Agroforestry Systems 2:3–18.

Traditional farming systems of south-central Chile, with special emphasis on agroforestry

M.A. ALTIERI[1] and J. FARRELL[2]

[1] Division of Biological Control, University of California, Berkeley CA 94720, USA
[2] Department of Forestry and Resource Management, University of California, Berkeley CA 94720, USA

Abstract. The paper describes some general structural and functional characteristics of actual Chilean farming systems managed by small farmers (campesinos) with traditional technologies. Campesino farming systems can be divided into two major groups: (a) small-scale (no more than 1 ha) intensive systems with a wide array of tree and annual crops and 3–4 animal species per farm; and (b) extensive semi-commercial systems (5–12 ha) composed of diversified combinations of crops and animals designed to increase production, producing a marketable surplus for the local community. In most systems campesinos include trees (whether for food, fodder, wood, construction materials, fuel, etc.) as integrated elements of farm management constituting agro-forestry systems. Understanding these traditional farming systems, and the rationales behind their management is an important first step towards the ultimate development of appropriate agricultural technologies attuned to the ecological and socio-economic circumstances of the Chilean campesinos.

Introduction

A common goal of small farmers throughout the world, whether in tropical or temperate regions, is to maximize returns from their limited resource base with low levels of technology. While maintaining stability within their farm systems, small farmers do so in a way that prevents the long term degradation of the productive capacity of the land [11, 13].

In most cases these farmers are faced with significant biophysical and socio-economic constraints on their productive capabilities [7]. Limitations to production may include land marginality, steep slopes, infertile soils, unpredictable water availability, low access to credit and technical assistance, seasonal unavailability of labor and power, distance to supplies and marketing centers, lack of economic incentives due to government policies, etc. [1, 9]. Given the various limiting conditions, and as a result of the experience of many generations, small farmers have evolved or inherited complex cropping systems and management technologies adapted to a specific local soil-climate complex and circumventing socio-economic framework [8, 16].

In mediterranean Chile, low soil fertility, water shortages and fluctuating temperatures, all limit the capacity of small farmers ('campesinos') to produce food. Recent declines in the economy have created new circumstances of costly farm inputs, low capital, and lack of credit forcing 'campesinos' to attune their agronomic systems and to make adjustments in their marketing strategies and social organization [2, 5, 6].

In this paper some general structural and functional characteristics of

actual Chilean farming systems managed by campesinos with traditional technologies are described. Special emphasis is given to systems that integrate the production of trees, whether for food, wood, or fodder with other argricultural enterprises. The information presented was obtained through an exploratory survey conducted during November 20–December 23, 1982 in south-central Chile (Santiago-Temuco). The purpose of this survey was to gather information through direct observation of cropping systems and interviews with campesinos, in order to describe farm designs, crop patterns, use of local resources and farmers' practices, as well as understanding why, in light of their particular circumstances, Chilean campesinos follow such land use practices and production methods.

The campesino sector

It is estimated that Chile has between 250–300,000 campesino 'units', which comprise 90% of all farms, but encompass only one third of the arable land of the country [12]. Assuming five persons per campesino family, together they represent about 14% of the national population. Their history dates back to the colonial period with the arrival of the Spaniards at which time there were two principal groups: (1) the 'Inquilinos' (campesinos of the haciendas or fundos) who were obliged to work the land of the owner in exchange for a small piece of land for themselves; (2) the independent campesinos who, due to the necessity of seasonal labor on the Spanish haciendas, were occupying, buying or receiving as donations low value marginal lands at the fringes of the fundos, particularly in the coastal areas and foothills of the cordillera. Only a few were fortunate enough to obtain good land in the central valley close to the central markets [2].

From these two groups has descended the campesino of today, of which there are three types [13]:

1) Those that have sufficient land and resources to completely support themselves from that land.
2) Those who must find salaried work to complement what they can draw from their limited resources. This group is the most numerous and their land has typically been reduced by subdivisions within the family with each successive generation.
3) Those with almost no land at all and who live principally from salaried labor. This is the poorest group and are often ex-inquilinos expelled from 'fundos' or ex-agrarian reform units (asentamientos).

Campesinos grow a wide array of crops such as cereals (wheat, rice, barley, etc.), vegetables, 'chacras' (potatoes, corn and beans) and fruit (grapes, citrus, apples, pears, apricots, avocadoes, peaches, figs, loquats, cherries, etc.). The amount of land devoted to growing these crops is dependent upon the size of the land, type of soil, level of technology, access to temporary labor or machinery, size of family and whether the farm operation is for autoconsumption or commercial purposes.

The Mapuche sector

An important component of the agrarian sector of Chile are the Mapuche indians. There are some 800 000 Mapuches in the south of Chile. Three hundred thousand of these live on reservations and still retain ties with their communal lands. However, a 1979 decree issued by the military government is rapidly changing this tradition, and all land the Mapuche communities have come to own and administer collectively now must be individually owned [5].

In the Mapuche community the family is the center of the agricultural and productive activity. For the Mapuche, the land has a 'use' value rather than an 'economic' value. According to a study of six Mapuche communities in Lautaro [3] the productive structure is oriented towards autosubsistence. In this region, 40% of the land is under wheat, and another 40% is devoted to pastures for animal grazing. The remainder of the land is devoted to chacras (especially potatoes and beans), home gardens and non-agricultural enterprises. On average, each Mapuche family has one oxen, one cow and several chickens. The land is therefore managed for the concurrent production of crops and domesticated animals.

The physical setting

Geographically, the survey included most of south-central Chile (Figure 1). Including the northern limits of the Santiago region south through Temuco, this narrow strip of land measures some 600 kilometers with an average width of only 200 kilometers. Approximately half of this land area is occupied by two transecting mountain ranges: the tall rugged Andes along the eastern border and the dry, well rounded slopes of the Coast Range. Between the two ranges lies a long central valley, offering a continuous, nearly level plain. This valley is crossed by a number of rivers and streams from the cordillera to the sea, providing a fairly constant water flow throughout the entire year.

The climate of south-central Chile is typical of mediterranean regions with mild wet winters and hot dry summers [10]. Average temperatures during winter months range between 5–10 °C with frost-free periods varying from 9–12 months. During the summer, average monthly temperatures may rise above 27 °C with maximum temperatures above 38 °C not uncommon. A high

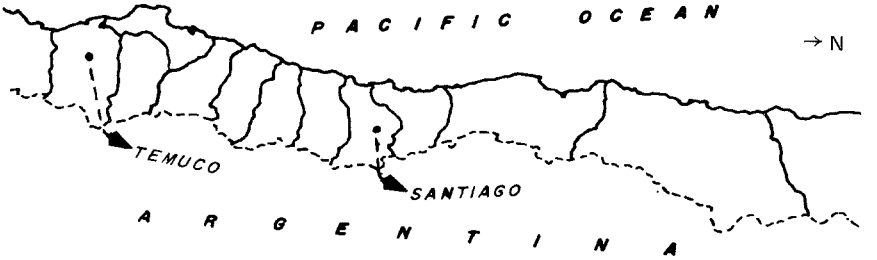

Figure 1. Map of south central Chile, including the surveyed zone (Santiago-Temuco).

percentage of sunshine is also characteristic, even during the rainy winter. Due to the combination of clear skies and high levels of radiation, diurnal temperature fluctuations tend to be fairly wide. The amount of yearly rainfall ranges from 250–750 mm and sometimes higher in coastal areas and mountain ranges, tending to be unreliable from year to year in both amount and distribution.

Generally, the soils of the central valley are alluvial, deep, fertile and high in orgainic matter. However, specific physio-chemical characteristics vary from site to site. In the slopes of the two mountain ranges, the soils decrease rapidly in quality, becoming shallow, infertile and often very heavy.

The farming systems

The farming systems of the campesinos of mediterranean Chile are diversified systems. In these systems, the critical factor in the efficient use of scarce resources is diversity. Thus, campesinos assemble crops, animals and other farm resources to optimize production efficiency, nutrient cycling, crop protection, etc.

Although the manner in which campesinos assemble a particular set of farm resources varies from site to site, farming systems can be divided into two major groups: (1) small-scale intensive systems; and (2) more extensive semi-commercial enterprises.

Small-scale intensive systems

These systems rarely exceed 1 ha in size; this limited land area generally does not provide for all the food requirements of the family. All items produced tend to be used for on-farm consumption, the remainder of the resource needs being purchased with earnings from off-farm work. On these farms, campesinos typically produce a great variety of crops and animals, and it is not unusual to find as many as 5 or 10 tree crops, 10–15 annual crops and 3 or 4 animal species on a single farm. These systems are somewhat similar to the home gardens (pekarangan) found in Java [4]. However, pekarangan systems are much more complex; it is not uncommon to find home gardens with 120 plant species assembled in a multi-storied vertical structure, very similar to a natural forest.

The physical layout of these farms varies, but often they include, in addition to the tree and annual food crops, an arbor of grapes ('parron') to provide shade, and fruit, herbs, medicinal plants and flowers. The typical animals of these farms are free ranging chickens and ducks, rabbits and occasionally a few pigs feeding on kitchen waste and crop residue. Intensified annual cropping usually involves the use of simple crop patterns (i.e., growing a set of annual crops only during the spring and summer), or more typically crop sequencing (planting a second crop after the harvest of the first). In both crop patterns, campesinos may practice intercropping (planting two or more

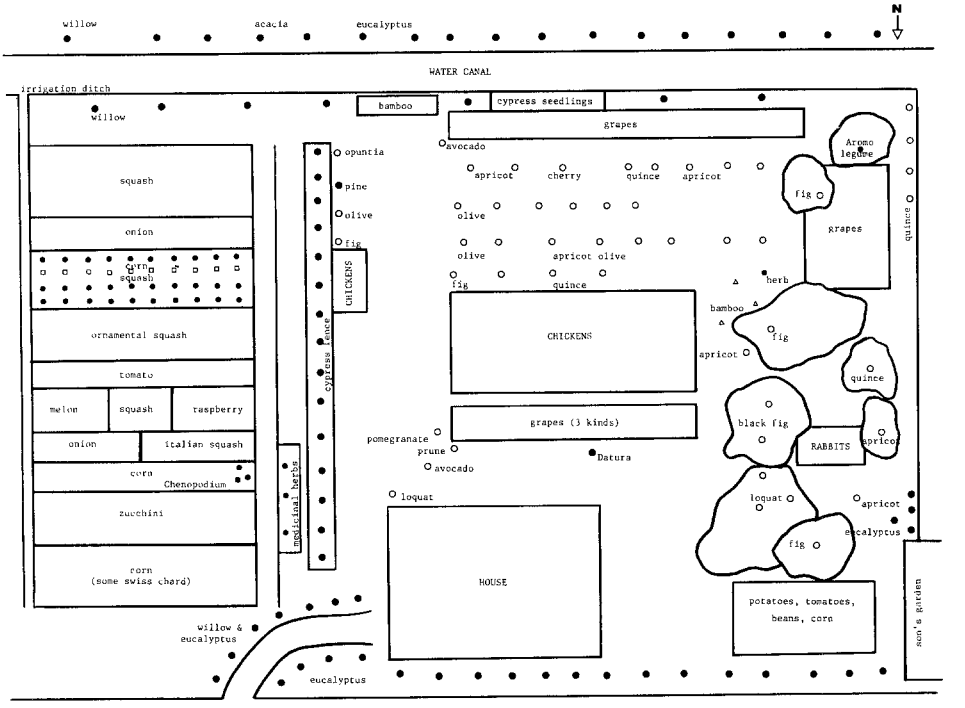

Figure 2. Structural layout of a small scale intensive farming system in the coastal zone of central Chile

crop species together in the same field at the same time). Common intercropping systems include corn and beans, garlic and/or onion mixed with lettuce and cabbage, and corn-potatoes.

Figure 2 depicts the structure of one very complex system near Melipilla in the central coast range. The land, characterized by a 25% slope, was divided into two sections. Half of it was devoted to annual crops and herbs grown in rows running parellel to the hill contour. The other half consisted of a mixed orchard of about 10 species of fruit trees, several varieties of grapes, a few non-crop trees such as pine (*Pinus radiata*), aromo (*Acacia* spp.), *Datura* spp. and a small stand of bamboo and cactus (*Opuntia* spp.). A living fence of cypress (*Cupressus macrocarpa*) separated the two sections. Chickens and rabbits were raised under the orchard in cages, and their manure, mixed with sawdust, was used to fertilize crops and trees. In addition to the fruit trees, *Eucalyptus globulus* were planted as a living fence on the lower boundary and harvested for fuelwood and poles. Additional fuelwood was gathered from the native 'espino' (*Acacia caven*) growing naturally on the hillside above the property. Also, beneath the orchard trees, some herbs were grown for medicinal purposes or as in the case of 'Ruda' (*Ruta tracteosa*) to keep chickens healthy. According to some campesinos the presence of this plant in the

chicken yard prevents the onset of infectious poultry diseases. Hinojo (*Hinojo officinalis*) were allowed to grow freely in the property margins and its cane was later used to construct fences or small huts. Irrigation water was diverted from the canal passing along the upper boundary of the property. Willows (*Salix chilensis*) were purposely planted by the campesinos along the canal to 'hold the soil down' and prevent soil sliding. The penetrating root systems, along with the dense canopy cover from the other orchard trees, provided good soil protection on this sloping site.

Extensive semi-commercial systems

These farms range between 5–20 ha in size. These systems are also diversified, but the crop and animal combinations are designed to increase production, producing a marketable surplus. With a larger area of land to work with, the campesino devotes much of it to more extensive activities such as pasture for livestock and grain cultivation. The additional land also affords more space for wood producing trees. In this way, nearly all of the household requirements are provided for on the farm.

Typically, the campesino grows crops preferred by the local community for commercial purposes. These crops, however, may entail relatively high risks. He hedges against this risk by growing several less valued and/or less risky crops. Growing of beans, squash, potato or corn between rows of high value fruit trees (peaches, cherries, apples, etc.) is a good example.

Figure 3 shows the design of a 12 ha farm about 10 km east of Temuco, where the campesino balanced his farm enterprises to provide for the needs of food, clothing, housing and capital. The farm consisted of an interplanted area of annual crops and fruit trees, a mixed orchard of fruit trees with rows of bee hives between the trees, approximately 5 ha of pasture, 2–3 ha of wheat and a stand of radiata pine. From 26 bee hives he harvested about 280 kg of honey/year, obtained 10–12 litters of milk per day from 3 cows, collected 10–11 eggs per day from his chickens, and from the wheat, suppied all of his flour for making bread. Pine trees were planted to provide for his wood requirements. The fast-burning wood was made into charcoal for cooking and heating and was also used in the construction of the house and barns. Guano (manure) from his animals and crop residues were collected in a compost pile for later use in crop fertilization.

Crop management practices

Crop protection

Although some campesinos seem to know that certain crop combinations can improve control of insect pests and diseases, they rarely rely solely on this strategy, instead using a variety of pest control methods. For example, in the case of 'pilme' (*Epicauta pilme*), a serious defoliator of potatoes and fava

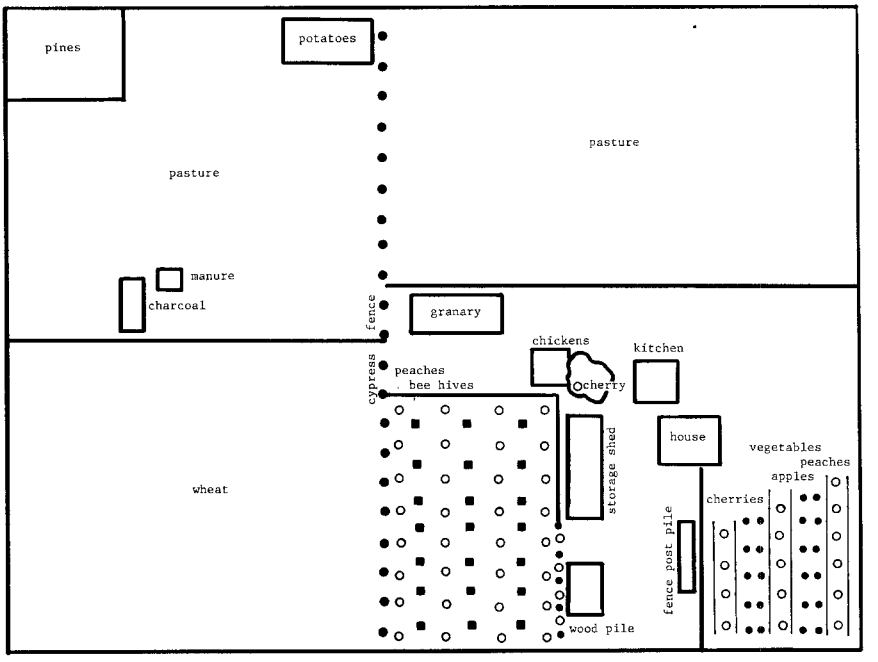

Figure 3. Structural layout of a twelve hectare extensive semi-commercial farming system new Temuco, Chile.

beans, some farmers used insecticides (i.e., 'gusatox', an organo-phosphate), while others cut branches of a local shrub, 'palqui' (*Cestrum parqui*) which were then scattered in the field. According to the campesinos 'pilmes' are repelled from the potato patch because of the strong odor of palqui. In small plots, farmers simply beat the pilmes off the plants over a can full of water.

Aphids recurrently infested wheat fields. Some campesinos relied on the unpredictable natural control provided by resident parasitic wasps. Others treated the fields with a boiled and filtered solution made of bark from 'canelo' (*Drimys* spp.), hot peppers (*Capsicum* spp.) and water. Other peasants sprayed a water-detergent mix. All methods proved to be only marginally effective.

Plant diseases did not seem to be a major limitation to crop production in the surveyed farms. Only apple scab (*Venturia inaequalis*) reached epidemic proportions in some apple orchards, deforming the fruit. Farmers effectively ameliorated *Oidium* spp. infections in garlic and onion by lowering soil moisture through less irrigation.

Weeds were controlled by a number of cultural practices, including hoeing, mulching and cultivation with wooden plows drawn by oxen or horses. Most farmers weeded their fields two or three times, but only during the initial period of the crop establishment. Near Temuco, Mapuche Indians kept sugar

Figure 4. Pigs used for weed control in a Mapuche Indian squash field near Temuco, Chile.

beets weed-free only during the initial 3 months of the crop with no further weed removal. They also rotated sugar beets with lupine and/or wheat which prevented the build-up of specific weed species. Other fast growing, semi-creeping crops such as peas (arvejas) were not weeded at all. Broadleaf weeds in wheat were treated with 2,4–D when available. South of Temuco, farmers allowed pigs to graze a squash field, with no apparent damage to the crop (Figure 4). In the same farm, geese were allowed to feed on the weeds (*Amaranthus* sp. and *Chenopodium album*) in a recently planted carrot field.

Soil management

On most Chilean soils, fertilizers are required to grow crops such as corn, potatoes, and vegetables. Legumes (i.e., beans, peas and favas), which provide their own nitrogen, can be grown more economically by campesinos. Typically, campesinos fertilize their fields with salitre (a natural fertilizer from northern Chile), although many use compost made of crop and weed residues, shrub foliage (i.e., *Rubus* spp.), guano (manure), ash and straw. Local rural aid groups funded by international foundations are assisting farmers in the construction of more efficient communal compost piles [10].

Seedlings of crops such as corn, beans, peas, fava beans, beets, onions, broccoli, acelga, cabbage, etc. were treated by surveyed farmers with a mix of water and human urine when showing yellow signs indicative of nitrogen deficiency. In the holes where trees were planted, some campesinos placed

handfuls of lentil and wheat seeds as a source of additional nutrients. According to local people, trees subjected to this treatment grew better ('pegan mejor').

Integrating trees into the farm system

The Chilean campesino includes trees (whether for food, fodder, wood or other functions) as integrated elements of farm management. Some of these systems can be categorized as agroforestry systems, as they combine the production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially on the same unit of land [15]. For the campesino the rationale for these practices differs according to his particular circumstances and needs, but generally involves the desire to increase and diversify production and/or enhance the protective functions that trees can provide to the farm.

Some of the various forms of integrated use of trees by the Chilean campesino are discussed below, considering the structural and functional relationships with other farm components.

Trees grown in association with annual and perennial crops

The mediterranean climate of south-central Chile cannot support the vertical stratification of associated plants as witnessed in the humid tropics. However, with the typically high degree of solar radiation and ample supply of irrigation water, coupled with optimal spacing of plants, various tree and annual crops can be produced in polycultural arrangement.

Annual crops

Throughout the survey, the most common association of treees and annual crops was found in mixed gardens of fruit and nut trees and row crops (Figure 5). The particular combination of trees and crops depended on the dietary needs of the family, size of the land and/or available markets. Trees were planted at various spacings and patterns, and annual crops of all types were cultivated in the remaining space. This combination of trees and crops (including herbs and medicinal plants) allowed the campesino to produce a wide range of products while utilizing the limited space most efficiently. Campesinos seemed aware that each crop may not be producing at its maximum capability but that total production was generally greater and more diverse.

Trees and annuals were also intercropped on a slightly larger scale in orchards (Figure 6). Especially during the early years of establishment, annual crops (i.e., corn, beans, squash, potatoes) are planted between rows of trees, utilizing the available inter-row space. With this practice of interplanting, the additional cost of caring for the trees is relatively low and the farmer gets a return from the land during the trees' unproductive years.

Figure 5. A mixed garden of fruit and nut trees with an understory of annual crops (potatoes, beans, squash, etc.) near Temuco, Chile.

Figure 6. A diversified orchard system composed of avocados, chirimoyas, and citrus with intercropped corn and beans between the rows in Quillota, central Chile.

Figure 7. A mixed garden system composed of grapes, fruit and nut trees with an understory of potatoes, squash and beans in central Chile.

Perennials

The perennial crop most often associated with tree crops are grapes, both in orchards and more intensive gardens. Although they may be planted in alternate rows with the trees, grapes are most commonly placed so that they utilize the inter-tree space within a given row.

Farmer interviews revealed that the management of this type of combination depends on the priority given to each crop. If the tree crops and grapes are of equal value, then trees are spaced to allow for adequate production of the understory grapes. If the trees have a higher priority, as in some orchards, then the grapes are maintained only until the tree canopies begin closing. In an orchard of alternating rows of pears and nectarines near Rancagua, grapes were planted between the pear trees but eventually removed once the pears had matured. Examples of the other extreme can be observed where the grower is managing primarily for grapes while allowing a scattered number of trees to grow in the vineyard.

Grapes are also combined with trees on a smaller more intensive scale as an additional component of a multicropped system. One such system near Linares combined 3 varieties of grapes with a one acre planting of 9 different types of fruit and nut trees. To add another component, annual crops such as beans or potatoes may be grown in the understory (Figure 7), a practice also reported in the Tuscany region of Italy [14].

Figure 8. A strip cropping system of corn and beans, with espino (*Acacia caven*) trees interspersed within the field of Casablanca, central Chile.

Native trees and crops

In areas that lack an abundance of native trees, trees that are a part of the natural vegetation (i.e., 'espino', *Acacia caven*) are generally left standing within farmers fields (Figure 8). Besides using espino as a source of wood and for their spiny branches used as fencing, there is some indication that the campesino recognizes the beneficial effects that this nitrogen-fixing legume has on the soil. The best example of this is in the foothills of the Andes east of Talca where the farmer must work with a heavy infertile soil. At least some of the campesinos in the area recognized the difference between their natural red soils and the 'dark' soils found under 'aromo' trees (*Acacia* sp.) growing nearby. In one village, a woman collected soil and litter from beneath a stand of aromo and used it in her garden. The effect was clearly visible. Those crops growing in the aromo soil were larger and more vigorous than the same crops growing in the untreated soil. This was particulary noteworthy considering that the aromo crops were planted 15 days after the others.

Trees growing in association with farm animals

The most common practice in central Chile of integrating trees and animals is the raising of farm animals in fruit and nut orchards. To the campesino, these agropastoral systems are an obvious way to use the normally unproductive space beneath the trees and are used extensively in the Temuco-Pitrufquen area. Not only does the farmer benefit from the increased

production by raising the animals (including cows, sheep, pigs, geese, chickens, turkeys, and rabbits) but also from the control of the understory grasses and weeds through grazing, and the addition of manure to the soil.

In some areas, orchard under stories provide a very important source of forage for livestock. Every year, some sheep herders in the Talca region bring their flocks down to the valley during the spring and early summer to graze on the cover crop of grasses and forbs in orchards. The owner of each orchard is generally compensated with a few of the new born lambs, in addition to having his weeds controlled. At the onset of the dry season when the cover vegetation begins to dry, the sheep are then taken back up into the hills for the remainder of the year.

Windbreak rows are a common component of the Chilean landscape in association with livestock as well as farm crops. The trees most commonly used in the surveyed farms were poplars (*Populus* spp.), eucalyptus (*Eucalyptus* spp.) and willow (*Salix* spp.) and to a limited extent, radiata pine and cypress. The trees were normally planted in single or double rows of one species, but combinations such as a row of 40' poplars next to 15' willows were also used. In areas of natural tree growth, seldom were pastures seen without a few scattered trees left standing for the shade they produce for the livestock during the hot periods of the year, as well as for the wood products harvested from them.

In central Chile, campesinos did not utilize trees as a source of food for their animals, except in the higher reaches of the Andes where the natural shrubs and trees served as fodder in the raising of goats.

The use of living fences

Many of the surveyed small farmers optimized the use of space by planting trees along property boundaries and borders within the farm. The value of this practice lay in the multiple functions provided by the trees. They played the role of living fences (as barriers to animals, marking property lines, etc.), sources of food, wood, and shelter for beneficial animals, birds and insects.

Rows of fruit and nut trees were common borders, sometimes being combined with lower growing perennials like grapes, berries or a fiber-producing plant called 'pita' between the trees. Probably the most common trees used as fences were the coppicing species such as poplar and eucalyptus. These not only produced valuable wood for fuel, poles and fence posts, but were also managed so as not to produce excessive shading of crops growing in close proximity (Figure 9).

Wood-producing trees on the farm

In the areas of central Chile lacking naturally-growing trees campesinos grew wood-producing trees to provide the wood products needed for fuel, building materials, fence posts, etc.

The wood-producing trees most widely used by the small farmer included

relative stability of production, minimize risks, make somewhat efficient use of labor and intensify use of the land with limited resources. Today, perhaps more than ever, Chilean campesinos have low capital, little or no available markets and few purchasable production inputs. To subsist they must constantly improve the productive efficiency of their farming systems, and this will depend to a large extent on how well organized are the component interactions of crops with other crops, grazing land, trees and crops with animals. Thus the integration of a variety of fruit and nut trees and non-crop trees into the farming operation becomes important to the optimum utilization of limited land, fuel, construction materials and animal feed.

Although this exploratory survey has yielded only preliminary 'observational' data on Chilean traditional farming systems and on some of the interactions within them, it is an important first step towards the ultimate development of appropriate technologies attuned to the circumstances of the campesinos [17]. Traditional campesino production has been extensively analyzed in its economic and social dimensions [2, 6, 7], but ecological studies aiming at formalizing the body of complex relationships of people and plants, plants with animals and plants with plants implicit in campesino farm systems are lacking. These types of studies, coupled with the campesinos' intimate knowledge of their environment, can serve as a starting point in the development of food self sufficiency programs. Emphasis on these programs, as opposed to emphasis on commercial production, is quite a logical (and urgent) effort given the actual circumstances of rural Chile.

Acknowledgements

We thank Kat Anderson for her editorial assistance and Joanne Fox for typing the manuscript. Linda Schmidt and Rafael Arias Godinez made the figures. This study was partially funded by a travel grant from the Center for Latin American Studies, University of California, Berkeley.

References

1. Altieri MA (1983) The question of small farm development: Who teaches whom? Agric Ecosyst and Environment 9:401–405.
2. Bengoa J, Crispi J, Cruz ME and Leiva C (1980) Capitalismo y campesinado en el agro chileno. Estudios Rurales Latino Americanos 3:227–269.
3. Bengoa J (1981) La cuestion del trigo y la region cerealera en Chile. Serie Resultados de Investigacion No 5. Grupo de Investigaciones Agrarias, Santiago. 231 p.
4. Christanty L, Abdoellah O and Iskander J (1982) Traditional agroforestry in West Java: The pekarangan (home garden) and talun-kebun (shifting cultivation) cropping systems. Unpublished material.
5. Collins J (1979) Agrarian reform and counter-reform in Chile. Institute for Food and Development Policy, San Francisco. 25 p.
6. Crispi J (1980) El agro chileno despues de 1973: expansion capitalista y campesinizacion pauperizante. Documento de trabajo, Grupo de Investigaciones Agrarias, Santiago, Chile. 46 p.

7. de Janvry A (1981) The Agrarian question and Reformism in Latin America. The John Hopkins Univ Press, Baltimore. 311 p.
8. Egger K (1981) Ecofarming in the tropics – characteristics and potentialities. Plant Res and Development 13:96–106.
9. Fracis CA (1974) Small farm cropping systems in the tropics. In: Soil, Water and Crop Production (DW Thorne and MD Thorne, eds). pp 318–348. AVI Pub Co, Inc, Connecticut.
10. Gibbon D (1981) Rainfed farming systems in the mediterranean region. Plant and Soil 58:54–80.
11. Gliessman SR, Garcia R and Amador M (1981) The ecological basis for the application of traditional agricultural technology in the management of tropical agro-ecosystems. Agro-Ecosystems 7:173–185.
12. Grupo de Invetigaciones Agrarias (1982) Que pasa con los campesinos. Cuadernillo de Informacion Agraria No 8, Santiago. 58 p.
13. Harwood RR (1979) Small farm development. IADS Development Oriented Literature Series. Westview Press, Colorado. 160 p.
14. Huget L (1978) Symbiosis of agriculture and forestry. Unasylva 30:25–29.
15. King KFS (1979) Agroforestry and the utilization of fragile ecosystems. Forest Ecology and Management 2:161–168.
16. Ruthenberg H (1976). Farming Systems of the Tropics. Oxford Univ Press, London.
17. Zandstra HG, Price EC, Litsinger JA and Morris RA (1981) A methodology for on-farm cropping systems research. IRRI, Los Banos, Philippines. 145 p.