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Even useful weeds are pests: Ethnobotany in the Bolivian Andes

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Abstract
Weed scientists, agronomists and an anthropologist in Bolivia surveyed farmers' practices and studied the ethnobotany of weeds. The hypothesis tested was that farmers managed weeds so as to take advantage of their uses. Farmers weeded row crops twice per cycle. Crop rotations usually began with potatoes and ended with an Old World cereal, broadcast in stands too dense to weed. Many weeds were fed to cattle, and fodder is the only use that requires more than an armload of weeds. Other uses of weeds (e.g., for home remedies) require just a few plants. Although most weeds have uses, they must still be controlled. The most important consideration regarding weeds is not their uses, but the fact that they are pests.

Keywords: *Weed control, ethnobotany, Bolivia, Quechua, Andes*

1. Introduction

Local knowledge of insect pests or microbial diseases often misses key information, e.g., overestimating damage, misunderstanding reproduction or natural enemies, or emphasising chemical control (Heong et al. 1994; Heong and Escalada 1998; Bentley and Rodríguez 2001; Nathaniels et al. 2003a,b; Stone 2004; Winarto 2004). This makes smallholder farmers vulnerable to manipulation by pesticide dealers, and prone to misuse agrochemicals (Van Mele et al. 2002). However, local knowledge of weeds should be different. Unlike insects and diseases, weeds are easy to observe, and cultural control of weeds is well-established in smallholder farming. Smallholder farmers know much about vascular plants (Berlin et al. 1974), and local knowledge of weeds should be much better than local knowledge of insects or plant diseases. As Jirström (1996) found in Malaysia, all smallholder farmers know that weeds lower crop yields, and they know how to control them, although hand-weeding is one of smallholder farming's greatest drudgeries. In farming systems where there is little or no use of herbicides, it may be a challenge to introduce new technology that is sensitive to local knowledge of weeds. One question is: What are local farmers' demands for new weed-control technology?

Asking tropical, smallholder farmers for their weed research demands is not as straightforward as it seems. They may place exaggerated expectations on research (e.g., 'How can we make *Spergula* disappear from our community?') Their relationships with weeds are more complex than outsiders can immediately grasp (some weeds are used as fodder, medicine, even toys, but others are just weeds). Ethnobotany can help elicit demand for research in a culturally and ecologically sensitive way.

Ethnobotany is 'the study of the relationships between plants and people' (Balick and Cox 1996). It is much more than the study of folk remedies made from plants. It includes the study of local names and folk taxonomy of plants as well as the local knowledge of them (Berlin 1992). The classic monograph on ethnobotany, *Principles of Tzeltal Plant Classification* describes four kinds of cultural importance of plants; they may be *cultivated* (i.e., crops), *protected* (e.g., fruit trees in the forest), *significant* (plants that people use without protecting) or *unimportant* (Berlin et al. 1974). We suggest here that a fifth kind of cultural importance is that of *pest*; local knowledge of weed control is also part of ethnobotany.

1.1. Geography

The study area is in the Bolivian Andes, in the department of Cochabamba. Rainfall: 400 – 600 mm of rainfall. Elevation: 2400 to over 4000 m. Latitude: 17 – 18° South. The first rains start in October, but 80% of the rain falls between December and March (Montes de Oca 1997), which limits crops to one season, unless there is irrigation. Rainfall is unreliable and uneven (leading to drought and heavy rain storms).

Farm communities cluster around relatively flat pockets of irrigated land. The Bolivian Andes are steep and dry, and native plants include cactus, needle grass (*Stipa* spp.), acacias and mesquite (*Prosopis* spp.). The parent rock is sedimentary, especially sandstone, so soil fertility is uneven and crops respond to fertiliser. The dry, rugged terrain

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makes for low population density, and many communities are over 60 km from the nearest city. Travel is expensive and uncomfortable, often in the backs of trucks. Potato is the main crop, but people also grow many others, to eat at home; they schedule crops for the efficient use of land and fertiliser, and have several species of crops to sell throughout the year. Few farmers cultivate more than one hectare of potato per year, and average yields (as measured in the early 1990s) are between 11 and 14 tonnes/ha (Terrazas et al. 1998). Provincial towns have weekly markets and buyers come from the city of Cochabamba (population about 750 000) to sell products such as soap, canned sardines and matches, and to buy potatoes, wheat, broad beans and other commodities for sale in the city.

Agronomists often describe Cochabamba and other highland areas of Bolivia as having low crop yields and high levels of soil erosion, generally blamed on increasing population pressure, ploughing-up of pasture land, shortening of fallow, and farming on steep slopes (Ellis-Jones and Mason 1999). Soil erosion is real, although it may be quantitatively exaggerated (see Maître et al. 2003). Most farmers do not regard it as a problem.

2. Materials and methods

The study was done in two phases. Over 4 weeks in January 2000, a botanical survey of weeds (Webb et al. 2001) accompanied farmer interviews on crop management and farmer decision-making in weed control (Bentley 2000). The survey included 34 farmers and covered 119 fields, in six villages, in three provinces (Esteban Arce, Tiraque and Ayopaya). Each farmer was asked specific questions for each field, including: Number of weedings? Tools and equipment used? Local names for weeding techniques? Relationship between crop, field slope, field size and technique? Interviews were conducted in each field, using a short questionnaire, which was structured sufficiently to guide the interview through the annual cropping cycle, but sufficiently open-ended to elicit concepts that were meaningful to the farmer and novel to the interviewers. The questionnaire was validated on farms close to the city. Interviews lasted 15–20 min per field, and most were conducted in Quechua, the native language of the area. In each village, the research team paid local farmers a small fee (about $3) to spend half a day visiting and discussing the sample fields. Farmers are busy, and even paying them a day's wage to work with us did not ensure a large group of collaborating farmers to chose from. In each community the team usually worked with a farmer they knew from previous projects, and friends and relatives that he could cajole into joining him. We would have preferred a random, stratified sample, but nevertheless, the farmers are probably representative of larger communities. The Revolution of 1952 and the land reform of the mid-1970s levelled many wealth differences in the Bolivian countryside, and while socioeconomic differences have since started to reappear, they are not as pronounced as in some other parts of the world. Few 'wealthy' farmers collaborated in this study.

Provinces visited in 2000 were re-visited in January 2001. J. Bentley, S. Nina and S. Pérez spent 2 weeks in the field, interviewing farmers about their knowledge of weeds and the behaviour of weeds. Semi-structured interviews (not questionnaires) were conducted in Quechua, in eight communities, usually in small groups of two to four people. In all, 17 farmers participated, sometimes accompanied by their neighbours. Five of the 17 had worked with us in the previous year. The team began the interviews by collecting 30–40 specimens of locally available weeds, then asking farmers which species were most troublesome. Farmers described the weeds species-by-species, in the order of their perceived importance. The interviews lasted for 3–4 h. Farmers were once again paid for their time. For each species, farmers told the local name, how serious it is as a pest, how people control it, and all of the uses they could name for the plant (see Annex A for the results, and Casagrande 2004 regarding how to elicit uses of plants).

3. Results

3.1. Cropping systems and management

Fields in Esteban Arce were predominantly situated on lower slopes and valley floors, hence a lower mean altitude (3280 m) and slope (13.2%), and greater soil depth (36.4 cm) and pH (6.2) compared to other locations. A higher proportion of fields in Ayopaya were at high altitude (3686 m), with a greater mean slope (32.7%), lower pH (5.1) and poor accessibility. Conditions in Tiraque are intermediate. The average period of time taken to walk from the homestead to fields visited in Ayopaya was 75 min compared to 27 min in Tiraque and 3 min in Esteban Arce. The principal crops are: potato (predominantly *Solanum tuberosum* ssp. *andigena)*, oca (*Oxalis tuberosa*), papalisa (*Ullucus tuberosus*), isaño (*Tropaeolum tuberosum*), maize, small grain cereals (wheat, barley, oats), and broad beans (*Vicia faba*).

Rotation fulfils many purposes in Andean farming systems, one of which is to control weeds. There are three named planting seasons. **Mishka** is a crop planted early, e.g., in August or September, especially with irrigation. (In this paper Quechua terms are given in bold. Spanish is italicised. Blended Quechua-Spanish phrases are given in bold and also italicised. Weeds tend to have only a Spanish name or only a Quechua name, not both.) The main season (**jatun tarpuy**, *siembra grande*, or **wata tarpuy**, *siembra de año*) for rain-fed, row crops, is planted once a year in October, November or December.

A late planting season occasionally occurs, especially for Old World cereals. A late crop may follow **mishka**, especially if the **mishka** is planted very early. But in general there is one crop a year. The basic rotation is approximately (with one crop per year):

Fallow → potatoes → other tubers
→ maize and/or broad beans → small grains
→ fallow (up to 10 years)

There are many variations on this rotation, some involving only two or three crops. Other options for unirrigated crops include:

Fallow → potatoes → small grains → fallow

Some intensive gardens near the homestead were planted in potatoes and broad beans in alternating years (one crop per year).

Potatoes → broad beans → potatoes → broad beans

There are other types. Terrazas et al. (1998) list 295 observed rotations in highland Bolivia. This very large number is made possible by counting every minor variation as a different rotation (e.g., classifying a cycle ending in wheat as different from one ending in barley). We do not dispute their data, but find it more useful to lump rotations into a smaller number of functional equivalents. The above rotations are the main ones. The main characteristics of rotation are:

- Fallow is common.
- Most rotations start with potatoes.
- Broad beans may end the cycle in intensive farming, without fallow.
- Small grains always end the cycle if there is a fallow afterwards.
- In more intensive systems, small grains may be eliminated or moved to the middle of the cycle, in order to fit two crops (potatoes and small grains) into 1 year.

A potato crop starts the cycle because it is usually the only crop that is fertilised, or at least the only one that is heavily fertilised. Other crops (e.g., tubers, maize) use nutrients banked during the potato crop.

When we asked farmers why they ended the cycle with small-grain crops, they said it was because grains improved the soil, or fed the soil for potatoes. But farmers frequently said things along the lines of: 'not even oats can eliminate such-and-such a weed', which suggested that local people were aware that small-grain crops out-compete weeds. When we explicitly asked some of the farmers if they ended a cycle with small-grain crops in order to eliminate weeds, they said yes. However, small grains can be grown during the fourth year of crop rotation because by then the field has become depleted of nutrients, and weed-infested, and small grain crops withstand these conditions better than other crops. Much of the grain crop is harvested with the straw and fed weeds-and-all to livestock (Table I).

3.2. Land preparation and weeding

3.2.1. Equipment. The team of oxen (*yunta*) has been used in Latin America since the 1600s with a wooden ard plough (González 2001). Since the early 1980s the wooden plough has been increasingly replaced by a small, metal plough, introduced by the Swiss-funded CIFEMA Project (Centro de Investigación, Fomento y Enseñanza de la Mecanización Agrícola).

The hoe (*azadón*) is a commercially available, steel hoe blade, fixed to a home-made wooden handle.

The triangular or pointed hoe (**chujchuka**) has a long, triangular metal blade, hafted onto a wooden handle.

3.2.2. Options. Farmers' first option for ploughing is generally with an ox team. In Sacabamba, Esteban Arce, there is a large, flat plain that can be ploughed with tractors, but machinery is not an option on most Cochabamba farms. Most farmers plough fields with oxen during the dry season, using the *cruzada y arada* (ploughing in one direction with an ox team, and then again, at a 90° angle to the first pass). Many fields are too steep even for oxen. Farmers told of ox teams rolling head over heels off some slopes. The steepest fields also tend to be the smallest and farthest from home, which also discourages working with oxen, since before ploughing, the farmer has to first reach the field, prodding the oxen up a long, steep trail while carrying a large, heavy plough over one shoulder. Many mountainsides must be worked entirely by **chujchukas** and other hand tools.

3.2.3. Effect of previous crop. As Table II shows, land prepared with hand tools tends to be steeper. Land ploughed by oxen is of intermediate slope and the land worked with tractors is fairly flat. However, 33 fields (28%) at a wide range of elevations were not ploughed at all, because they were planted in **qallpa** (soil from which a crop has recently been harvested, often potatoes or another root crop). Especially when the proceeding crop was potatoes, farmers sow directly into soil, heavily worked during the harvest.

Farmers use little herbicide; in 119 fields, farmers said they had not used herbicides in any of them,

Table I. Years since last fallow, and duration of fallow.

	No recent fallow	0–1 Years	2–3 Years	4–10 Years	>10 Years
Years since last fallow	18	69	10	3	
Duration of fallow	18	24	24	20	14

Data given as a percentage of all (119) fields visited.

Table II. Choice of land preparation technique and slope, Cochabamba, Bolivia.

Technique	Number of cases	Average slope[1]	Range of slope
Manual	7	44.9	5–67
Oxen	72	19.8	2–58
Tractor	7	10.9	7–20
Qallpa[2]	33	28.8	9–60

[1]A flat piece of land has a value of '0' and land at a 45° angle has a slope of '100'. [2]'**Qallpa**' means land from which a previous crop has been harvested. For example, if a farmer says, 'I planted these peas in maize **qallpa**' it means that peas were planted in a field after maize was harvested. In this table **qallpa** refers to root and tuber crops, especially potato. While harvesting the tubers, farmers turn the soil so completely (usually with hoes) that the next crop can simply be planted in the loose soil (although it may be smoothed and furrowed first).

although one farmer planned to apply herbicide that year in one of his fields. However, insecticide and fungicide use is common. Of 119 fields surveyed, farmers had used insecticide on 37 (30%), during the current season. Of the 37 fields that had received insecticide, 28 (76%) were planted in potato, eight (22%) in broad beans and one (3%) in peas. Fungicides are generally applied several times in potatoes, to control late blight (caused by *Phytophthora* spp.), but are not usually used in other crops.

Weeding practices vary according to crop (Table III). Potatoes and Andean tubers are weeded, usually with pointed hoes, until essentially no weeds survive (researchers wondered if the tall, bare ridges of soil left by weeding and furrowing increased the risk of erosion, but few if any farmers mentioned erosion as a concern). In January, 2000 the team counted the number of weed species and estimated how much ground each covered. Potatoes and the other Andean tubers had the fewest weeds (Figure 1). If the team visited the field within a few days of weeding, the soil was essentially bare. Although maize and potatoes are both weeded twice, maize tends to be planted at lower elevations (below 3000 m) and earlier, often in August or September, several weeks before the potatoes: the main season (*siembra de año*) is planted in November or December. Therefore, in January, when the team counted the weeds, the maize was older, and weedier than the potatoes (Table IV). Oats, barley and wheat are broadcast and receive no weeding, because the grains are planted so densely that a hoe would damage the crop. Towards the end of the cycle, farmers hand pull the tall stalks of flowering *Brassica campestris*, both to eliminate *B. campestris* seeds and to feed the weeds to oxen. And as Table IV shows, these Old World grains are weedier than maize or potatoes. The difference would have been even more striking if the team had measured each field as it neared maturity. Not only were the maize fields slightly older on average than the potatoes, but the Old World grains were younger.

Table III. Number of weedings per major crop.

Crop	Number of weedings	Description
Andean tubers	2–3	Usually one hoe-weeding, and two *aporques* (hilling-up) with an ox plough or pointed hoe
Maize	2–3	Usually one hoe-weeding, one *aporque*, with plough or pointed hoe, and late-season one harvest of weeds (for fodder) with a sickle
Small grains	0–1	One hand-pulling of tall weeds, especially *Brassica campestris*, for eliminating weeds, their seeds, and for fodder. Small grains are sown broadcast, and weeding with tools would cause crop damage
Broad beans	2	One hoe-weeding and one *aporque* with plough or pointed hoe. Beans shade out weeds late-season, so there are usually few weeds to harvest for fodder

Figure 1. In Ayopaya, smallholder farmer Germán Alegre pointed out these two, neighbouring fields of oca as a definitive example of weeding. He explained that the field on the left is well-weeded, and has more oca plants, while the one on the right is poorly weeded and will yield less. Note that even the field on the right has few weeds, and a great deal of bare, rocky soil.

Five of the grain fields had been planted in January, following the harvest of **mishka** potatoes.

3.2.4. Decision making. When we asked farmers to describe how they decided to weed, they often looked at us as though the answer was obvious. One elderly farmer said 'Sonny Boy, if I didn't weed, I wouldn't harvest anything'. They occasionally volunteered the information that they were waiting for the soil to dry more before doing the next hilling up, or *aporque* (1999–2000 was a wet year). They said they wanted to work the soil when it was neither muddy nor very dry, but simply moist (a condition they described as **phiri,** which is a word for dishes made by boiling grains just until the visible, liquid water is gone i.e.,

about the consistency of steamed rice). They weed and ridge less in dry years, because they are fully aware that this dries the soil. Farmers said they decided to weed when there was 'a lot' (**ashka**) of weeds, or 'when weeds appear' (**qhora rikhojtin**). (The category **qhora** includes most herbaceous and grassy plants, whether weeds or not.)

Table V summarises weeding methods used according to crop, field, or weed type.

4. Ethnobotany

Bolivian Quechua-speaking farmers have names for nearly all of the weeds in their fields. Farmers are more likely to name and know about the plants that are the most serious pests, and the ones that are the most useful. Farmers said that of the perhaps 30–40 common weeds, only three or four really bothered the crop. *Nabo* (*Brassica campestris*), **muni** (*Bidens trinervia*, *B. subalterna* and *B. pilosa*), **ch'iki** (*Pennisetum clandestinum*), **sunch'u** (*Viguiera lanceolata*), **puka qhora** (*Rumex acetosella*), and **wila qhora** (*Spergula arvensis*) are considered the major, serious weeds. *Nabo* because it must be hand-pulled in wheat, barley and oats, and **muni** because it is so much work to weed, and the other four weeds because they tend to grow back quickly after weeding.

We knew, before doing the field work, that Bolivian farmers made use of many of the weeds in their fields. Our hypothesis was that they managed them in ways that left some weeds standing. We found this not to be the case; people did have uses for almost all weeds, but weeds were still more important as pests than as beneficial plants.

Table IV. Weeds and crops, Cochabamba, Bolivia.

Crop	Number of cases	Average weed score[1]
Andean tubers		
Papalisa	3	12.5
Oca	10	13.9
Potatoes	37	18.5
American cereals		
Maize	20	42.0
Old World cereals		
Barley	6	22.4
Oats	13	33.7
Wheat	10	35.0
Legumes		
Broad beans	16	44.4
Peas	3	61.8
Lupin (**tarwi**)	1	47.0

[1]The team counted the number of species in each field, and estimated its incidence (weeds in group one < 1% ground cover, group two = 1–4.9%, group three = 5–25% and group four > 25%). The weed score multiplies the number of species in each field by 0.5 (for those in group 1), by 1 (for those in group 2), by 5 (for group 3) and by 25 for group 4. For example, if a field had three weeds in group 1, two in group 2 and one in group 3, its weed score would be: $(3 \times 0.5) + (2 \times 1) + (1 \times 5) = 8.5$. The data were taken in January, when potatoes were generally recently weeded, which gives a lower score for potatoes and most other crops, but a higher score for Old World cereals and maize.

4.1. Criteria of useful weeds

Farmers consistently described fodder as the most important use of weeds. Local people knew which livestock species ate which plant, at which stage in its life-cycle and whether the animal could eat the plant in the field or whether it could only eat the plant if the farmers harvested it and fed it to the animal (Annex A). Farmers understood whether or not livestock found the plants palatable, or merely ate them out of hunger, when there was nothing else. Other uses, such as medicine or toys were of much less importance.

4.2. Damage and control

4.2.1. Infuriating weeds. Smallholder farmers in Cochabamba describe a serious weed by saying that it makes one furious (***rabiachin***). Infuriating weeds

Table V. Menu of control options and field or weed types.

Control type	Field or weed type	Reason
Weeding with a hoe	Andean tubers, maize or broad beans, especially early in the season.	To eliminate weeds quickly, to clear the ground before *aporque* (hilling or ridging) with an ox plough.
Aporque with an ox plough	On flat or moderately sloping fields, especially if the field is not too small.	To dry the soil and manage soil-born diseases, and weeds, but especially to pile soil over tubers, which keeps them from surfacing and helps prevent wind lodging.
Aporque with a pointed hoe	On small or steep fields of Andean tubers, maize and broad bean.	For the same reasons as above, but is more labour-intensive. Used on fields too small or steep for an ox team.
Hand pulling	Tall weeds, especially *B. campestris* in fields of small grain.	Eliminate weeds, keep them from producing seeds and provide fodder.
Cutting weeds with sickle	Mature weeds, late in the cycle, especially in maize fields.	Prevent rodent damage and provide fodder in the hungry season.

are: both abundant and difficult to control. We were a bit surprised that most of the infuriating weeds have some uses, but farmers still regard them on the whole as negative. **Ch'iki** (*Pennisetum clandestinum*) is such extremely good fodder that farmers give it a kind of begrudged appreciation, yet it is still infuriating in a field, because it is aggressive, and once established, it is difficult to weed out. Sometimes farmers must first loosen the soil with a plough, then rake out the grass, pile it and burn it. Some weeds, e.g., **ch'oqe ch'api** (*Xantium spinosum*), are not very abundant, but farmers consider them infuriating because they are thorny. Farmers complain about it because livestock will not eat it, and because the weed jabs people's hands as they work.

4.2.2. Control: It comes out in the weeding. Farmers speak of weeds that are easy to control as **qhorana lloqsen** (*sale en la carpida*—it comes out in the weeding). That is, the weed is controlled by the regular operations of hoeing and cultivating and does not require any special treatment. This contrasts with other weeds that for some reason, usually architecture, demand a special control: e.g., *nabo* (*Brassica campestris*) grows low to the ground when it is young, which makes it hard to remove from a field of cereals. Farmers must wait until *nabo* grows its flower stalk, then hand pull it, i.e., they grasp the plant just below the flower and pull it up by the roots, taking care to do so before the seeds set, because the mature seed heads shatter when the plant is pulled. Farmers are fully aware of the functional relationship between the weed and its seeds.

4.3. Use

The weed scientists in this study wanted to take useful weeds into account when designing control strategies. But it transpired that almost all weeds had a use of some sort. However, only a few weeds were required by farmers in large volumes (i.e., more than a handful or two), usually fodder. Another bulk use would be the occasional, but dramatic, use as a famine food. Most other weeds are used as speciality items: medicine, playthings, etc., that use only four or five individual plants.

4.3.1. Fodder. In Cochabamba, animals graze on weeds in fallow fields, as they did on the open fields of England until the enclosure movement of the late eighteenth century (Turner et al. 2003). As land supply decreases, the weeds become more important as fodder (see Table VI). We did not measure the amounts of weeds used as fodder. Even when people carry weeds home, they are limited to what a person or a donkey can carry (Figure 2). While this may not seem like a lot, weeds are important for feeding livestock when they need to work hardest (during the ploughing season). This is at the end of the dry season, or the beginning of the rainy season, when forage is in short supply, and weeds help sustain animals, especially oxen, through a critical season. Farmers described how helpful it was to be able to graze oxen on a weedy, fallow field when ploughing, or to be able to pull weeds up from a neighbouring field while earthing-up (or ridging-up) (*aporcando*) to feed the ox team.

Farmers pay close attention to which plants animals eat. People distinguish between the plants eaten by sheep, cattle, donkeys, etc. They also distinguish between plants that are removed from fields as fodder, and also between plants that are eaten only when they grow in pasture or fallow land.

Farmers said that many species are used as fodder only on fallow lands: in cropland the same weeds are simply hoed up and left to rot (**ismupun**). *Nabo* (*Brassica*) that is hand-pulled from cereals is fed to livestock (Figure 3), and the legume *garrotilla* (*Medicago hispida*) is tolerated in some fields and harvested and even stored as fodder (see Anderson et al. 2001:20); however, most weeds in farmers' fields are weeded-out and not used as fodder

Table VI. The greater the land pressure, the more weeds are used as fodder.

Province	Land supply	Weed use as fodder	Explanation
Ayopaya	*Abundant* (much fallow land, some pastures and much irrigation)	Low	Farmers pasture livestock on weeds in fallow land. When smallholders cultivate with oxen, far from the village, they may use a few armloads of recently cut weeds as fodder for the ox team, but otherwise make little use of weeds as fodder.
Tiraque	*Less abundant* (less fallow land, some pastures, some irrigation)	Medium	Farmers harvest weeds, and haul them home in **q'epis** (cloth bundles) for animals.
Esteban Arce	*Scarce* (little fallow land, degraded pastures, no irrigation in some crop areas)	High	People often haul weeds in **q'epis** to feed to livestock. Farmers also wash weeds for livestock and haul weeds on donkeys to feed to other animals.

Figure 2. Guillermo Osoria loads his donkey with weeds, (mostly *Viguiera lanceolata*, but also other species) to take home as fodder. Province of Esteban Arce, Cochabamba, Bolivia.

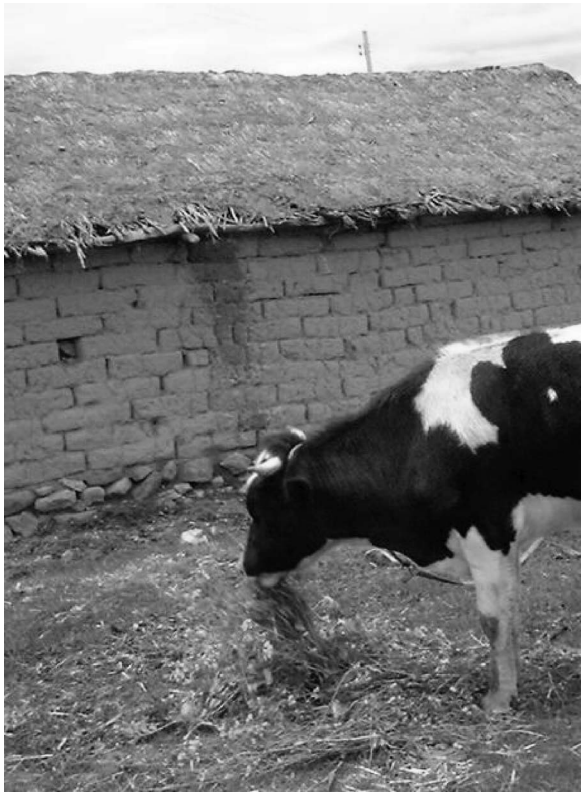

Figure 3. Cow in Tiraque eating *nabo* after farmers pulled the tall, flowering *Brassica* weed from a field of oats.

(see Annex A for a description by each species of weed). When we pressed farmers to explain the uses of weeds, they replied that *any* crop is much more valuable than the weeds in it. They full appreciated that weed competition must be reduced for a crop to grow.

4.3.2. Food. Cojo pollo (amaranth) and **ajara** (*Chenopodium album*) may be eaten as greens a few times a year. Some people use a few other plants as spices or in sauces, but weeds are not a major, staple part of the diet in Cochabamba. During famines in the early twentieth century, people ate the root of *nabo*, and possibly also of **apharuma** (*Solanum toralapanum*).

4.3.3. Construction material. Farmers use **sunch'u** (*Viguiera lanceolata*) for building **pirwas** (basket-like cylindrical granaries, about a metre tall and about a metre in diameter. **Pirwas** are used mainly for maize). Viguiera grows tall and woody, especially on field edges. Farmers harvest some of the dried, hollow stalks and tie them together to make the **pirwas**.

4.3.4. Toys. Several times, the farmers smiled as they spoke about their childhood, when they made flutes from **kina kina** (*Siegesbeckia orientalis*), or played carnival with streamers of *pajarillo* (*Tropaeolum cochabambense*). Farm children often go to the fields with their parents, and play there while the adults work. Rural Bolivian children possess few store-bought toys. People who play with weeds as children grow up to know them in a more intimate, immediate way than people exposed to plants through formal education. Playing with wild plants and animals is an entrée to learning about them. Children in Nepal and the Philippines play with some insects, and while doing so learn about them (Nazarea-Sandoval 1995; Gurung 2003). By age 9, Tzeltal Maya children can correctly identify at least 50% of the plants in their environment on the trail, and by age 12 identify 95%, the same as adults.

4.3.5 Medicine. Medicinal plants are often weeds (Begossi et al. 2002). Cochabamba's folk pharmacology may have once been fairly extensive, but it is eroding. For some species, farmers recall that such-and-such a weed once had a medical use, but they no longer know what it was. When smallholders discuss forage, they are unequivocal. They speak with clear intellectual authority about which species are palatable, which species eat it and which part of the plant they will eat and when. It is often the first thing farmers mention about a plant. This is not the case with knowledge about medicinal plants. Middle-aged men hesitate to respond, saying that their grandmothers knew about this plant, but that they have not really tried the remedy themselves. In a few cases, people described a first-hand experience with a medicinal plant.

4.4. Local knowledge

4.4.1. Habitat. Most communities distinguish two kinds of land 'high and low' (*arriba y abajo*; **patapi urapi**). Farmers frequently describe where a plant grows in these terms. Farmers also know if a plant is more common in fields or field edges or pastures, and can describe for example, that an **oqa oqa** plant grows better in a ploughed field than in fallow. In

other words, local people are quite aware of the habitat of each species.

The farmers know much about certain topics, such as architecture of the plant, habitat, and life-cycle. For example farmers in Ayopaya gave us a detailed description of how there is more **chhujlla** (*Paspalum repens*) in oca than in potatoes because birds eat the seeds of the weed when it grows in potatoes, then deposit (via defecation) the seed in the same fields, which are planted in oca the following year. Farmers are a slightly less familiar with the species growing in the hard soil on the field edges. Nevertheless, farmers have a name and know uses for most of these species. Besides the weeds, there are plant species in field edges, in pastures, along roadsides, along rivers, in fallow land and wild lands. These make up a huge ethno-flora, which is beyond the scope of this paper.

4.4.2. Manure. Many species arrived in Ayopaya as seeds in the manure from the Valley of Cochabamba. The people are fully aware that they are planting weeds with manure. However, farmers are not very concerned about them, because these weeds are controlled in regular weedings.

4.4.3. A resilient system. Weeds in Cochabamba are part of a resilient farming system that has withstood many shocks. Some weeds, old ones, seem to have disappeared, perhaps out of competition with other, new weeds (see Annex A: **ch'iñi ch'iwa** and **wila qhora** (*Spergula arvensis*)). Many of the major plants in the system have only been there for a few years. **Puka qhora** (*Rumex acetosella*), **ch'iki** (*Pennisetum clandestinum*) and **wila qhora** (*Spergula arvesnsis*) are not only some of the most damaging weeds, but some of the newest (and *Cynodon dactylon* is becoming established). However, people are coping with these aggressive new weeds. The Cochabamba weed system is dynamic, but control is fairly thorough, because farmers invest much hand labour in it, and are familiar with each species. This allows people to adjust rapidly and successfully to change. Farmers may frequently face new weed invasions. For example, Timor has experienced three serious weed invasions in the twentieth century. Since the 1980s, Timorese farmers have had to adapt to the invasive shrub *Chromolaena odorata*, but local solutions have so far done little to remedy the problem (McWilliam 2000).

5. Discussion

The botanical survey that accompanied this work (Webb et al. 2001) identified 138 weed species. *S. arvensis* was the most common, and the only species occurring frequently at high population densities. *B. campestris*, *B. trinervia*, *P. clandestinum* and *R. acetosella* were also among the 10 most common species, and confirmed by farmers in this study as some of the major, serious weeds. Weed scientists were reassured that both they and the farmers identified the same weed species as problems.

Of the 72 weed species we discussed with farmers, 55 (76%) are used for fodder. However, most of these fodder weeds are only eaten by livestock while being pastured in fallowed fields. Fewer farmers carry species (at least 10) home to animals. Even weeds that are good fodder are still regarded by farmers as noxious when the weed is in a cultivated field. It vexes the farmer (***rabiachin***) and has to be controlled.

Weed control is labour-intensive in Cochabamba. For potatoes, farmers typically plough, hill up (or ridge up, i.e., *aporcar*) twice (cutting weeds by hand before they do so, to make it easier for the ox team to move through the field). Each crop has a different weeding strategy, but in general crops are intensely weeded.

Farmers have clear, logical, local concepts for weed control. For instance, farmers say that the weeds that are controlled by the normal labours (ploughing, hoeing and cultivation) 'come out with the weeding' (*salen en la carpida*, **qhorana lloqsin**). Farmers consider weeds that do not 'come out with the weeding' as serious problems, in part because people have to perform special tasks in order to kill them. For example, *nabo* in grains must be hand pulled.

Farmers carry out one or usually two *aporques* in potatoes and other root crops for several reasons: to regulate soil moisture and to help manage soil-borne diseases. Farmers also explained that ridging the potato rows helps the crop tubers to develop properly. Herbicides would not be useful; farmers would still need to perform the *aporque*, even if herbicides controlled the weeds. In fact, even when there are hardly any weeds, as happens sometimes at 4000 m a.s.l., farmers still hill-up the soil around the crop, for the reasons mentioned above.

Existing weed control was thorough and was performed with hand tools and animal-drawn implements. Weeding tasks fulfilled various functions that could not be provided by herbicides (e.g., farmers hill-up potatoes to protect the tubers and manage disease, and would still have to perform this task even in the absence of weeds). Local people had some uses of weeds, e.g., fodder, especially at the critical ploughing time, especially in communities with little land. In spite of the uses of weeds, farmers still complained that some species were difficult to control. Farmers suggested that they think of weeds more as 'pests' than as useful items. In other words, the damage done by a weed is more important to people than its use.

6. Conclusions

Smallholder farmers may misunderstand insect pests, and be easily led to step on the 'pesticide treadmill'. But smallholders have an easy familiarity

with weeds, and they have their own control measures. We believed before we did this study that there were useful weeds, this was confirmed, most of the weeds had one or several uses. But many of these were trivial or required very little plant material. One does not need a whole field of weeds to brew a cup of herbal tea. Only weeds as fodder demand more than an armload of weeds, and while the actual amounts of weeds may not be large (a topic for further study), weeds as feed are a crucial stop-gap, especially for hard-working oxen during the 'hungry season' (Copa and Zambrana 2001).

In spite of all the uses of weeds, farmers still complained about them. Farmers do not manage their crops to preserve weeds, as some researchers originally hypothesised (Espinoza et al. 2000); even weeds with uses are still pests. The same may be true of other pests; Japadhola-speaking farmers in Uganda reported that many of the most serious pest species of termites were also the ones with the most uses, e.g., they had edible alates, or hosted edible fungi (Nyeko and Olubayo 2005).

Ethno-botanists have documented the uses of plants, including weeds, as folk medicines (Stepp and Moerman 2001; see also Ankli et al. 1999; Balée 1994; Begossi et al. 2002; Greene 2004; Huai and Pei 2004; Shepard 2004; to name a few). Useful things are certainly part of people's environments, but so are harmful things, such as weeds and other pests. Local knowledge of how to control weeds is as much a part of ethnobotany as is the lore of plant uses. Folk medicine has excited a disproportionate amount of interest in ethnobotany. Mundane uses such as fodder also deserve attention.

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Annex A. Weeds in Cochabamba, Pest status and uses.

Local and scientific names	Pest status of the weed	Local knowledge and uses
Nabo (*Brassica campestris*) **Meaning of folk name**. 'Turnip' (in loose, fertile soil, the root grows to about the size and shape of a carrot, but is white, like a turnip, which is also a crucifer).	Serious and abundant in most crops. If left untended, *nabo* will destroy a crop. **Management.** When *nabo* is young, it can be weeded with hoes or animal-drawn ploughs in row crops, e.g., potatoes. It can be tedious to hoe. In densely sown crops, especially the Old World cereals, *nabo* cannot be hoed without harming the crop, so farmers wait until it flowers, then pull it up by its tall stalk. Insulation kills *nabo* as soon as it is removed from the earth. *Nabo* grows many seeds, so it should be pulled before it goes to seed.	**Fodder**. Farmers often feed *nabo* to livestock after plucking it from fields. Most animals eat it, but not the burro. Animals will eat tender or flowering plants, but not those that have gone to seed. Animals also eat *nabo* in fallow fields. Some farmers wash *nabo* in the river before feeding it, to make it more attractive to livestock, which usually eat the leaves but not the stalk. **Medicine**. Leaves are used to treat the folk diseases *arrebato* and *colerina*, caused by excessive anger. After an attack of rage, the forehead and the soles of the patient's feet are rubbed with *nabo* leaves, to prevent internal organs from bursting and to avoid yellow vomit. **Birdseed**. Several farmers reported that merchants buy the seed of *nabo*, sold in the city as birdseed. **Famine food**. In the early twentieth century some people ate the root of *nabo* during famines.
Castilla nabo (*Raphanus raphanistrum*) **Meaning of folk name**. Castilian turnip.	Weed of rye and wheat in Ayopaya. Mice also climb it to eat ripening grain. **Management**. Removed with hand tools. It has a single, tough root that ploughs will not remove.	**Medicine**. Its roots are boiled and people bathe in the water to cure the folk diseases *arrebato* and *colerina*.
Muni (*Bidens* sp.) **Meaning of folk name**. Unanalysable.	Serious weed in many crops, especially wheat. The thorn-like seeds are a nuisance because stick to people's clothing, 'we leave the field (furry) like bears'. During the wheat	**Fodder**. Livestock eat some **muni**, especially if it is young, but they seldom eat the whole plant. Farmers rarely carry **muni** home for their animals.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
	harvest the sharp seeds can fly off the plant and poke people in the eye. **Management**. Controlled in the regular weeding, but it is best to weed **muni** when it is young, before it grows seeds. It must be cut with a hoe or a sickle, because when **muni** is pulled either the stems snap or the roots come out with a clod of earth. It is almost impossible to remove from wheat, because cutting or pulling **muni** damages the small wheat plants.	**Medicine**. The seeds can be toasted, powdered and drunk in water as a cough remedy.
Chhina muni (*Bidens* sp.) **Meaning of folk name**. Female **muni**.	A serious weed, especially in wheat on the large pampa of Sacabamba. **Management**. Hand pulled.	**Fodder**. Sheep eat it.
Mach'a qhora, *comino qhora*, yuraj t'ika, asnan qhora, wila qhora (*Spergula arvensis*) **Meaning of folk names**. Sticky herb, cumin herb, white flower, stink herb, **wila** (unanalysable) herb.	A serious weed in all crops, even though it has only been in Cochabamba since about 1985. Spergula 'sucks' (**ch'onqan**) the soil (of fertility.) If not weeded it soon blankets the ground. **Management**. Must be hand weeded, but even so it reappears rapidly from the pieces left in the soil.	**Fodder**. Farmers agree that livestock eat spergula, although some claimed that animals eat it more readily when it is young, or when it is mixed with straw or other forage. Some farmers said it helped cattle to give more milk and to gain weight. Farmers with less land regard spergula as less of a problem because they cut it with sickles in their fields to stall-feed animals.
Ch'iki, *grama, grama dulce, dulce grama* (*Pennisetum clandestinum*) **Meaning of folk names**. Unanalysable, grass, sweet grass, sweet grass.	A serious, aggressive, weed, which appeared after 1970. Kikuyu grass affects all crops, especially maize. It 'sucks' the earth. **Management**. Must be dug out with a hoe. The underground portions grow like cables which are so strong that when the plough hooks into them, the ox team may be stopped in its tracks. Herbicides are ineffective. In severe cases, the grass is dug, piled and burned.	**Fodder**. An excellent, 'sweet' fodder which livestock eat as readily 'as toasted grain'. Some farmers remove Kikuyu grass from fields for livestock; others pasture animals in fallow fields where the grass grows. When Kikuyu grass is hand pulled it breaks off in large pieces, which are easy for cattle to eat.
Puka qhora (*Rumex acetosella*) **Meaning of folk name**. Red herb.	A new, rapidly spreading weed, now a major pest in many areas. Dock out-competes other plants and damages the soil. **Management**. Weeded with hoes, **chujchukas** or animal-drawn ploughs. It sometimes has to be ploughed 3 times, because it does not come out unless the plough hits it directly: ploughing it 'is like passing through straw'. To remove	**Fodder**. Farmers in Ayopaya said that livestock eat it readily, although cattle and horses will not eat it if it is mature. Farmers in Tiraque said it had a sour (**q'allku**) taste, and cattle and guinea pigs will not eat it, especially if it is mature.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
	it from fallow lands, it helps to plough the soil when dry, but even this does not give total control. Herbicide does not affect it.	
Sunch'u (*Viguiera lanceolata*) **Meaning of folk name**. Unanalysable.	A serious weed in Esteban Arce. It 'sucks' the earth. **Management**. Controlled with hand tools and animal cultivation. Some farmers use animal cultivation, then a second weeding with hand tools, to remove pieces from the soil, before they take root. Some farmers cut **sunch'u** and pile it to dry it in the sun, to kill it, yet it is so resilient that if it gets wet, some of the plants take root. The dense roots sometimes break ploughs.	**Fodder**. Livestock eat it when it is young. Some farmers use it as stall feed. **Construction material**. The dried, mature stalks are a meter or more tall, and woody but hollow. Farmers tie them into a circle, upright, to fashion a basket-like granary called a **pirwa**, used for storing grains, especially maize.
Sunch'u, lap'iya (q'ellu t'ika) (*Viguiera* sp.) **Meaning of folk names**. Farmers are aware that this is 'another **sunch'u**' i.e. not the same one described above. '**Lap'iya**' is unanalysable but **q'ellu t'ika** means 'yellow flowers'.	Not abundant, but it appears in potatoes, oca and many other crops. **Management**. Weeded with **chujchuka** and plough.	**Fodder**. Animals eat it when they find it in the pasture or if it is fed to them.
Chhujlla, *cucharilla,* **sara sara, piki piki** (*Paspalum repens*) **Meaning of folk names**. Unanalysable, teaspoon, maize–maize (because the grass blades resemble maize leaves), small insect.	A weed of oca, but also of potatoes, papalisa and maize. If it is abundant it can be serious. Difficult to eliminate if populations are high. **Management**. Weeded with hand tools. Can be killed by uprooting and placing it upside down, with the roots in the sun. Often hoed and fed to animals.	**Fodder**. Excellent for cattle, sheep and llamas. Animals will not eat this grass if it has been uprooted, because the roots have a lot of earth on them. Farmers who rely more on this grass for fodder do not regard it as a serious pest. **Soil conservation**. One farmer mentioned that it improved and protected the soil.
Qallu qallu, ***lanten lanten, llantín*** (*Plantago lanceolata*) **Meaning of folk names**. Tongue–tongue. The second and third names are derived from the Spanish common name: *llantén llantén*.	Is a weed in maize, potatoes, alfalfa, etc. It can be difficult to eliminate, but in most areas it is not regarded as a serious weed. **Management**. It comes out in the regular weeding.	**Fodder**. All livestock eat it, when it is young. Grows in fallow lands, where animals eat it. **Medicine**. Some people use the roots to make remedy for canker sores of the mouth.
Cebadilla (*Bromus lanatus*) **Meaning of folk name**. Little barley.	An aggressive weed in some places, in many crops. It 'sucks' the soil. The thorn-like seeds hurt peoples' hands when pulling it up. **Management**. 'We can't get rid of it'. Weeded with hand tools.	**Fodder**. 'It's a bastard weed, but the cows really eat it'. People carry it home in bundles (**q'epis**) to stall feed it to animals.
Janu k'ara, k'impi (*Lepidium ruderale*) **Meaning of folk names**. Unanalysable, although the second name is a play on the word **impi**,	Not a serious weed, although it occurs in many fields, especially in potato. **Management**. Controlled with routine weeding, along with other crops. 'It dies easily'.	**Fodder**. Animals eat it, especially in fallow lands. **Medicine**. Used to cure **impi**, crusty skin that forms on children's cheeks at very high altitudes. The

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
a type of skin irritation common in the Andes.		plant is ground, mixed with urine and applied to the skin, where it burns and 'ploughs' the children's skin, until the **impi** comes off. **Toy**. Some children play with this doily-shaped plant, uprooting it and wearing it on their heads, like a hat.
Garrotillo, garrotilla (*Medicago hispida*) **Meaning of folk names**. Little stick.	Abundant, fast-growing and thrives in many fields, but not a pest. Many farmers tolerate it in fields. **Management**. Easy to weed. It has only one root and comes out of the soil easily. It dies quickly if uprooted and left in the sun. Often harvested as fodder.	**Fodder**. If the medick is abundant and fodder is scarce, farmers harvest it, roll it into balls, dry and store it like hay. Some store it mixed with straw (chopped or in layers). Livestock accept it readily. For horses, farmers harvest medick with sickles, since it is difficult for horses to eat it off the ground.
Oqa oqa, ch'ullku ch'ulku, ch'ullku (*Oxalis latifolia*) **Meaning of folk names**. The first name reduplicates the name of the native Andean tuber crop, **oqa**, in Quechua or *oca* in Spanish (*Oxalis tuberosum.*) The second and third names may mean 'something with one stem and various leaves'.	Occurs in fields, but is not a serious pest. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat some of it, when they come across it. **Food**. While adults work in fields, children harvest the small tubers and eat them, half in play, half out of hunger. The tubers are sour, but become sweeter if dried in the sun for a few days. Children also eat the flowers, which are sweet. **Medicine**. The tuber is ground and placed on a sore tooth to relieve the pain.
Ch'ullku (*Oxalis corniculata*) **Meaning of folk name**. Something with one stem and various leaves (?)	Not an important weed. **Management**. Comes out in the regular weeding. It dies easily.	**None**. It is too sour to eat or to be fodder.
Qalti, **kina kina, *tuka tukana*** (*Siegesbeckia orientalis*) **Meaning of folk names**. The first name is unanalysable. The second name may be derived from the word **qena**, 'flute' or 'panpipes', or it may reduplicate the word **kina** (*Cinchona calisaya*) the tree who's bark is made into quinine. The third name means 'something on which to play (music)' and is derived from the Spanish *tocar* ('to play').	Common in maize, and in irrigated crops. **Management**. It comes out in the regular weeding. It dies easily. It is often cut with a sickly for stall feeding to livestock.	**Fodder.** It often must be mixed with more palatable plants so animals will eat it. **Toy**. Children make toy flutes from the dry, hollow plant stems.
Ch'oqe ch'api, ch'oqo ch'api, ch'oqa ch'api, *amor seco,* **ch'oqela** (*Xantium spinosum*) **Meaning of folk names**. The first 3 and the last are related to each other, but unanalysable. They are a set obviously derived from a common source. *Amor seco* means	Not abundant enough to be a major weed, but farmers say its thorns make it difficult to weed. The prick of its thorn is painful and may fester. **Management**. May be weeded when young, before the thorns grow. Mature plants are gingerly	**Medicine**. The leaves are brewed as a tea for 'kidney disease' and the boiled leaves placed in a person's mouth help to relieve toothache.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
'dry love', perhaps in reference to the delicate yellow flower, and the thorns.	grasped at the base of the stem, and removed by hand, or with a sickle or hoe. Discarded separately from other weeds, to avoid hurting livestock.	
Ajara (*Chenopodium album*) **Meaning of folk names**. Unanalysable. Possibly a loanword from Aymara.	Can be serious in broad beans, potatoes. The roots can wrap around and stunt potato tubers. In Old World cereals, hand pulling would uproot the crop, so it is not weeded. At harvest, the weed seeds shatter and fall to the ground. It 'sucks' the soil. **Management**. Weeded with hand tools, or hand pulled. Hard to get rid of.	**Fodder**. Animals eat a little of it, especially burros. **Food**. Some people eat a few of the young leaves, boiled as greens. **Firewood**. If allowed to mature the weed may grow to over a meter tall. Some people burn the woody stalk as fuel.
Payqo (*Chenopodium ambrosioides*) **Meaning of folk name**. Unanalysable.	Considered a weed in some places. **Management**. Cut and dumped off the field (to discourage it from growing back in the field).	**Food.** Some people eat a few leaves 'like parsley'. **Medicine**. Its dried leaves are used as a remedy for folk diseases like *arrebato* and *colerina*, and stomach ache. **Fodder**. Animals eat it.
Cojo Pollo, **ataqo** (*Amaranthus hybridus*) **Meaning of folk names**. Limping chicken; unanalysable.	Not a common weed. **Management**. Collected as food and fodder.	**Food**. The leaves are eaten as a green, boiled, with spices. **Fodder**. All livestock species eat it.
Millma malva, pampa malva, mast'a malva, k'ita malva, qhari malva, *malva no más or* ***malvalla*** (*Malva campestris*) **Meaning of folk names**. Wool mallow, pampa mallow, mat-forming mallow, runaway mallow, male mallow. *Malva no más* and ***malvalla*** both mean 'just mallow'. *Malva* is the Spanish common name for mallow.	A serious weed in some places. It can be poisonous to sheep and cattle if it is either wet with dew, rain, or heated by the sun. **Management**. Easily controlled with hand tools. It dies when taken from the ground. Sometimes harvested as fodder, with care taken not to transport seeds.	**Fodder**. Cows, sheep and horses eat young plants. It grows so close to the ground that it is difficult for some animals to eat. It may be stall-fed. Sheep and pigs eat the leaves, but not the stems. To avoid killing animals, mallow must be 'neither heated by the sun nor dewy' (**Nitaj qawisqachu, nitaj chhullasqachu**.)
Q'ara malva, warmi malva (*Malva rotundifolia*) **Meaning of folk names**. Smooth mallow, female mallow.	Occurs in potato, maize and other fields. **Management**. Comes out in the regular weeding.	**Medicine**. One person thought this could be brewed as a tea and made into a bath for curing fever.
Leche leche, **khishka khishka** (*Sonchus asper*) **Meaning of folk names**. Milk–milk, thorn–thorn.	Uncommon and not considered a pest. **Management**. It comes out in the regular weeding.	**Fodder**. Cattle eat it.
Leche leche, salsa salsa (*Sonchus oleraceus*) **Meaning of folk names**. Milk–milk, sauce–sauce. Farmers do not confuse the two *Sonchus* species.	There is little of it. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat it.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
Leche leche (*Taraxacum officinale* and *Taraxacum* sp.) **Meaning of folk name**. Milk–milk.	Not a pest. 'It is just there in the field, alone, like and orphan'. **Management**. Harvested.	**Food**. When young and tender, eaten 'like lettuce' with oil and cheese. **Medicine**. The leaves are brewed until the milky sap comes out. Taken as a tea with breakfast for kidney and liver disease.
Leche leche (*Ipoecharis* sp.) **Meaning of folk name**. Milk–milk.	Uncommon and not a pest. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat it.
Ñajch'a ñajch'a, *awja awja*, *reloj reloj,* qolmalachin, p'isqo simin (*Erodium cicutarium*) **Meaning of folk names**. **Ñajch'a** means 'new born baby'. ***Awja*** is 'needle', a loanword from the Spanish *aguja*. *Reloj* means 'clock or watch'. **Qolmalachin** is unanalysable. **P'isqo simin** means 'bird's mouth'.	Uncommon and not a serious pest. **Management**. Easy to hoe out. Once cut, it does not recuperate. Often harvested with a sickle, and fed to livestock.	**Fodder**. Pigs are fond of it. When harvesting oca in the high mountains, if people are staying for several days in their stone cabins, they may take their pigs, which root the weed from the soil of the harvested oca fields. Cattle and sheep also eat it.
Rumasa, loq'o loq'o (*Rumex obtusifolius*) **Meaning of folk names**. Unanalysable.	Not a serious pest. **Management**. When weeding, if the tool or plough hits the root, the plant dies. It is easy to control.	**Fodder**. Sheep eat it. Cattle eat a few leaves of young plants. **Medicine**. Dipped in boiling water and applied as a compress to the skin for relief of fever and pain. May be brewed as tea, for pain.
Suyku, *burro suyku* (*Tagetes minuta*) **Meaning of folk names**. **Suyku** is unanalysable. Burro, of course, is a donkey.	Usually not serious. Occurs mostly on field edges. Is a weed on the dry plain of Sacabamba. **Management**. Comes out in the weeding, or is hand pulled and fed to animals.	**Fodder**. Burros, sheep and goats eat a little, if it is young, but not cattle.
Suyku (*Tagetes mandoni*) **Meaning of folk name**. Unanalysable.	A pest in potatoes, oca, papalisa and other crops. **Management**. Hand pulled.	**Fodder**. Sheep eat a little, but cattle will not. **Food**. Its leaves are mixed into hot sauce (**llajwa**.)
Anis, anis anis (*Tagetes pusilla*) **Meaning of folk names**. Anise. From the Spanish '*anís*'.	Not common in fields. **Management**. Not weeded. Fed to sheep.	**Fodder**. Sheep eat it. **Food**. Used to spice *humintas* (tamales.) Brewed as tea and mixed with distilled alcohol to drink. **Medicine**. Boiled as a remedy for stomach ache.
Wakateya suyku (*Tagetes graveolens*) **Meaning of folk names**. **Suyku** is associated with various species of *Tagetes*, but **wakateya** is unanalysable.	Not a serious weed. **Management**. Harvested.	**Food**. Crushed and used in sauce (**llajwa**.) **Fodder**. Sheep and goats eat some, but cattle do not.
Wira wira, yuraj wasa (*Gnaphalium* spp.)	Not abundant.	**Medicine**. Some people brew a tea from its leaves, as a cough remedy.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
Meaning of folk names. Tallow–tallow, white back. Both names probably refer to the white colour of the underside of the leaves.	**Management**. Easy to control. Comes out with the regular weeding.	One farmer reported cutting himself harvesting rye. He wrapped the wound in leaves, bound it with a rag and the cut healed. **Fodder.** Livestock eat it.
Pajarillo, pajarilla (*Tropaeolum cochabambense*) **Meaning of folk names**. Little bird.	A serious problem in some fields, especially maize and wheat. This long, fast-growing vine climbs maize plants and pulls them over. **Management**. Disengaged from the crop, by hand, one plant at a time.	**Fodder**. Sheep, goats and burros eat a little, but cattle will not, because it stinks. **Toys**. Children like to collect pieces of this vine with bright yellow flowers, and pretend that they are paper streamers from Carnival.
Layu, kinsa laqhe, chhijmu (*Trifolium amabile*) **Meaning of folk names**. The first and last are unanalysable. The second means 'three leaves'.	Not important. Grows in fallow or uncultivated land. **Management**. Eliminated by ploughing fallow lands; not common in fields.	**Fodder**. All animals eat it, even ducks, pigs and llamas. **Medicine**. Hangover remedy: the roots are brewed as a tea.
Janu k'ara, *cucharilla* (*Portulaca* sp.) **Meaning of folk names**. The first is unanalysable. The second means 'teaspoon'.	A serious pest. Occurs in all crops and can destroy a crop if left unattended. **Management**. Must be removed with hand tools.	**Fodder**. Animals eat it, especially in pastures and fallow lands.
Asnan qhora (*Senecio vulgaris*) **Meaning of folk name**. Stink herb.	A weed in broad beans and maize. **Management**. Weeded with hoe and **chujchuka**. Has many roots and may grow back after weeding.	**Fodder**. Animals do not eat it, not even birds, because it has a bad smell.
Waych'a (*Senecio liviculus*) **Meaning of folk name**. Unanalysable.	Not common, but can be a weed. **Management**. Regular weeding.	**Fodder**. Sheep and goats eat it. **Medicine**. The plant is boiled and the patient bathes in the water to cure 'allergies' (**mara**,) especially spots on the legs. **Soil conservation**. Protects and improves the soil.
Yuraj qhora, khuchi qhora (*Senecio* sp.) **Meaning of folk names**. White herb, pig herb.	A serious weed on the Sacabamba plains, especially in wheat and potatoes. It 'sucks' the soil and grows rapidly. **Management**. Weeding is not effective enough.	**None**. Nothing will eat it.
Jatun ch'iwa (*Veronica persica*) **Meaning of folk name**. Big **ch'iwa**.	Can be serious, especially in high country. **Management**. Weeded with hand tools.	**Fodder**. All livestock eat it.
Ch'iñi ch'iwa (unidentified) **Meaning of folk name**. Small and dense **ch'iwa**.	A fast-growing weed, found in potatoes and oca in high mountains. Not as common as it once was. **Management**. Each individual plant must be turned over with hand tools, or it tends to keep living.	**Fodder**. Cattle eat it, but only in pasture, not in fields.
P'uchonqora (*Solanum radicans*)	Not a pest.	**Food**. Children eat its small, orange fruits.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
Meaning of folk name. Unanalysable.	**Management**. Tolerated or harvested.	**Medicine**. Its leaves are brewed as tea to make a remedy for children with canker sores (**phasku**).
Apharuma, katari papa, k'ita papa (*Solanum toralapanum*) **Meaning of folk names**. The first name is unanalysable. Snake potato, runaway potato (second and third names).	A minor weed in a few, high areas. **Management**. Tolerated, or it comes out in the regular weeding.	**Fodder**. Livestock eat little of it. Cattle get drunk (**waka machan**) if they eat it. **Medicine**. The tiny white tubers can be used as medicine for **wajchilla**, a certain kind of white marks on a person's face (caused by fungus?). The tubers are split open and placed on the marks.
Papa papa (*Solanum* sp.) **Meaning of folk name**. Potato–potato.	Not a pest. **Management**. None.	None.
Lap'iya, para t'ika (*Cosmos* sp.) **Meaning of folk names**. Unanalysable, rain flower.	After the maize harvest, when the soil is ploughed, this weed's small tubers come to the surface. Sheep that eat them die. **Management**. Comes out in the regular weeding.	None.
Wirbina, verbenita, verbeñita (*Verbena litoralis*) **Meaning of folk names**. All three names are derived from the scientific genus name.	Not usually serious, but is a weed in wheat in Sacabamba. Also grows on field edges and in fallows. **Management**. Comes out in regular weeding. Hand pulled when necessary, especially in wheat.	**Fodder**. Sheep eat a little. **Medicine**. Brewed as a tea for stomach ache. Also taken by some women during menstruation. Can be brewed with or without the root.
Wajcha barbero (*Poligonum hidropiperoides*) **Meaning of folk name**. Orphan barber.	Thrives in maize. **Management**. Comes out in the regular weeding.	**Fodder**. Cattle eat it. **Medicine**. Leaves are ground and applied to large goitre sores on the neck.
Qhora no más (*Gallinsoga parviflora*) **Meaning of folk name**. Just an herb (i.e. it does not have a folk name.)	Not a serious weed. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat a little of it.
Alfalfa (*Polygonum avicularis*) **Meaning of folk name**. Alfalfa.	Not abundant. **Management**. Comes out in the regular weeding.	**Fodder**. All animals eat it, except birds.
Qhora (*Capsella bursa-pastoris*) **Meaning of folk name**. No folk name recorded.	Occurs in many crops, but is not a serious weed. **Management**. Comes out with the regular weeding.	**Fodder**. Sheep and cattle eat it when it is tender. **Soil conservation**. It improves the soil.
Alqo perejil (*Apium leptophillum*) **Meaning of folk name**. Dog parsley.	Not common. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat a little of it, but there are only a few plants.
Chhujlla (*Bromus* sp.) **Meaning of folk name**. Unanalysable.	Not an important weed. **Management**. Tolerated in Old World cereals, cut and stored with the straw. In fallow lands animals are tied near patches of it.	**Fodder**. A good fodder.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
Mula watana (*Juncus* sp.) **Meaning of folk name**. For tying mules.	Uncommon. Grows in humid areas and on field edges. **Management**. Only occurs in fields that have not been ploughed properly.	In the times of the haciendas (i.e. during the great poverty before the 1952 revolution) it was used for tying mules.
Dulce grama (*Brachipodium?* sp.) **Meaning of folk names**. Sweet grass.	Not a serious weed. **Management**. Comes out in the regular weeding.	**Fodder**. Animals eat it.
Cebadilla pastu (*Poa annua*) **Meaning of folk name**. Little rye grass.	Not a serious weed. **Management**. Can be pulled up if the ground is wet, otherwise the grass breaks off in one's hand.	**Fodder**. Sheep eat it readily.
Cebadilla (*Eragrostis* sp.) **Meaning of folk name**. Little rye.	A weed of wheat in Sacabamba. **Management**. Difficult, because weeding often uproots the wheat plants.	**Fodder**. Cattle eat it.
Sirk'i qhora (*Alternanthera* sp.) **Meaning of folk name**. Wart herb.	A serious weed in Sacabamba. **Management**. Farmers want an herbicide for it.	**Fodder**. Sheep eat some of it. Cattle eat less.
Jayaj pichana (*Skuria pinnata*) **Meaning of folk name**. Hot (spicy) broom.	A weed of potatoes and wheat in Sacabamba. **Management**. Hand pulled.	Broom. People take them home and to sweep their houses.
Llaq'o Llaq'o (*Plantago major*) **Meaning of folk name**. Unanalysable.		**Fodder**. Animals eat it.
Turu Turu Khishkan (*Erigium?* sp.) **Meaning of folk name**. Thorns like a bull.	Grows in field edges. People dislike this grass because, when they cut it, the thorns prick their hands.	**None**.
Llama thasa (unidentified) **Meaning of folk name**. Llama fart.	A weed in loose, deep soil. **Management**. Weeded with a **chujchuka** when it is young.	**None**. Animals will not eat it.
Qhora (*Cotula australis*) **Meaning of folk name**. No name recorded.	Not common. **Management**. Not explicitly managed.	**Fodder**. Animals may eat it.
Kanlla khishka (unidentified) **Meaning of folk name**. **Kanlla** thorn.	Occurs in fallow and wild land, not in fields. **Management**. Disappears when the soil is ploughed.	**Medicine**. Half of the plant is toasted and ground and the other half is left raw. These are brewed into a tea for measles, cough and for the folk disease *alfombrillo*.
Qhora (*Cerastium glomeratum*) **Meaning of folk name**. No folk name recorded.	A pest in some fields. **Management**. Hand pulled, piled in the field to rot, and ploughed into the soil the next year.	**Fodder**. All animals eat it.
Qhora (*Stellaria media*) **Meaning of folk name**. No folk name recorded.	Not a serious pest. **Management**. Hand pulled, but as it is pulled it snaps off.	**Fodder**. Animals eat it.

(*continued*)

Annex A. (*Continued*)

Local and scientific names	Pest status of the weed	Local knowledge and uses
Qhora (*Dichondra* sp.) **Meaning of folk name**. No folk name recorded.	Serious pest in potatoes in Sacabamba.	**Fodder**. Sheep eat a little of it, but cattle will not.
Qhora (*Helianthus* sp.) **Meaning of folk name**. No folk name recorded.	Reproduces rapidly and is a weed in Sacabamba.	**Fodder**. Animals eat it.
Qhora (*Richardia brasiliensis?*) **Meaning of folk name**. No folk name recorded.	Its seeds stick to the clothing of people as they cut wheat.	**Fodder**. Animals eat it.
Qhora (*Partenium* sp.) **Meaning of folk name**. No folk name recorded.	It is a pest in Sacabamba.	**Fodder**. The animals will barely eat it. Only when there is no grass left.
Ch'awqa rumi (*Argemone mexicana*) **Meaning of folk name**. **Ch'awqa** rock.	Grows along stream banks, not in fields.	**Medicine**. People brew its flowers as a tea, for cough.
Qhora (*Cynodon dactylon*) **Meaning of folk name**. No folk name recorded.	Becoming serious in Sacabamba. **Management**. It is removed from potatoes with picks and hoes.	**Fodder**. Sheep eat it.

Errata

Bentley, Webb, Pérez & Nina 2005 "Even Useful Weeds Are Pests." *International Journal of Pest Management* 51(3):189

Scientific names listed in Bentley et al. 2005	Should have appeared as:
Paspalum repens	*Paspalum aff. penicillatum*
Bromus lanatus	*Bromus unioloides*
Oxalis latifolia	*Oxalis latfifolia*
Xantium spinosum	*Xanthium spinosum*
Ipoecharis sp	*Hypochoeris* sp
Rumex obtusifolius	*Rumex cuneifolius*
Portulaca sp	*Calandrinia ciliata*
Senecio liviculus	*Senecio clivicolus*
Poligonum hydropiperoides	*Polygonum laphatifolium*
Skuria pinnata	*Sckuhria pinnata*

Also the Quechua phrase	Should have been:
Qhorana lloqsen	**Qhoranapi lloqsen**