productive farms or larger systems in the region to reach a firm conclusion.

TABLE 2. Groups of species found on characterized farms.

Crops	Species	Farms with these species
Vegetables	12	12
Legumes	3	13
Fruit	13	14
Andean tubers	3	10
Tree and shrub species	5	3
Herbs and spices	10	8
Corn and other grains	2	11
Potato	2	16
Andean roots	1	9
	Animal species identified	
Turkey (*Meleagris gallopavo* L.)	Cows (*Bos taurus* L.)	Sheep (*Ovis aries*)
Pigs (*Sus scrofa domestica* L.)	Horses (*Equus caballus* L.)	Ducks (Anatinae)
Rabbits (*Oryctolagus cuniculus* L.)	Hens (*Gallus gallus* L.)	Guinea pig (*Cavia porcellus* E.)

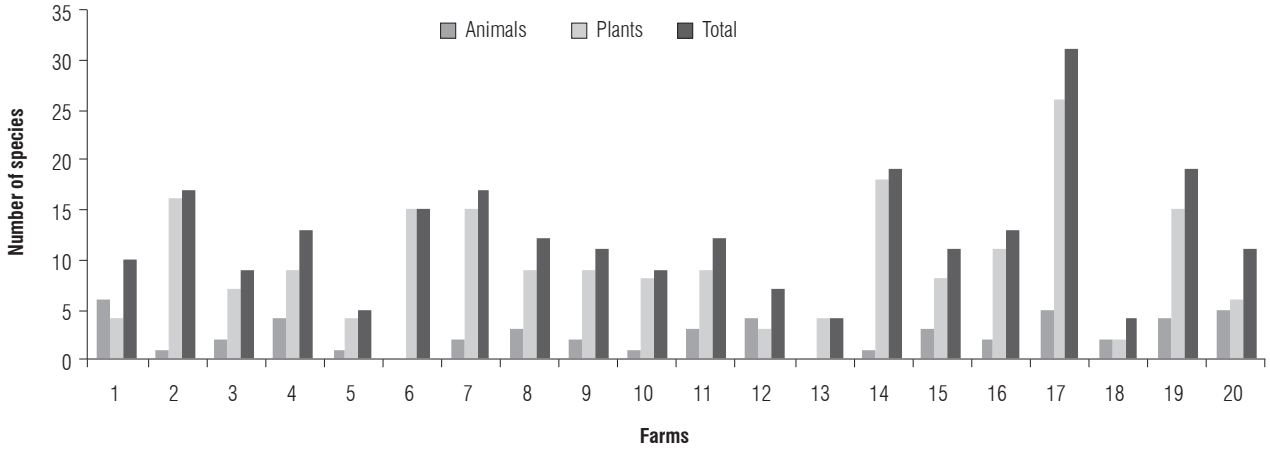

FIGURE 2. Number of species per characterized farm.

The subsystem "Andean tuber crop"

During the characterization process, the presence of AT on the farms was evaluated, we found that 50% of the farms had established some AT of interest, this does not mean that other production systems do not have the occasional presence of these species, as depending on the production planning by the producer or not that these tubers cannot be planted.

Through a preliminarily participatory workshop, the diversity of seeds commonly used in the cultivation of AT (*U. tuberosus*, *O. tuberosa*, and *T. tuberosum*) was determined resulting in the information compiled in Tab 3.

As you can see the producers of AT in the study area identify a limited part of agrobiodiversity present in these species, because they perform discrimination of varieties based on a single characteristic, morphological color, therefore it is expected that in the territories more diversity than reported in the workshops.

It is emphasized that these species have been present in the fields of farmers as food for a long time and recognized as being of indigenous ancestral municipalities, inhabited in antiquity, leading to their presence in Turmequé and Ventaquemada.

Sowing, harvesting, pests and diseases of AT

Through the seasonal calendar, it was found that there is heavy reliance on crop cycles over the state of the climate, this is due to the limited technology and resources available for on-farm irrigation systems, that would allow growing outside periods of rain, so planting of the tubers occurs in the month of March, at the beginning of the period of highest precipitation in the area.

The harvest varies according to life cycle. For *U.tuberosus* the growing season lasts from 7 to 8 months, depending on the altitude at which varieties are grown and used. The *O. tuberosa* have a large crop cycle lasting between 8 to 9 months. The *T. tuberosum* complete their cycle 4 to 5 months after

TABLE 3. Agrobiodiversity of Andean tubers recognized by producers.

Crop	Variety	Characteristics	Time in the zone
U. tuberosus	White	Round elongated White color Dispersed production Deep and long stolons	Known since childhood of the producers and is believed to be of Indian origin
	Red	Round elongated Red color Production concentrated in the middle of the plant Short stolons	
O. tuberosa	Pink	Pink color The largest It is sweet Hard heart It has the best production Sown in the Páramo No need to spray	No information
	Yellow	Yellow color Medium sized Minor outbreaks of insufficient production Cultivated in warmer climates	
	Red	Red color The smallest Not well known, little success in the market	
T. tuberosum	Yellow	Yellow color Medium sized	15 years
	White	White color, long, hairy	80 years
	Costal	Purple color The smallest	100 years
	White/purple	White with purple spots	From the origin of the Indians

planting, which, due to their hardiness and its wide tolerance to water deficit can be planted every month of the year.

Pests and diseases are rare in the AT, however, farmers have identified that slug (Mollusca: Pulmonata) attacks occur in growing ruba during tuberization. The present *O. tuberosa* suffers cutworms and grubs attacks (*Ancognatha scarabaeoides* (Coleoptera: *Scarabaeidae*) at the beginning of the periods of low rainfall, due to increased insect activity; and they have also identified spots on the tubers in times of low humidity without establishing if there is a causal agent of this symptom or because it is a chilling plant.

The *T. tuberosum* does not appear to have important health problems, possibly due to the presence of metabolic compounds (glucosinolates) that protect them from pests and diseases (National Research Council, 1989).

Specific activities in the cultivation of AT

The flowchart of activities that allowed the discovery of characteristics of production systems in areas of study. The result is shown in Tabs. 4, 5, 6 (the tables are the result of a workshop for producers in Turmequé, June 6, 2009).

As a general feature that is observed in the AT activities, work is performed manually with traditional tools such as hoes, crops are also managed with techniques very similar to the potato crop.

Please note that observation and tradition have allowed the recognition by producers of exact times for activities, without which the crops would not be productive on the days of harvest or the heights of plants sufficient for weeding and other activities.

Another feature of production systems is that although they are slightly dependent on external source inputs to the farm, fertilizers play an important role in crop productivity, therefore it is used routinely but not too much.

Division of AT farming activities in the family

Cultivation on characterized AT farms have a specific role in food security of rural families, as they provide dietary diversity and allow excess to buy other food crops, it is for this reason that the care activities involve all members of the family.

One can say that in general in the three crops, cultivation is performed similarly among family members, we see that the producer participates in all activities of the crop and his wife is present at most of the preparation tasks, weeding and crop filling. For children, there are variations in the tasks performed by culture, in the case of cubios and

TABLE 4. Flowchart of activities in the cultivation of *O. tuberosa*.

Activity	How do you do it?	When?
Seed handling	In a basket	
In a dry place		
Do not accumulate without separating	Aproximately 2 months	
Fixing the land	Loosen the land	
Fertilize with chicken manure or black manure	In the rainy season, small delay	
In summer, long delay		
Plowing the land	Distance between rows 60 cm and between plants 30-40 cm	-----
Sowing	Turn over the land with manure	
Place the seeds and cover with soil		
Place one large seed or one or two small or slender seeds	Wait 15 d between plowing and sowing	
Weeding	Remove bad parts of the plants	
Loosen the land	When the plant is 20 a 30 cm tall	
Tending the land	Fertilize	
Add soil	When the plant is 40 cm tall	
Harvest	Start when the plant turns yellow and leaves begin to fall.	
The tubers can be removed and the plants covered, apply fertilizer and restart the cycle	----	
Consume and sell		

TABLE 5. Flowchart of activities in growing *U. tuberosus*.

Activity	How do you do it?	When?
Seed selection	Best seed, paired and curved	----
Preperation of the land	Manually with hoe	
Loosen the land well	----	
Fertilize and sow	Lime	
Fertilize with organic manure		
Auger at 40 x 40 cm		
Sow the seed	Month zero (0)	
Weeding and fertilizing	Manually	
Apply small amount of chemical fertilizer and covering	Month and a half after sowing (15-15-15)	
Weeding	Manually without damaging segments	---
Observation and care of cutworms	Sampling	Summer (liquid insecticide)
Harvest	When the plant is dry	8-9 months

TABLE 6. Flowchart of activities in the cultivation of *T. tuberosum*.

Activity	How do you do it?	When?
Soil analysis	---	Before sowing
Seed selection	Select a healthy seed in good shape that is budding	
Preperation of the land	Manual, semi-humid, loose earth	-----
Sowing	Sow at 15 cm	
Distance between plants 40 cm		
Distance between rows 60 cm		
One seed per site		
Organic manure, place one handful below the seed		
Cover the seed	-----	
Weeding and fertilizing	Apply about 60 g of chemical fertilizer after weeding	As necessary (monitoring)
Generally 20 d after emergence (15-15-15 ó 13-26-6)		
Harvest	When the flower wilts	
at 90-120 d	----	
Irrigation and drainage	Cubi does not require much water	
If there is a lot of rain to draining is necessary	----	

rubas, children provide limited help in planting and harvesting, in growing ocas, children participate in the work of fertilization during cultivation, planting and harvesting.

The explanation for the low participation of children in the work to be performed on crops is because they are in school and their relation to crops is limited by time.

Conclusions

The development of the research concluded that production systems are typically characterized as highly heterogeneous in the size of the farms, and the number and variety of crop species.

Four sub-systems could be identified in most of the characterized farms: agriculture, livestock, native forest and the house where the families live. Each of these unique particularities have shaped the structure of the system and allowed the viability of these units over time despite external pressures such as market and generational change in the field.

Also, the wide diversity of plant and animal species that are normally kept on the farm was identified, which promotes household food security and allows for diversification of production, leading to greater flexibility in the acquisition of income at a time when major crops such as potatoes are at low prices, or have suffered significant plant damage leading to loss of production.

A key feature of production systems is their high dependence on the cycles of precipitation in the area, due to lack of technical and technological infrastructure to allow greater agricultural productivity per unit.

The presence of AT was evident in characterized farms at different scales of planting, from their presence in small strips in the kitchen garden even to medium-sized areas that become major crop production systems. Its use is common and closely linked with the culture of food and agricultural area, which has allowed its preservation until today, although its existence is becoming more restricted due to dietary changes of the rural population, the high seasonal and permanent shortage of these foods because of their production cycle and economic pressure from more profitable crops such as potatoes.

It is also clear that there is a plant resource represented in the AT, with all the potential to be used as an integrator in some communities, where rural development plans and strategies will also reassess its use, improve farming practices, initiate agribusiness around these products, creating processes for creating value added, translated into higher incomes, expanding the dietary base, improving the quality of their diet and therefore their quality of life.

The encouragement of the production and consumption of AT through their assessment as resources of the territories will serve as a general strategy for the preservation of a plant genetic resource and diversification of the diet of rural communities, with further progress towards the improvement of these species and their commercial exploitation and as an agro generator of value added in the territory.

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