J. Ethnobiol. 11(1):23–49 Summer 1991

MANAGING DIVERSITY IN POTATO AND MAIZE FIELDS OF THE PERUVIAN ANDES

KARL S. ZIMMERER[1]
Department of Geography
CB #3220
University of North Carolina
Chapel Hill, N.C. 27599

ABSTRACT.—This paper examines the management of mixed-cultivar (polycultivar) fields in the Andes of Southern Peru. It focuses on the two field systems used to produce native potatoes (*Solanum* spp.) and maize (*Zea mays* L.). The organization of diverse cultivars within fields and the context of diverse-cultivar fields in peasant farm production are analyzed from a human-geographic "landscape perspective."

Research findings indicate that contrasting selection practices guide polycultivar agriculture in each crop. Potato diversity is maintained primarily through the selection of morphologically distinct cultivars that leads to high and notably uniform levels of diversity within fields (mean 21.1 cultivars/225 plants; standard deviation 5.1). The maintenance of diverse potato cultivars serves to reproduce socio-cultural signs of Quechua identity. Maize cultivars number fewer per field (mean 2.9 cultivars/field) and are chosen individually for specific traits linked to consumption and production. Different modes of selection in each crop correspond to contrasting rates of biological recombination.

Polycultivar fields of potatoes and maize are differentiated according to a little-recognized grouping referred to as "use-category." "Use-category" is a utilization-based ranking at the supra-cultivar level that specifies the taxonomic composition and location of fields. The continuation of "use-category" management is a requisite for *in situ* crop conservation.

RESUMEN.—Este artículo trata el manejo de chacras (ó campos) de variedades mezcladas (referido como chacras policultivadas) en la parte sur de los andes peruanos. El artículo lleva un enfoque sobre los dos sistemas utilizados para cultivar la papa (*Solanum* spp.) i el maíz (*Zea mays* L.). Tanto la organización de variedades diversas dentro de las chacras como el contexto de chacras policultivadas dentro de la producción campesina son analizados desde una perspectiva de la geografía humana.

Los resultados de la investigación indica que la papa y el maíz difieren en cuanto de practicas para la agricultura policultivada. En la papa la elección de singularidad morfológica sirve para mantener una diversidad dentro de las chacras la que es alta y notablamente uniforme (promedio 21.1 cultivos/225 plantas; error normal 5.1). El manenimiento de las variedades diversas de papa proviene signos socio-culturales de la identidad quechua. Los cultivos del maíz por chacra alcance un numero bastante menos (promedio 2.9 cultivos/chacra) y son escogidos individualmente por characteristicas especificas del consumo y producción. Los sistemas diferentes de elección de cultivos de papa y maíz relaciona con tasas distinctas de recombinación biológica en cada uno.

Chacras policultivadas de papa y maíz son diferenciadas según una agrupación poco conocida llamado la "categoría de uso," la que es una clase definido por uso que especifica la composición taxonómica y la ubicación de chacras. La continuación del manejo por "categoría de uso" es necesario para la conservación *in situ* de cultivos nativos.

RESUME.—Dans cet article on va examiner la direction des champs des Andes du sur du Peru qui ont de la cultivation mélangée. On met en pris les deux systèmes des champs employés pour produir des pommes de terre natives (*Solanum* spp.) et du maïs (*Zea mays* L.). On analyse la cultivation des divers cultivars dans les champs et le contexte des champs de cultivation mélangée chez l'agriculture paysanne d'un perspectif de la géographie humaine.

Les resultats de la recherche indiquent que les practiques contrastanes de la selection guident l'agriculture mélangée avec chaque récolte. On maintient la diversité des pommes de terres par la selection des cultivars morphologicamment divers, qui produit un niveau haut et uniform de diversité culturel dans la plupart des champs (moyen 21.1/225 plantes, erreur normal 5.1). La maintenance des cultivars divers de la pomme de terre produit des signes socio-culturel de l'identité Quechua. Les cultivars du maïs sont de diversité plus bas (2.9 cultivars/champ) et on les choisit selon les caractères spécifiques de la consumption et la production. Les divers modes de selection chez chaque récolte correspondent aux taux contrastants de la récombination biologique.

On distingue entre les champs mélangés du maïs et de la pomme de terre selon les groupes peu connus qui s'appellent les "catégories d'usage," qui son les classes de rang plus haut que les cultivars, definis selon l'usage qui specifie la composition taxonomique et l'emplacement des champs. La continuation de la direction des "catégories d'usage" est nécessaire chez la conservation *in situ* des récoltes natives.

INTRODUCTION

The maintenance of diverse crop cultivars hinges on the management practices of agriculturalists. In the tropical montane environments of the Peruvian Andes, Quechua peasants cultivate the world's most genetically diverse assemblages of cultivated potatoes and maize (Grobman *et al.* 1961, Vavilov 1926). Several comprehensive studies deal with the ecology and ethnobotany of these crops in highland Peru (e.g., Bird 1971, Gade 1975). With the notable exception of Brush *et al.* (1981), few field investigations have focused on agricultural management of the mixed-cultivar (polycultivar) fields employed by Andean farmers in maintaining the diversity of native potatoes and maize. Notwithstanding the paucity of studies aimed at the polycultivar planting of these particular crops, ethnobotanical research increasingly has addressed the management of such parcels and the associated maintenance of diverse cultivars (e.g., Boster 1985, Clawson 1985, Johannessen *et al.* 1970).

The present study examines the management of polycultivar fields of potatoes and maize in the highland Paucartambo region of Peru's southern Andes (Fig. 1). It follows the perception–selection–maintenance–dispersal model of Johannessen *et al.* (1970) to describe the wide array of relevant agricultural management prac-

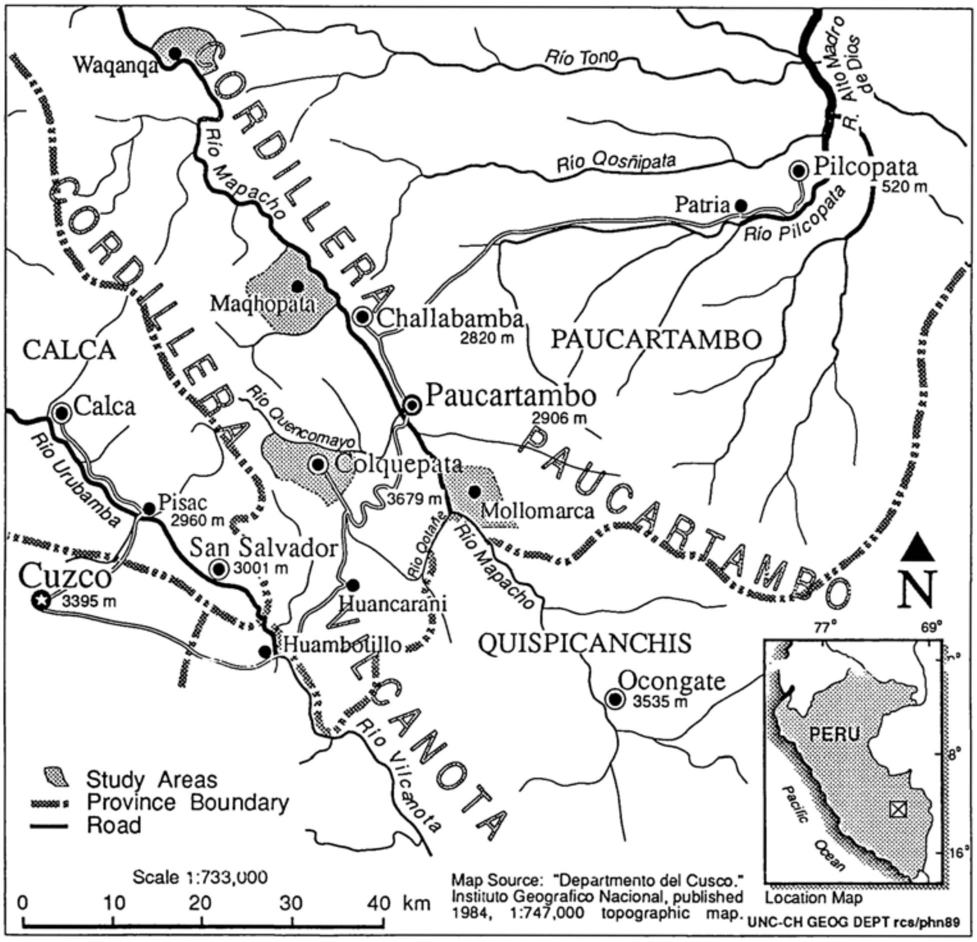

FIG. 1.—Study areas in highland Paucartambo.

tices. One principal goal of the study is to evaluate the applicability of existing explanations concerning how and why cultivar diversity is managed within polycultivar fields of both crops (potatoes and maize). The second major aim is to develop a comprehensive conceptual framework for understanding the multi-faceted management of polycultivar agriculture. The study formulates a human-geographic "landscape perspective" that complements the ecological and perceptual-cognitive foci that form necessary but not sufficient accounts of the agricultural management of cultivar diversity.

Two contrasting explanations concerning the selection of intra-specific diversity need to be compared in examining potato and maize agriculture in the Andes. Discussing the substantial genetic diversity of Andean potatoes, Brush and Guillet (1985:24) summarize the first of the proposed explanations in the following manner: "Selection matches agronomic qualities [of cultivars] to microenvironmental conditions." Bird's (1971) interpretation of management practices utilized in Andean maize production similarly highlights the direct selection of diverse cultivars for agroecological objectives. The second explanation, and a notable contrast to the selection of cultivar diversity for agroecological rationales, is Boster's (1985) model of selection based on perceptual differences. Boster proposes that the large number of manioc cultivars in western Amazonia is "a result of people's efforts to distinguish and maintain the cultivar inventory" (Boster 1985:310). He suggests that a similar explanation applies to diverse assemblages of other tuber-bearing crops such as Andean potatoes. The present study's close examination of the two proposed explanations for diverse-cultivar management shows that the majority of potato cultivars in polycultivar fields are selected for perceptual distinctiveness whereas maize types are selected directly for consumption and production traits. The resolution of agricultural selection, however, does not fully explicate the maintenance of cultivar diversity.

Few frameworks have been proposed to deal comprehensively with the management and maintenance of cultivar diversity. One exception is a model that combines the perception, selection, maintenance, and dispersal of crops (Johannessen 1966: Johannessen *et al.* 1970). Although it encompasses the gamut of activities involved in managing polycultivar fields, the model does not specifically address the combination of ecological-economic (production, consumption) and socio-cultural (symbolic meanings) considerations that are likely to underpin the agricultural practices of peasant farmers. The present study adopts a human-geographic "landscape perspective" in order to view polycultivar agriculture as representing both the economic and socio-cultural strategies organized by rural inhabitants.[2] Identifying these strategies as contingent relations in the human modification of ecological processes is thought to remain an unrealized imperative for ethnobiology (Ellen 1986:89).[3] A central finding of the present study is that several characteristics of cultivar management actually are based on a supra-cultivar level of classification referred to as the use-category, a contextual designation that specifies the parcel's taxonomic composition, ecological location, and utilization.

The "landscape perspective" is used also to integrate the material (ecological-economic) and symbolic objectives involved in the management of multiple cultivars within single fields, thus avoiding an exclusively economistic view of subsistence food production. Landscape features are known to serve as important symbols in the everyday lives of Andean peasants. Allen's (1988) recent ethnography of a community in the Southern Peruvian Andes illustrates how landscape elements, many of them evincing human modification, are commonly attributed with symbolic meanings. These symbols, at first glance representing portions of the "natural setting," are used by highland Quechua to interweave cosmological beliefs and group social identity vis-a-vis outsiders. Yet highland Andean environments are not simply "natural" or even a "setting" but rather largely reflect the result of human labor ensuring inhabitants' survival. Polycultivar fields need to be viewed as one of several landscape elements forged by the combination of ecological-economic and socio-cultural practices. The present study finds that agriculturalists maintaining polycultivar fields imbue native cultivars, especially potatoes, with a symbolic importance that helps explain why selection for perceptual distinctiveness occurs.

This article begins by reviewing the study of diverse-cultivar maintenance and the management of polycultivar fields. It examines the extent to which existing explanations account for the following three interconnected aspects of polycultivar agriculture: the objectives of agriculturalists, their practices, and the biological properties of cultivars and field ecology. The second section introduces the study area, crop species, and field research methodology. The third and fourth parts present research findings concerning the maintenance and diversity of Andean potatoes and maize, respectively. Here I attempt to explain the maintenance of diverse cultivars and polycultivar fields by integrating the three central areas of inquiry introduced in the opening section. Finally, the concluding section discusses the limitations of existing explanations and proposes incorporating them into a more flexible framework, or "landscape perspective," that emphasizes the economic and social contexts entrained in the reproduction of polycultivar fields. It argues that this broader vision is a necessary part of the successful design of *in situ* programs for crop conservation.

STUDIES OF POLYCULTIVAR AGRICULTURE

Research in several disciplines, including agronomy, economics, geography, and anthropology, cultural and human ecology, and ethnobiology, has addressed the maintenance of multiple crop cultivars in peasant agriculture.[4] The majority of studies have examined the composition and ecology of fields containing diverse cultivars and species by focusing on the questions of which taxa characterize such parcels and why they are planted by agriculturalists. Polycultural fields, a term referring to mixtures of cultivars as well as species, have been found to hold many ecological advantages over monocultures: "Generally polycultures are more productive, utilize soil resources and photo-synthetically active radiation more efficiently, resist pests, epidemics, and weeds better ..." (Altieri *et al.* 1983:46).

The ecological benefits of polycultivar agriculture, especially the reduced risk of crop loss, frequently have been used by researchers to explain why farmers maintain diverse-cultivar fields. These accounts cite either presumed or demonstrated variation in the ecological properties of diverse cultivars, combined with the supposed reluctance of peasant farmers to adopt new technologies, as evidence of management motives based on averting risk and otherwise ensuring harvest (e.g., Altieri and Merrick 1987, Clawson 1985). Contrary interpretations, however, have arisen from economic analyses of decision-making among small-holder agriculturalists. Findings concerning peasant agriculturalists' economic behavior offer little support for risk-aversion as a guide to most of their farm practices (Binswanger *et al.* 1984, Roumasset *et al.* 1979). Thus, although polycultivar fields presumably reduce farm risk, it is unfounded to assume that this function necessarily motivates agriculturalists' decisions about planting.

Various claims for the directed selection of individual taxa in the polycultivar field emphasize ecological motives other than risk aversion *per se.* One example is specialization to climatic or edaphic conditions (e.g., Harlan 1975a). Such explanations too are often based on deductive logic, purported rationales tending to be imputed rather than verified. They frequently draw on observations by Sauer (1952) and others that tuber-bearing domesticates and New World cereals are planted individually in polycultivar fields rather than through broadcast sowing. To deduce the intent of agriculturalists based on the form of field composition, however, is to assume the concurrence of the two phenomena. Ethnobiologists have pointed to the epistemological fallacy of assigning motives to human actions based solely on their consequences, biological and otherwise: ''The argument [for adaptation] is trivial when the usefulness of an item of cultural knowledge is deduced from the fact of its existence, tautologically, then 'explained' by analytic tour de force'' (Hunn 1982:831; also see Hays 1982).

The question of how agriculturalists select diverse cultivars has been examined less than field composition and cultivator rationale. To date, a pair of quite different interpretations of how agriculturalists choose diverse cultivars have based their contrasting arguments on the striking divergence of seed and tuber color among intra-specific cultivars during the course of crop evolution. Most authors have asserted that color and other non-adaptive characters serve as morphological ''markers'' that flag agroecologically favorable traits such as drought or frost tolerance that otherwise would remain visually indistinguishable (Clawson 1985, Harlan 1975a). According to the ''marker'' explanation, agriculturalists select for and then maintain the morphological diversity of cultivars in pursuit of agroecological objectives.

Boster (1985) has formulated the most significant alternative to the ''marker'' thesis. Investigating the selection of diverse manioc cultivars in western Amazonia, he found that Aguaruna agriculturalists select and maintain cultivars possessing distinct morphotypes. His results support a proposed model of ''selection for perceptual distinctiveness.'' Although Boster speculates that selection for morphological diversity might result in ecologically variable cultivars—essentially the inverse of evolutionary cause-effect proposed by the ''marker'' explanation—the question of why agriculturalists choose perceptually distinct cultivars appears not to have been a major inquiry in his research.

In summary, evidence from several perspectives indicates that ethnobotanical study needs to resolve and augment currently contradictory and incomplete interpretations of diverse-cultivar agriculture. A conceptual chasm frequently separates the two questions of why and how cultivators maintain polycultivar plantings. Arguments based on agroecological rationales lack supporting evidence about how such cultivars are selected. Conversely, a ''selection for perceptual distinctiveness'' model does not account for why agriculturalists undertake such practices. Finally, with a few exceptions, interpretations of polycultivar agriculture have primarily considered the selection of propagules without examining other activities that shape the management and maintenance of diverse cultivars.

Johannessen and his colleagues have posited a model of the domestication process in crop species that delineates four fundamental agricultural activities: ''perception of differences, selection for improvement; maintenance of improved genotypes; and dispersal of improved varieties'' (Johannessen *et al.* 1970:394). A similar framework was adopted by Brush *et al.* (1981:71) to assess the contemporary dynamics of potato agriculture in the Central Peruvian Highlands. Applied to the management and maintenance of diverse cultivars, the Johannessen model offers the most comprehensive framework for linking the questions of why agriculturalists produce diverse native cultivars, how they manage diverse cultivars, and what comprises resulting field composition and cultivar characteristics. The following discussion examines the broad scope of agricultural activities circumscribed by the perception-selection-maintenance-dispersal model while emphasizing the relations between polycultivar management and its economic and socio-cultural contexts.

THE STUDY AREA, CROP SPECIES, AND METHODOLOGY

The study area of highland Paucartambo forms an easterly segment of the Southern Peruvian Andes (Fig. 1). A prominent inter-Andean valley carved by the Mapacho River roughly bisects the region and deeply dissects its upland topography. Highland Paucartambo supports approximately 20,000 rural Quechua-speaking inhabitants (known to one another as ***runa***), most of whom belong to peasant communities consisting of between 20 and 150 families. Socio-economically and politically subordinate, peasants of the region carry out a variety of "everyday practices" that contest the conditions of their material and symbolic domination by small groups of regional elite (known to peasants as ***mistis***) (see Allen 1988). Agriculture is the main occupation of rural inhabitants in the region. Relying on an amalgam of native and introduced crops and technologies, cultivators produce a portion of household subsistence as well as surplus for marketing.

Fields ranging from the base of sharply incised gorges at 2800 m to the high-elevation plateau at 3900–4100 m are possessed by the majority of peasant cultivators in highland Paucartambo. Their access to a wide range of contiguous elevational environments characterizes the so-called compressed-type of Andean zonation (Brush 1976:161). Potatoes, which comprise the most important crop in the region on the basis of measures such as area, labor inputs, and production, cover most agricultural areas above 3800 m. The production of maize fields, in contrast, contributes significantly less than potatoes to the subsistence and commercial economies of households due to environmental constraints that limit its cultivation to canyon slopes below 3500 m. Nonetheless, the maize crop is coveted by peasants for consumption and ritual use.

The breeding systems and genetic architecture of potatoes and maize present cultivators with contrasting biological templates. Domesticated mostly in the Central Andes (Bolivia, Peru, Ecuador), potatoes comprise a complex of eight related species (Hawkes 1978). Seven of these eight taxa occur in highland Paucartambo, although one (*Solanum phureja* Juz. et Buk.) is endemic to humid environments that are uncommon in the region. The areally less restricted distributions of the remaining six species—two diploids (*S. stenotomum* Juz. et Buk., *S. goniocalyx* Juz. et Buk.) and four polyploids (*S. x chaucha* Juz. et Buk., *S. tuberosum* L., *S. x juzepczukii* Buk., *S. x curtilobum* Juz. et Buk.)—are limited primarily by elevation. Of the six widely distributed taxa, four species (*S. steno-*

tomum, S. goniocalyx, S. x chaucha, S. tuberosum subsp. *andigenum*) contain thousands of native cultivars or land races.[5]

Maize (*Zea mays* L.), which probably was domesticated in Mesoamerica (Iltis 1983), reached South America at least as early as 2,000 B.C. (Zevallos *et al.* 1977). The crop subsequently diverged into so many sub-specific forms that the Central Andes, and Peru in particular, today contain the world's greatest diversity of maize types (Grobman *et al.* 1961). Cultivar formation and maintenance in maize, characterized by the strong tendency for sexual recombination via outcrossing, are shaped by the crop's monoecious habit and various cytological and genetic characteristics such as heterosis. In domesticated potatoes, on the other hand, the rate of adoption of sexual recombinants and hence that of cultivar formation is severely restricted due to the predominance of vegetative propagation. Furthermore, only diploid species in the series of potato domesticates show high rates of sexual recombination.

Field research was conducted between February 1986 and July 1987 in four study areas of highland Paucartambo (Fig. 1). Each study area included one or more peasant communities. Agricultural practices related to diverse-cultivar production were investigated using participant-observation. The author and an assistant also interviewed agriculturalists concerning their preference, classification, exchange, and identification of potato and maize cultivars. Ecological sampling was carried out in polycultivar fields of both crops.

POTATOES

Context.—Most cultivators in highland Paucartambo annually produce between three and six fields of potatoes that together cover .5–1.5 ha.[6] Potato production is organized according to four "production zones" (see Mayer 1985), each characterized by a specific or sub-specific taxonomic grouping of potatoes, agricultural environment, and production calendar (Table 1).[7] Fields of "improved" potatoes (*S. tuberosum* subsp. *tuberosum*) characterize the inner-canyon and intermediate-elevation production zones between 2800 m and 3800 m (***kheshuar*** and ***yunglla***, respectively). The same subspecies distinguishes the "early planting" production zone (***maway***) which is interspersed within the first two zones. The highest agricultural zone (***loma***) is divided between an upper and lower part. Fields of bitter potatoes (*S. x juzepczukii* and *S. x curtilobum*) are located in the upper section (4000–4150 m).

Potato fields in the lower tier (3800–4000m) of the high-elevation production zone (***loma***) contain the vast majority of biologically diverse potato cultivars in the study region. They are planted with mixtures of native cultivars belonging to as many as four species (*S. stenotomum, S. goniocalyx, S. x chaucha,* and *S. tuberosum* subsp. *andigenum*). Selection, propagation, and storage activities underpin the maintenance of these diverse cultivars. In addition, the exchange of tubers of native cultivars is needed once every five or six years to replenish the household's supply, thus contributing to the continuation of cultivar diversity in fields.[8] The various management activities responsible for the taxonomic composition of polycultivar fields in the low ***loma*** result in a strikingly consistent species composition as listed above. Rather than occurring as a "natural" phenomenon, the elevational distribution of cultivated potato species is shaped by cognitive categories, representing the different uses of specific taxa, that guide farmer's practices.

TABLE 1.—*"Production Zones" of Potato Agriculture in Highland Paucartambo.*

"Production Zone" (Dominant Crop)	Potato Taxa	Elevation Limits (meters)	Calendar	Use–Category
Kheshuar (Maize)	improved vars. (*S. tuberosum* subsp. *tuberosum*)	3100-3500	Nov 15– May 1	"money"
Yunglla (Potatoes)	improved vars. *S. tuberosum* subsp. *tuberosum* some mixed native cultivars (see ***Loma*** below)	3500-3800	Oct 15– May 15	"soup–making"
Maway (Potatoes)	improved vars. (*S. tuberosum* subsp. *tuberosum*)	3100-3800	July 15– Feb 15	"money"/ "soup"
Loma (lower) (Potatoes)	*S. stenotomum*, *S. goniocalyx*, *S. x chaucha*, *S. tuberosum* subsp. *andigenum*	3800-4000	Oct 15– June 1	"boiling"
Loma (higher) (Potatoes)	*S. x juzepczukii* *S. x curtilobum*	4000-4150	Sept 15– June 1	"freeze–drying"

The taxonomic composition of polycultivar potato fields relates to ecological habitat and production zone location via cognitive categories subsequently referred to as use–categories (Table 1, far-right column). Each use–category specifies potatoes for a distinct purpose: freeze–drying, boiling, commerce, and soup-making.[9] In the highest fields (4000–4150 m), agriculturalists plant only freeze-drying cultivars (***ruk'i*** or ***chunu papa***). Fields in the lower portion of the high-elevation zone 3800–4000 m), discussed in the preceding paragraph, contain potato cultivars suitable for boiling (***wayk'u papa***). Fields of the remaining zones (***yunglla, kheshuar, maway***), whose production is destined for market, primarily yield "money potatoes" (***qolqe papa***). Subsistence production from the latter zones is used for soup-making (***bondon papa***). Use–category is the classification level most critical to the management of polycultivar fields in the overall context of peasant production. Classification and naming at other levels, however, provide insights into agricultural practices such as selection that shape within-field dynamics.

Classification, naming, and selection.—The cultivators of highland Paucartambo classify potatoes according to four taxonomic groups: "crop," "use-category," "cultivar," and "sub-cultivar" (Table 2).[10] La Barre (1947:84) was the first to note that potato naming might reflect a hierarchical organization of these four categories.[11] Later, in research on potato agriculture in the Central Peruvian highlands, Brush's (1981) team used the proposed universal folk taxonomy of Berlin and his botanist collaborators (Berlin *et al.* 1973, 1974) to assign the four above-mentioned groups a parallel series of "folk taxonomic ranks," i.e., genus, species, variety, and sub-variety. Potato naming and classification in highland Paucartambo show several incongruencies with the postulated universal model, differences that are important for understanding the management of polycultivar fields.

Table 2.—*Folk Taxonomic Classification of Potatoes in Highland Paucartambo.*

Crop	Use-Category	Cultivar	Sub-cultivar
	wayk'u papa	***chequefuru***	***yana chequefuru*** ***puka chequefuru*** ***yuraq chequefuru***
papa	***bondon papa***	***mariva*** ***yungay*** ***mi Peru***	
	chunu papa	***k'usi***	***yuraq k'usi*** ***yana k'usi*** ***moro k'usi***

Potato naming in the study region violates an important rule of the proposed universal model which stipulates that "nomenclature is a near-perfect guide to folk taxonomic structure" (Berlin *et al.* 1973:216). In particular, the model specifies that folk varieties are labelled by secondary lexemes, i.e., two-word names in which one word refers to the immediately inclusive category. Yet, agriculturalists in highland Paucartambo, as well as the Central Peruvian Highlands (Brush 1980), do not use secondary lexemes (e.g., post oak, white oak) to name cultivars. Instead they utilize primary lexemes such as ***chequefuru*** and ***chimako*** (see Table 2). The practices of Paucartambo peasants diverge yet further from the universal model in adding an extra taxonomic level, the folk sub-variety (e.g., ***yana cheqefuru, yuraq cheqefuru***). The prevalence in everyday usage of sub-variety labels demonstrates the high level of precision employed by local agriculturalists in naming potatoes. A precise indigenous system is equally evident in the classification system applied to potato crop.

The classification of potato types in highland Paucartambo only partly resembles the hierarchical relations portrayed by the proposed universal folk taxonomy (Berlin *et al.* 1973, 1974). Non-exclusive taxonomic relations point to considerable flexibility in classifying. Certain cultivars classified as members of the "boiling potato" use-category (*wayk'u papa*), for instance, can also be assigned to the "soup-making" class (*bondon papa*). The non-exclusive property of the local folk taxonomy suggests "heterarchical" rather than hierarchical relations within the classification system (see Hunn 1976 for a discussion of the exclusivity problem in folk taxonomy). Despite evidence of incongruences, results of the field study concur with the proposal for a universal model in finding that the taxonomic groups identified by cultivators generally correspond to biologically important divisions. In particular, the rank of use-category (the folk-taxonomic species) is used to distinguish biological species (see Table 1, also LaBarre 1947:87, Gade 1975:206-207, Brush *et al.* 1981:71) while cultivar and sub-cultivar (variety and sub-variety in the folk-taxonomic schema) represent sub-specific biological categories that have been referred to by the same names (Harlan and deWet 1961; see footnote 5).

Agriculturalists identify the use-category, cultivar, and sub-cultivar affiliation of a given tuber based on morphological differences. They particularly use tuber shape, eye characteristics, and water content of the flesh to distinguish among use-categories and cultivars.[12] Most sub-cultivars, on the other hand, are distinguished from one another solely on the basis of skin color. Furthermore, whereas the names of use-categories indicate properties related to utilization, labels of cultivars and sub-cultivars do not refer to consumption or even production attributes. Instead, approximately one-half of the commonly used sub-cultivar labels refer to landscape and social features (Table 3).

TABLE 3.—*References Indicated by Potato Names in Highland Paucartambo.*

Landscape References		Social References	
paqocha senqa	"alpaca nose"	***misti pichilo***	"penis of a ***misti***"
condor runtu	"condor egg"	***ch'ilkas warmi***	"***ch'ilkas*** woman"
puma runtu	"puma testicles"	***qachum waqachi***	"that which makes the daughter-in-law cry"

Referential names attached to many cultivars are not only colorful and a topic of amusement and discussion among agriculturalists but they also incorporate prominent symbols of the local landscape. Many referential labels (e.g., ***paqocha senqa, condor runtu, puma runtu,*** see Table 3) describe landscape elements characteristic of the high-elevation grassland, or ***loma*** as it is known in the study region. Quechua peasants attribute spiritual power and closely link their social and cultural identities to this environment (Allen 1988). Other names (e.g., ***qachum***

waqachi, misti pichilo, ch'ilkas warmi) specify social groups within the region. Usually a tuber attribute, frequently shape or color, at least partly resembles the object to which the common name refers.

Consistency of identification determines the degree to which agriculturalists might control the composition of polycultivar fields. Among cultivators of common beans (*Phaseolus vulgaris* L.) in the Northern Peruvian Andes, for instance, pronounced variation in identification was found to be associated with a near absence of the direct selection of cultivars, thus preventing close management of field composition (Zimmerer 1985). In contrast, the identification of potatoes in highland Paucartambo varies little. Agriculturalists recognize and readily identify those cultivars that they plant. In the sampling of over 6,000 tubers in 26 fields, as discussed below, owners' identifications could be doubted only on a few occasions.

Notwithstanding their detailed knowledge of cultivar identification, most highland Paucartambo agriculturalists employ selection and storage practices that mainly involve the recognition of use-categories within the native potato crop rather than more precise taxonomic ranks. In either the field or storehouse (Fig. 2), tubers within each use-category are separated on the basis of size into the following groups: (1) ''first class'' (referred to locally as ***primera clase***) consists of large tubers which are displayed proudly before sale or household consumption; (2) ''second class'' (***segunda clase***) contains medium-large tubers that are either sold or, ideally, used for seed; and (3) ''third class'' (***tercera clase***) comprises relatively small tubers to be consumed by the household. (Sometimes a fourth category of yet smaller tubers is designated for freeze-drying as ***chunu*** or feed for the household's animals.) Individual cultivars are not culled from each of the end-use groups but instead remain mixed with others belonging to the same use-category.[13]

In preparation for sowing, the woman head of the household either gathers tubers from storage or plants the entire remaining stock. She chooses few tubers individually but instead separates a portion of the remaining tubers, which typically contains a more or less representative mixture of previously planted cultivars. Despite being able to identify upwards of 40 cultivar types, most women seed selectors purposefully ensure the planting of only a handful of favorite cultivars, usually for either their production or consumption qualities. Within the ''boiling potato'' use-category, most agriculturalists prefer three cultivars (***qompis, suyt'u,*** and ***olones***) as good producers. The best-tasting of ''boiling potato'' cultivars comprise a separate group, including the cultivars ***ch'uruspina, choqllos,*** and ***runtu.***

Field composition.—Using a modified point intercept method (Barbour *et al.* 1980: 173), 225 plants were sampled in each of 26 fields containing the ''boiling potato'' (***wayk'u papa***) use-category. Sampled fields were located in each study area except the lower-valley site centered on Waqanqa (Fig. 1). The cultivar identification of tubers was made by the author, an assistant, and the field owner on the basis of morphological characteristics and local names, two independent sets of criteria that can be used to identify native crop cultivars in general and potato

FIG. 2.—Agriculturalist in highland Paucartambo culling "third-class" potatoes at harvest.

cultivars in particular (Brush *et al.* 1981, Harlan 1975b; see also the discussion under *Classification* above). Sampling results indicated a mean of 21.1 cultivars per 225 plants. In addition to demonstrating the high degree of diversity, findings reveal a remarkable uniformity of cultivar variation within polycultivar fields. The sample's low standard deviation (5.1) indicates a pronounced evenness of diversity levels among parcels. Concerning spatial patterning cultivars within most "boiling potato" fields are distributed randomly, a pattern referred to locally as ***charqhosqa***. Block-type patterning of cultivars (***taka-takasqa***) is limited to fields in high-elevation, eco-territorially "extended" peasant communities.[14]

The second measure of diversity examined character differences among tubers in the sample. The 79 cultivars identified during sampling were distinguished on the basis of several character differences including tuber shape, eye pattern, and flesh color (Zimmerer 1988). Nearly half of 179 sub-cultivars, on the other hand, differed only in tuber skin color. Several groups of closely related sub-cultivars could be distinguished solely by this trait. Many sub-cultivar groups were found to contain parallel series of colors. Red-black and white-yellow-black particularly differentiated sub-cultivar pairs or triplets, respectively. Sampling showed that fields containing one member of a sub-cultivar series were likely to include the other members ($p < .05$).

Selection of cultivars.—Limited support for ecological rationales in the selection of potato cultivars for planting *within* the field is offered by the above findings on agricultural practices, objectives, and field composition. The agriculturalists of highland Paucartambo organize the composition of fields primarily according to use-category rather than individual cultivar. As a result of the taxonomic composition specified by each use-category, potato species are confined to a well-defined range of agroecological habitats (via the contrasting ecological parameters of different production zones). The choice of cultivars within single fields, however, does not involve a similar level of culinary or agroecological specification. Agriculturalists specifically select only a few cultivars for these purposes. Directed selection related to divergent production and consumption preferences accounts for only as many as eight or so of the roughly 21 cultivars that typically occur in "boiling potato" fields.

The absence of cultivar-by-cultivar management in "boiling potato" fields also was revealed by an interview completed with owners following the sampling of their fields. It showed that those "boiling potato" cultivars gauged to be most favorable were consistently among the least common. The similar lack of correspondence between preference and frequency in potato fields in a nearby region of the Southern Peruvian Andes surprised Jackson and his colleagues (1980:113) who found that "three varieties classed as poor were grown at a higher frequency than some of those which were considered good or intermediate." This evidence further argues against the role of directed selection in polycultivar fields. Combined with other findings, it reveals that selection for ecological objectives is not an adequate explanation of how and why agriculturalists in highland Paucartambo maintain diverse potato cultivars.

Agricultural practices and cultivar composition of "boiling potato" fields support a model of selection based on perceptual distinctiveness. As Boster (1985:324) suggests, Andean potato agriculture shows characteristics (e.g., polycultivar plantings, vegetative propagation) that favor the targeting of perceptual differences in seed selection. Moreover, if tuber skin color is posited as the perceptual focus of selection efforts, the potato crop meets the following preconditions proposed by Boster (1985:313): (1) variation of the trait must exist in the gene pool; (2) the character must be perceptually salient to the cultivator; and (3) the character cannot interfere with the utility of the cultivar.[15]

Both biological and ethnographic findings of research in highland Paucartambo support selection for skin-color distinctiveness as a major guide in maintaining taxonomic diversity within polycultivar potato fields. Biologically, the selection of distinct color types is evinced by the high frequency of related sub-cultivars within single fields that differ only in the hue of the tuber's skin. Moreover, uniform levels of cultivar diversity in "boiling potato" fields (standard deviation = 5.1; see the discussion under *Field composition*) suggests that agriculturalists share culturally constructed perceptions of distinctness among cultivars. The removal of a sub-sample of stored tubers rather than the selection of individual specimens permits agriculturalists to contrast cultivars with one another, even if based only on the overall impression of diversity.

Three additional features of polycultivar potato fields need to be underscored. First, the biological manifestation of selection for perceptual distinctiveness is shaped by economic and social contexts, namely the organization of fields according to use-categories. Secondly, results of experimental and field studies have demonstrated the non-specialized adaptation of most conspecific potato taxa to climatic environments, thus suggesting that directed selection (intra-specifically) for agroecological purposes might offer little advantage (Zimmerer 1990). Thirdly, as in Boster's original formulation, selection for perceptual distinctiveness only accounts for how agriculturalists choose diverse cultivars but not why they do so. Before examining this latter question in the concluding section, the planting of diverse maize cultivars in the Paucartambo highlands is examined.

MAIZE

Context.—The agricultural complexity of maintaining diverse maize cultivars rivals potato production and offers several counterpoints including ecology, areal extent, and religious importance (see Mayer 1985, Murra 1960, Yamamoto 1985). In highland Paucartambo, maize cultivation comprises one of the major forms of land use in the production zone of the inner canyons below 3500 m (***kheshuar***). Although the majority of households in the region cultivate only one or two maize fields, the crop is widely esteemed as both a dietary item and an element of ritual and ceremonial practice.[16] Unlike potatoes, maize is exchanged frequently, and even annually, especially among peasant farmers in marginal growing environments of the upper valleys (3100–3500 m).

Maize is organized into three "field plantings," each matched to a distinct calendar, elevational range, and intra-specific groups of cultivars belonging to separate taxonomic races (Table 4). The "late planting," for instance, consists of maize types with a short growing season suited to late planting and early

TABLE 4.—*Maize "Field Plantings" in Highland Paucartambo.*

"Field Planting" (Local name)	Calendar (Planting–Harvest)	Elevational Limits (meters)	Major Races	Major Uses
"Early Planting" (***hatun muhu***; "large seed")	Sept 15–June 15	2700-2800	Huancavelicano	boiling
			Ancashino	boiling
			Paro	boiling
			Uchuquilla	boiling
"Middle Planting" (***chaupi muhu***; "middle seed")	Oct 15-May 15	2800-3300	Pisccoruntu	parching
			Kulli	beer-making
			Confite	popcorn
			Puntiagudo	
"Late Planting" (***uch'uy muhu***; "small seed")	Nov 15-May 1	2800-3500	Cusco Cristalino Amarillo	boiling
			Cusco	boiling
			Morocho	boiling

harvest. It occupies the uppermost elevations of maize production.[17] Differences in the diversity and number of plantings per household depend largely on the availability of suitable environments. A striking contrast distinguishes the humid lower Mapacho valley (e.g., Waqanqa, see Fig. 1), where agriculturalists produce each of the three types of "field plantings," from the semi-arid upper valley (e.g., Mollomarca and Colquepata), where many of their counterparts rely on a single planting regime.

Maize types for boiling and parching, two distinct use-categories, are paired loosely with different "field plantings" and their associated labor calendars and agricultural habitats (Table 4). Cultivars used for boiling (referred to collectively as ***mut'i sara***) mostly comprise the "early planting" and "late planting" and only a small fraction of the "middle planting," the majority of which is made up of parching cultivars (***hank'a sara***). Although some "middle planting" cultivars such as those belonging to the race Pisccorunto actually mature in less time than "late planting" cultivars (see Grobman *et al.* 1961:356), the former are grown for a longer period to ensure complete maturation and thereby guarantee a floury endosperm suitable for parching. The prominence of two use-categories for maize in highland Paucartambo (one for boiling and one for parching), as well as the racial affinities of their cultivar constituents, appears to resemble agriculture in other Central Andean regions (Bird 1971, Gade 1975).

Cultivars intended for parching and boiling are also employed in a wide variety of secondary preparations in the study region. As a result, single fields contain cultivars intended for several dishes. Less common yet nonetheless important uses include beer (***aqha,*** Sp. ***chicha***), hominy (***fata***), crushed maize (***chaqhe***), popcorn (***mana***), mush (***api***), corn-on-the-cob (***choqllo***), soup thickener (***lawa***), pudding (***mazamorra***), and tamale (***tamales, huminta***). (The array of local culinary preparations encompasses most of those recorded for the Peruvian Andes [Bird 1971, Gade 1975, Grobman *et al.* 1961]). Except for popcorn, which requires a single type, secondary uses are not matched exclusively to certain cultivars. Several cultivars employed in secondary preparations are in fact grouped according to their use as boiling types (***mut'i sara***).

Classification, naming, and selection.—The structure of maize classification in highland Paucartambo closely approximates that of potatoes. Crop (Q. ***sara,*** Sp. ***maiz***), use-category (e.g., ***mut'i sara, hank'a sara***), cultivar, and sub-cultivar form the major taxonomic categories (Table 5).[18] Like potato classification in the study region, taxonomic groups tend to represent biologically significant categories. The maize types prepared by boiling (***mut'i sara***), for instance, consist mainly of cultivars that belong to the races Cusco Cristalino Amarillo, Cusco, and Morocho (Grobman *et al.* 1961). Cultivars belonging to the use-category designated for parching (***hank'a sara***), on the other hand, are derived primarily from the race Pisccoruntu. Yet, as shown below, the resemblance of classification as well as naming in the maize and potato crops does not correspond to similar systems of cultivar selection. The comparison of cognitive-linguistic practices in highland Paucartambo and those predicted by the proposed universal model offers a useful basis for showing the properties of cultivar management in the maize crop.

TABLE 5.—*Folk Taxonomic Classification of Maize in Highland Paucartambo.*

Crop	Use-Category	Cultivar	Sub-cultivar
	hank'a sara	*parakay*	*leche parakay* *oqe parakay* *yuraq parakay*
		saqsa	*puka saqsa* *yuraq saqsa* *fallcha saqsa*
sara	*mut'i sara*		
		k'ellu	
	aqha sara	*kulli*	

Maize classification in highland Paucartambo veers considerably from the universal model of folk taxonomy proposed by Berlin *et al.* (1973, 1974). Perhaps most notably, the local system does not evince inclusive relations between the use-category (folk species) and cultivar (folk variety) ranks. The non-exclusive associations of cultivars with use-categories reflect "heterarchical" rather than hierarchical forms of taxonomic organization. Cultivars classified as boiling types, for instance, periodically serve in other dishes as mentioned above. One of these, ***k'ellu sara***, is often classified as belonging to both the boiling and beer-making use-categories (Table 5). Maize classification also transgresses the rules of the proposed universal model by assigning primary lexemes to many would-be folk varieties (i.e., cultivars [see Table 5]). And, like the systems of classification and naming used for the local potato crop, those of maize extend to the level of folk sub-variety (sub-cultivar). The common usage of sub-variety labels for maize reveals the considerable precision characteristic of local crop naming.

Agricultural management of maize ears demonstrates a key link between the classification system, "field planting," and the cultivar composition of fields. This connection is due to the sharing of certain criteria by both the local and scientific systems of intra-specific classification. It is especially evident in identifying "field planting," for which cultivators draw on morphological markers that also are important in biological classification. In particular, the designation of most ears with hard flinty endosperm for either the "early planting" or "late planting" and those with a soft floury interior solely for the "middle planting" parallels the biological division of flint and flour corns, respectively, which in highland Paucartambo are represented primarily by cultivars belonging to the races Cusco Cristalino Amarillo and Pisccorunto. Local agriculturalists' organization of field composition by "field planting" and maturation therefore maintains a major evolutionary divergence within the maize crop of highland Paucartambo.

Maize naming by peasant farmers in the study region draws on many of the same symbols represented in potato nomenclature despite their contrasting growing environments and cultivation practices. Some cultivars, such as ***ruk'i,***

waqankilla and ***qompis***, receive the same labels as their potato counterparts. The names of many maize cultivars derive from features of the high-elevation grassland, including flowers (e.g., ***fallcha,*** a liliaceous herb), plants (e.g., ***saqsa***, a bromeliad), and animals (e.g., ***pisco*** [sparrow], ***urpi*** [dove], ***llut'u*** [quail]). In contrast, landscape features characteristic of the maize-growing zone are rarely utilized to label members of the crop. ***Ch'uspi*** ("flea"), which refers to a speckled parching maize, is the most notable representation of the maize environment in cultivar nomenclature. This finding counters the possible suggestion that agriculturalists necessarily derive referential cultivar names from the landscape that surrounds production. Although the names of some maize cultivars express social and cultural ties to the symbolically potent high-elevation landscape, this similarity does not imply that maize naming is identical to that of potatoes.

Maize naming does not evince nearly the symbolic richness present in potato nomenclature. Color terms, for instance, are much more conspicuous among cultivar names of the former (e.g., ***k'ellu sara*** ["yellow maize"], ***puka sara*** ["red maize"], ***oqe sara*** ["gray maize"]). In contrast, the labelling of cultivars based on color is notably absent from the nomenclature system created for native potatoes. (Note, however, that many sub-cultivars in the native potato crop are differentiated according to color.) The use of more color terms but fewer symbolic labels in maize naming than in that of potatoes might be due to the brighter palette in maize coloration and the greater cultural-historical legacy of potatoes among Andean peoples (Murra 1960).

Agriculturalists identify consistently all but the most morphologically "mixed" maize ears grown in their fields. Mixed ears (a condition referred to locally as ***amachayoq***) arise from hybridization and display morphotypes partially resembling those of two or more cultivars. To maintain the identity and ultimately the diversity of cultivars, agriculturalists must share criteria for disqualifying mixed types as potential seed sources. Elimination of strongly mixed ears is guaranteed by a commonly recognized array of indicators (number and orientation of rows, color and shape of kernels) and designations (e.g., ***saliasqa, cholosqa***) that are used to distinguish extremely variable off-types.

The selection and storage of maize involves the designation of ears belonging to individual cultivars from within use-category groups. This highly specific form of management begins prior to storage. After husking, ears are carried to the "drying floor" (***tendal***) where they are separated according to cultivar type (Fig. 3). Dried ears are then stored, an activity undertaken almost exclusively by women heads of household. Women also select seed ears from the array of separately stored types. When selecting seed ears for future use, they choose individual specimens, setting them aside in order to shell by hand shortly before planting.[19] (Only kernels from the ear's middle section are selected due to their uniform development and better see viability.) The direct selection of maize cultivars for inclusion in polycultivar fields, evident in the designation of ears to provide seed, sharply contrasts the group-type selection used to choose the majority of potato cultivars.

By considering diverse criteria to specify individual maize cultivars within a use-category, agriculturalists assure the maintenance of more than one type

FIG. 3.—Harvested ears of boiling and parching maize separated by cultivar type on the "drying floor" (highland Paucartambo).

in nearly all subsistence fields. Two practices in particular indicate rationales for the polycultivar composition of maize fields. First, many cultivars preferred consumption differ from those possessing esteemed production traits within the same use-category. ***Chullpi***, for instance, is widely thought to be the best-tasting cultivar among the parching (***hank'a***) types although others such as ***leche parakay*** are much preferred for their yield. Secondly, single maize fields sometimes include more than one "field planting." Different sections of the field are effectively managed as separate "field plantings." As a consequence of this practice, certain fields contain maize types for both parching and boiling, thereby including as many as four or five cultivars, each of which is designated for a specific production or consumption attribute.

Field composition.—The cultivar diversity of polycultivar maize fields is significantly less than that of potato parcels. Sampling of fields belonging to 36 households evenly divided among the four study regions (Fig. 1) revealed that maize fields contain a mean of 2.9 cultivars. The household's total stock of cultivars was found to vary according to the diversity of distinct "field plantings." Households in the upper Mapacho valley, where most agriculturalists produce the "middle planting" as well as the "late planting," cultivate a mean of roughly 6 cultivars. Lower valley households, on the other hand, typically maintain between nine and 10 cultivars.

Two spatial patterns of planting characterize maize fields. Most subsistence producers mix cultivar seed randomly within a single field, an agricultural practice shared by their counterparts in other Central Andean regions (Bird 1971, Gade 1975). The random planting of cultivars, referred to locally as ***michusqa***, is analogous to the mixtures commonly sown in nearby potato fields. Some agriculturalists in the lower Mapacho valley, on the other hand, plant maize cultivars in blocks (referred to as ***melga-melgantin***). The block arrangement permits separate sowing according to the maturation period of cultivars within the same ''field planting.'' Popcorn, for instance, matures more slowly than other ''late planting'' cultivars and therefore is sown slightly earlier.

The visually impressive morphological diversity of ears produced in single polycultivar fields is promoted by the planting of cultivars in mixtures, a practice that assures high rates of sexual recombination. Taxonomic identification of the field sample, however, revealed that much morphological variation does not correspond to significant biological divisions. Although sample fields contained 11 of the 33 maize races found in highland Peru and a total of 27 cultivars identified on the basis of row length and number (Zimmerer 1988), the much larger number of sub-cultivars (117) reflects many identifications based solely on differences in kernel color. Unlike their counterparts in the potato crop, maize sub-cultivars do not show regular series of morphological variation within related groups.

Selection of cultivars.—Culinary and production rationales guide peasants' maintenance of diverse maize cultivars in highland Paucartambo. Directly selection of individual maize types differs substantially from the group-type selection of potatoes. Two scales of examination are required to explain how directed selection maintains the diversity of maize cultivars: polycultivar diversity within the field and overall diversity within the region. Although the regional diversity of maize cultivars is moderate (27), within-field variation involves few cultivar types (mean 2.9).

Directed selection of a few favored cultivars for production or culinary attributes suffices to explain the variation within polycultivar fields. Maintenance of maize diversity at the regional scale, on the other hand, is built on the system of staggered ''field plantings.'' Temporally distinct calendars for maize production even out labor requirements and the supply of harvested products while also providing households with maize suited to various culinary uses. In effect, regional maize diversity is maintained mainly by the delimitation of growing season and ''field planting'' while within-field variation is dictated by the selection of preferred cultivars in the context of each ''field planting.'' (It is noteworthy that the production schedules of other crops in the study region, such as potatoes [see Table 1] and ***lisas*** [*Ullucus tuberosus* Lozano; known in most of Peru as ***olluco***], reveal similar combinations of staggered agricultural calendars in association with diverse cultivar types.)

Little evidence from the classification, selection, and cultivar characteristics of maize agriculture in highland Paucartambo supports a model of seed selection based on perceptual distinctiveness. Furthermore, the pattern of variation in kernel characteristics among sub-cultivars would be unlikely to result from the selection of perceptually distinct morphotypes based on color. Rather than maintain perceptually distinct types, seed selectors rely on kernel color to eliminate off-type coloration patterns. Thus, maize producers mainly select for different growing seasons among the cultivars found in separate "field plantings." Morphologically similar cultivars possessing markedly different growing seasons (e.g., the related sub-cultivars ***k'ellu sara uch'uy muhu, k'ellu sara chaupi muhu, k'ellu sara hatun muhu***) particularly evidence this mode of selection.

Reproductive biology and genetic architecture are central to understanding the maintenance of diversity in polycultivar maize fields. Repeated selection for perceptual distinctiveness in maize would create an unwieldy number of cultivars and sub-cultivars within no more than a few years. The majority of variants produced under such selection would display either agroecologically insignificant or unfavorable attributes. Even with an ample supply of labor—unlike the deficit condition of the region's present rural economy—highland Paucartambo agriculturalists would probably be unable to marshal the additional effort necessary to manage such a large cultivar pool.

CONCLUSIONS

Previous studies of polycultivar fields in non-industrial agriculture have dealt partially with three interconnected questions: (1) what is the nature of cultivar diversity both in terms of field composition and cultivar characteristics?; (2) how do agriculturalists maintain these stocks of diverse cultivars?; and (3) why do agriculturalists plant polycultivar fields? Explanatory models tend to focus on one or two of the above inquiries. Two contrasting explanations—selection for perceptual distinctiveness (Boster 1985) and directed selection for production and consumption objectives (e.g., Harlan 1975a)—were found to account only partly for the maintenance of diverse potato and maize cultivars in the highland Paucartambo region of Southern Peru.

Selection for perceptual distinctiveness complements direct selection as the key practices that Paucartambo agriculturalists use to manage polycultivar fields of "boiling potatoes." Such parcels show a high level of cultivar diversity (21.2 cultivars/225 fields) that is remarkably uniform (standard deviation = 5.1). Agriculturalists do not directly choose most potato cultivars individually but instead select stock for planting based on perceptions of overall variation. In contrast, maize ears are selected directly for both production and consumption characteristics, resulting in a much lower diversity per polycultivar field (2–4 cultivars/field). The twin explanations of potato and maize selection, however, do not account for crucial contextual parameters and cultural meanings that envelop the management of polycultivar fields and thus the maintenance of diverse cultivars.

Polycultivar potato and maize fields are integrated into peasant production by the organization of use-categories. Use-categories reflect divergent culinary, commercial, and household-economic objectives. They also are associated with differences in agricultural environments, calendars, and taxonomic groupings. (Potato use-categories correspond to one or more species or sub-species while each use-category of maize contains one or more sub-specific races.) Characteristic of separate polycultivar fields (or sometimes sections within fields), use-categories structure the selection and maintenance of diverse cultivars. The close tie between the taxonomic specification provided by use-categories and the socio-economic context of peasant livelihood is of great practical and biological significance. Although the management of use-categories has not been highlighted previously, the prominence of certain "contextual categories" suggests the possibly widespread importance of this supra-cultivar level(s) of organization in poly-cultivar agriculture (e.g., Boster 1985:317).

The contrasting rationales for cultivar selection in potatoes and maize further divide the management practices distinguishing their cultivation in the Central Andes. In the subsistence maize crop, direct selection is carried out to meet preferences for production and consumption traits. The maintenance of most diverse potatoes through selection for perceptual distinctiveness, however, is clearly not motivated in the same way. Peasant farmers do not individually select the majority of potato cultivars. Indeed, the cultural significance of potato cultivars appears to be more general and symbolic than individual and ecological. The greater role of a symbolic logic in potato than in maize cultivation might stem from the much lengthier and richer legacy of the former in Andean prehistory (Murra 1960). It is reflected especially by cultivar naming, which draws heavily on images from the high-elevation grassland, the landscape source of abundant icons that local inhabitants spin into their webs of group identity.

Cultural meanings infusing diverse cultivars of potatoes as well as maize need to be counted among the reasons for the *in situ* conservation of crop diversity. Although recent research has focused attention on the urgent need to conserve native crop cultivars as biological resources (e.g., National Academy of Sciences 1972), and to maintain then *in situ* without hindering development or the loss of local control (Altieri and Merrick 1987, Brush 1989), the value of permitting continued development of symbolic landscapes has received little attention. The symbolism of diverse cultivars represent one aspect of "being Quechua" in contemporary highland life. In essence biological icons, native crops constitute important cultural resources for dominated Andean highlanders as they view themselves in relation to the non-Quechua and work towards constructing alternative and more just social relations.

ACKNOWLEDGEMENTS

Fieldwork for this study was completed between March 1986 and August 1987 with the support of dissertation grants from the Fulbright Foundation, the National Science Foundation, and the Joint Committee on Latin American Studies of the Social Science Research Council and American Council of Learned Societies with funds provided by the Andrew W. Mellon Foundation. The initial research (March-June 1986) was undertaken while I was employed as Field Supervisor for the "Changes in Andean Agriculture" project of Drs. Stephen B. Brush and Enrique Mayer. I am appreciative of their support and encouragement for this project. I also am indebted to field assistants Cornelio Cusi, Ing. Leonidas Conchas, Ing. Edgar Gudiel, and Claudio Palamino and to the many Paucartambo inhabitants who cooperated in this study. Bruce Winterhalder provided helpful comments on a draft of this paper as did reviewer Jim Baumel. Full responsibility, of course, rests with the author.

LITERATURE CITED

ALLEN, CATHERINE J. 1988. The hold life has: Coca and cultural identity in an Andean community. Smithsonian Institution Press, Washington, D.C.

ALTIERI, MIGUEL A., DEBORAH K. LETOURNEAU, and JAMES R. DAVIS. 1983. Developing sustainable agroecosystems. BioScience 33(1):45-50.

ALTIERI, MIGUEL A., and LAURA C. MERRICK. 1987. *In situ* conservation of crop genetic resources through maintenance of traditional farming systems. Economic Botany 41(1):86-96.

BARBOUR, MICHAEL G., JACK H. BURK and WANNA D. PITTS. 1980. Terrestial plant ecology. The Benjamin/Cummings Publishing Co., Menlo Park, California.

BECKERMAN, STEPHEN. 1983. Does the swidden ape the jungle? Human Ecology 11(1):1-11.

BERLIN, BRENT, DENNIS E. BREEDLOVE, and PETER H. RAVEN. 1973. General principles of classification and nomenclature in folk biology. American Anthropologist 75(1):214-242.

___________. 1974. Principles of Tzeltal plant classification. Academic Press, New York.

BINSWANGER, HANS P., and DONALD A. SILLERS. 1984. Risk aversion and credit constraints in farmers' decision-making: A reinterpretation. Journal of Development Studies 5-21.

BIRD, ROBERT MCKELVY. 1971. Maize and its cultural and natural environment in the sierra of Huanuco, Peru. Ph.D. dissertation, University of California, Berkeley.

BOSTER, JAMES SHILTS. 1985. Selection for perceptual distinctiveness: Evidence from Aguaruna cultivars of *Manihot esculenta*. Economic Botany 39(3):310-325.

BRUSH, STEPHEN B. 1976. Man's use of an Andean ecosystem. Human Ecology 4(2):147-166.

___________. 1980. Potato taxonomies in Andean agriculture. Pp. 37-47 *in* D.W. Brokensha, D.M. Warren, and O. Werner (eds.). Indigenous Knowledge Systems and Development. The University Press of America, New York.

___________. 1989. Rethinking crop genetic resource conservation. Conservation Biology 3(1):1-11.

BRUSH, STEPHEN B., HEATH J. CARNEY and ZOSIMO HUAMAN. 1981. Dynamics of Andean Potato Agriculture. Economic Botany 35(1):70-88.

BRUSH, STEPHEN B., and DAVID W. GUILLET. 1985. Small-scale agro-pastoral production in the Central Andes. Mountain Research and Development 5(1): 19-30.

CLAWSON, DAVID L. 1985. Harvest security and intraspecific diversity in traditional tropical agriculture. Economic Botany 39(1):56-67.

ELLEN, R.F. 1986. Ethnobiology, cognition, and structure of prehension: Some general theoretical notes. Journal of Ethnobiology 6(1):83-98.

GADE, DANIEL W. 1975. Plants, man and the land in the Vilcanota Valley of Peru. Dr. W. Junk B. V., The Hague.

GILMOUR, J.S.L., F.R. HORNE, E.L. LITTLE JR., F.A. STAFLEN, and R.H. RICHENS, EDS. 1969. International Code of Nomenclature of Cultivated Plants—1969. International Bureau for Plant Taxonomy and Nomenclature of the International Association for Plant Taxonomy. Utrecht, Netherlands.

GROBMAN, A., W. SALHUANA, and R. SEVILLA in cooperation with P.C. MANGELSDORF. 1961. Races of maize in Peru. National Academy of Sciences —National Research Council Publication 915, Washington, D.C.

HAMES, RAYMOND. 1983. Monoculture, polyculture, and polyvariety in tropical forest swidden cultivation. Human Ecology 11(1):13-34.

HARLAN, JACK R. 1975(a). Crops and man. American Society of Agronomy and Crop Science Society of America, Madison, Wisconsin.

LITERATURE CITED (continued)

___________. 1975(b). Our vanishing genetic resources. Science 188:618-621.
HARLAN, J.R., and J.M.J. DEWET. 1971. Toward a rational classification of cultivated plants. Taxon 20(4):509-517.
HAWKES, J.G. 1978. Biosystematics of the potato. Pp. 15-69 *in* P.M. Harris (ed.). The potato crop: The scientific basis for improvement. Chapman and Hall, London.
HAYS, TERENCE E. 1982. Utilitarian/adaptationist explanations of folk biological classification: Some cautionary notes. Journal of Ethnobiology 2(1):89-94.
HUNN, EUGENE. 1976. Toward a perceptual model of folk biological classification. American Ethnologist 3:508-524.
___________. 1982. The utilitarian factor in folk biological classification. American Anthropologist 84:830-847.
ILTIS, HUGH H. 1983. From teosinte to maize: The catastrophic sexual transmutation. Science 222:886-894.
JACKSON, M.T., J.G. HAWKES, and P.R. ROWE. 1980. An ethnobotanical field study of primitive potato varieties in Peru. Euphytica 29:107-113.
JOHANNESSEN, CARL L. 1966. The domestication process in trees reproduced by seed: The pejibaye palm in Costa Rica. Geographical Review 56(3): 363-387.
JOHANNESSEN, CARL L., MICHAEL R. WILSON and WILLIAM A. DAVENPORT. 1970. The domestication of maize: Process or event? Geographical Review 60(3):393-413.
LABARRE, WESTON. 1947. Potato taxonomy among the Aymara Indians of Bolivia. Acta Americana 5:83-103.
MAYER, ENRIQUE. 1979. Land use in the Andes: Ecology and agriculture in the Mantaro Valley of Peru with special reference to potatoes. Centro Internacional de la Papa, Social Science Unit, Lima.
___________. 1985. Production zones. Pp. 45-84 *in* S. Masuda, I. Shimada, and C. Morris (eds.). Andean ecology and civilization. University of Tokyo Press, Tokyo.
MEINIG, DONALD W. 1979. The interpretation of ordinary landscapes: Geographical essays. Oxford University Press, Oxford.
MURRA, JOHN V. 1960. Rite and crop in the Inca state. Pp. 393-407 *in* S. Diamond (ed.). Culture in history: Essays in honor of Paul Radin. Columbia University Press, New York.
NATIONAL ACADEMY OF SCIENCES. 1972. Genetic vulnerability of major crops. Washington, D.C.
PATRON, PABLO. 1902. La papa en el Peru primitivo. Boletin de la Sociedad Geografica de Lima 6:316-324.
ROUMASSET, J., J. BOUSSARD and S. SINGH, eds. 1979. Risk, uncertainty, and agricultural development. Agricultural Development Council, New York.
SAUER, CARL O. 1952. Agricultural origins and dispersals. The American Geographical Society, Washington, D.C.
VAVILOV, NICHOLI I. 1926. Studies on the origin of cultivated plants. Institute of Applied Botany and Plant Breeding, Leningrad.
WELLHAUSEN, E.J., A.O. FUENTES, and A. HERNANDEZ CORZO. 1957. Races of maize in Central America. National Academy of Sciences—National Research Council Publication 511, Washington, D.C.
YAMAMOTO, NORIO. 1985. The ecological complementarity of agro-pastoralism: Some comments. Pp. 85-99 *in* S. Masuda, I. Shimada, and C. Morris, Andean ecology and civilization. University of Tokyo Press, Tokyo.
ZEVALLOS, CARLOS W., WALTON C. GALINAT, DONALD W. LATHRAP, EARL R. LENG, JORGE G. MARCOS, and KATHLEEN M. KLUMPP. 1977. The San Pablo corn kernel and its

LITERATURE CITED (continued)

friends. Science 196:385-389.

ZIMMERER, KARL S. 1985. Agricultural inheritances: Peasant management of common bean *(Phaseolus vulgaris)* variation in Northern Peru. M.A. Thesis, University of California, Berkeley.

___________. 1988. Seeds of peasant subsistence: Agrarian structure, crop ecology, and Quechua agricultural knowledge in reference to the loss of biological diversity in the Southern Peruvian Andes. Ph.D. Dissertation, University of California, Berkeley.

___________. 1990. The regional biogeography of native potato cultivars in Highland Peru. Journal of Biogeography 18(2):165-178.

ZIMMERER, KARL S., and DAVID S. DOUCHES. n.d. Geographical approaches to native crop research and conservation: The partitioning of genetic diversity in Andean potatoes.

NOTES

[1]Present Address: Department of Geography, 384 Science Hall, 550 N. Park St., University of Wisconsin, Madison, WI 53706. This paper was submitted on January 3, 1990. It was accepted for publication on August 28, 1990.

[2]Although most "landscape" studies in human geography do not deal with the theme of peasant landscapes but rather address the construction of environments by dominant social groups, especially the built or architectural environment (see review by Meinig 1979), the perspective potentially integrates the material (agroecologic) and symbolic relations underpinning polycultivar agriculture.

[3]The present study does not focus on the "conditions of existence" that determine why diverse-cultivar systems of agriculture either persist or disappear. Although analysis of the "conditions of existence" enveloping polycultivar agriculture overlap with the question of field management, it mostly comprises the distinct theme of cultivar loss or so-called genetic erosion.

[4]Research in cultural and human ecology initially investigated polyspecific ("many-species") plantings but overlooked the prominence of polycultivar plantings until fairly recently (cf, Beckerman 1983, Hames 1983).

[5]The terms cultivar or land race refer to "variable, integrated, adapted populations" (Harlan 1975b: 618, also see Harlan and deWet 1971). The *International Code of Nomenclature of Cultivated Plants—1969* defines the term in the following way: "The international term *cultivar* denotes an assemblage of cultivated plants which is clearly distinguished by any characters (morphological, physiological, cytological, chemical, or others), and which, when reproduced (sexually or asexually), retains its distinguishing characters ... This term is derived from *culti*vated *var*iety, or their etymological equivalents in other languages" (Gilmour *et al.* 1969:12).

[6]The number of cultivated potato fields per household varies between one and 14 or more. Potato cultivation represents between one-half and two-thirds of annual agricultural production for most highland Paucartambo households.

[7]Mayer (1985) defines production zones as both land-use areas and as distinct agricultural systems.

[8]Tuber exchange has been found to be particularly important in determining regional distribution patterns of the cultivars as well as alleles of native potatoes (Zimmerer 1990, Zimmerer and Douches n.d.).

[9]Potato agriculture in the Central Peruvian highlands was found to contain the equivalent of three use-categories: bitter potatoes, native potatoes, and improved varieties (Brush *et al.* 1981:80).

[10]Other studies of native-potato agriculture in the Peruvian Andes reveal identical or similar categories (Brush 1980, Gade 1975, LaBarre 1947, Patron 1902).

[11]LaBarre (1947:85–86) also presaged the latter development of a formal folk taxonomic model, writing that "The Aymara potato taxonomy is based on the use of a descriptive word for the variety, with the addition of a modifying adjectival word (often a color-name) to distinguish sub-varieties."

[12]Paucartambo highlanders resemble other Andean agriculturalists (Brush *et al.* 1981:77, Gade 1975:205), in mainly using tuber characteristics to identify cultivars.

[13]The separate management of individual native potato cultivars within polycultivar fields is practiced by some agriculturalists residing in "extensive" (as opposed to "compact") communities that consist primarily of high-elevation grassland habitats. Although these potato growers manage several cultivars separately, at least half of their diverse stock is maintained in a fashion similar to that utilized by their counterparts occupying valley sites.

[14]Analogous patterns of intra-field cultivar diversity were noted by Brush and his colleagues (1981) in the highlands of Central Peru. Although oral histories collected in Paucartambo suggest that random plantings might represent the historic simplification of more time-consuming block arrangements, this evidence remains incomplete. As underscored by Hame's (1983:19) critique of previous assumptions that commercialization caused the ecological simplification of intercropping along the Venezuelan Orinoco, the reasoning of agricultural change requires historical substantiation.

[15]Tuber skin color could interfere with utility by undermining storage capacity. Light-skin tubers are more liable to begin photosynthesis in skin tissue and subsequently generate distasteful, and toxic, alkaloids (Brush *et al.* 1981:83). Paucartambo cultivators, however, do not weigh this criterion when choosing potatoes.

[16]Murra (1960) shows that the prestige attributed to maize by Central Andean people originated in the expansion and promotion of the crop by the Inca state. Maize production in highland Paucartambo is less commercialized than potatoes although specialty production of a cultivar bought by Cusco beer (***chicha***) manufacturers characterizes its economy in certain areas of the region.

[17]Each planting is named according to seed size, reflecting a loose-knit correspondence between seed size and the maturation period of maize cultivars. Hence, the early planting, which requires the longest to mature, is referred to as ***hatun muhu*** ("big seed"). The terms ***chaupi muhu*** and ***uch'uy muhu*** ("middle seed" and "small seed") are attached to the middle and early plantings, respectively.

[18]Each of these four groups also is used in the identification of maize in other Central Andean regions, such as the neighboring Vilcanota Valley (Gade 1975:112–119) and the highlands of Central Peru (Bird 1971:113).

[19]The great effort evident in separating and selecting maize seed highlights the considerable labor required for Quechua peasant cultivators, like smallholder agriculturalists of other Amerind ethnic groups (see, for example, Wellhausen *et al.* 1957 on Central America), to maintain diverse cultivars.

[20]Cultivators refer to the slightly advanced planting of the popcorn cultivar *(perlas)* as an "early planting" *(nawpaq tarpuy)* within the late crop. They sow this cultivar on infertile soils (locally *q'ara hallpa*). This is the sole case of microenvironmental siting in the management of the Paucartambo maize crop.

BOOK REVIEW

Thompson Ethnobotany: Knowledge and Usage of Plants by the Thompson Indians of British Columbia. Nancy J. Turner, Laurence C. Thompson, M. Terry Thompson, and Annie Z. York. 1990. Memoir No. 3, Royal British Columbia Museum, Victoria, B.C., Canada. 335 pp., illustrations, five appendices, index. $15.00 Canadian.

Thompson Ethnobotany is perhaps the most comprehensive ethnobotanical ethnography for native North America and the most detailed account of the ethnobotanical knowledge of any non-agricultural people. It is the result of a collaboration of more than 20 years among the authors, Nancy Turner, a botanist of outstanding anthropological sensitivity, Laurence and Terry Thompson, leading Salishan linguists, and Annie York, born in 1904, a native speaker of Thompson Salish, and a life-long resident of the Thompson homeland. To this winning combination must be added an additional collaborator, James Teit (mentored by Franz Boas), whose pioneering Thompson ethnobotanical research (conducted 1896–1918), enhance the time depth of this study by a full 90 years. It is significant to note, however, that only some 20 species are no longer recognized by contemporary elders.

The core of this book is the "Inventory of Plants Species Named and/or Used by the Thompsons," 224 pages annotating (and often illustrating with clear black and white photos) nearly 400 species of plants. These entries are listed alphabetically by scientific name within each major grouping, from algae and fungi through the flowering plants. Each entry includes Latin species and genus name, authority (with major synonyms), then a list of Thompson Salish Terms recorded for that species, with the initials of specific informants noted. Terms are interpreted linguistically and compared to other published versions of the native names. An encyclopedic summary of ethnobiological data follows. While a few entries—mostly for introduced plants—are brief (even plants that are not named are noted if they were recognized), other entries run to several pages, as for western red cedar, Douglas fir, yellow-avalanche lily, serviceberry, and Indian hemp.

The cultural significance of plants is broadly conceived, but organized in standard fashion under such headings as foods (120+ species), materials (115+ species) and medicines (200+ species). Species used as food are subgrouped as