Evolution of agricultural extension and information dissemination in Peru: An historical perspective focusing on potato-related pest control.

Oscar Ortiz[1]

[1]*Integrated Crop Management Division, International Potato Center, Lima, Peru*

Accepted for publication in Agriculture and Human Values 2006.

Abstract. Multiplicity and continual change characterize the Peruvian agricultural knowledge and information system (AKIS), reflecting changes in the agricultural sector as a whole. The evolution of these changes can be traced back to the pre-Columbian era when a relatively stable and well-organized system based on indigenous knowledge prevailed. During colonial (1532 to 1821) and early Republican times (beginning 1821) several changes affecting the agricultural sector contributed to a weakening of indigenous knowledge systems. During the 20th century extension services provided by the government and a variety of private organizations began to play an important role in the dissemination of information, albeit in an erratic way. Since the 1970s the system increased in complexity with the emergence of non-governmental institutions. Today government participation is limited and there is a more important participation by a number of NGOs and private organizations. This diversity of actors using different approaches has generated disarray in the information system owing to the lack of coherent policies to guide the interaction among actors. This paper uses the case of potato pest control-related information to illustrate changes in local knowledge systems. It differentiates pest control based on indigenous knowledge, chemical control, and integrated pest management (IPM) and explains how changes in the system have influenced the use of these three types of information in the AKIS. Currently, the coexistence of different types of potato pest control information promoted and used by diverse and usually unconnected sets of organizations and individuals presents a challenge and requires inter-institutional action guided by clear policies to promote sustainable agriculture.

Key words: Agricultural extension, Agricultural history, Agricultural knowledge and information systems (AKIS), Peru, Indigenous knowledge, Integrated pest management, Pest control, Potato

Abbreviations: AKIS – Agricultural knowledge and information systems;

Oscar Ortiz *is an agronomist who specializes in agricultural extension, knowledge systems, and participatory research. He holds an MSc degree in crop production and agricultural extension from the La Molina National Agrarian University of Peru and a PhD from the Agricultural Extension and Rural Development Department at the University of Reading, UK. He has worked for the National Agricultural Research Institute and Nestle Company in Peru and is currently Division Leader for Integrated Crop Management at the International Potato Center (CIP) in Lima. Since 2001 he has been a visiting lecturer at the Graduate School of the La Molina National Agrarian University of Peru. He is a member of the Latin American Potato Association and the International Society for Horticultural Science.*

Introduction

Currently, information about potato-related pest control in Peru is provided by a number of institutions with different approaches, the result of processes operating over time. In this paper an outline of the historical evolution of the agricultural sector in Peru, particularly as it relates to extension and research systems, is presented to contribute to an understanding of the evolution of agricultural knowledge and information systems (AKIS). The case of pest control in the potato crop is used as an example. The objectives of the paper are to analyze this evolution and reflect on the lessons learned for the future dissemination of sustainable technologies, especially pest control approaches such as integrated pest management (IPM).[1]

The paper utilizes results from a larger study that looked at the information system for IPM in subsistence potato production in Peru. The study analyzed the experience of introducing innovative information on potato pest control in communities of the northern highlands of Peru (Ortiz, 1997). Part of the study involved an historical analysis based on the review of available

secondary sources, which included not only books and journal articles, but also gray literature such as the internal reports of institutions. However, historical sources, particularly those from pre-Columbian and colonial times, do not refer specifically to agricultural extension or agricultural information dissemination, so in some cases reasonable speculations were made and are made explicit in the paper.

The framework for the present analysis is the theory of agricultural knowledge and information systems – AKIS (Röling, 1990; Engel, 1997). AKIS is defined as the set of individuals, groups, organizations, and institutions that generates, exchanges, and uses knowledge and information to solve specific problems. This concept includes research and extension services as important components of such systems. For its analysis, this paper focuses on knowledge and information related to pest control in the potato crop. Individuals and groups of people are constantly searching for information to solve problems, and the events that affect the interactions among people also affect information exchange and use. Theory is applied using an evolutionary approach to explain changes in the system over time. Figure 1 shows control based on indigenous knowledge, on chemical control, or on integrated pest management. It outlines the possible influence of different historic events on AKIS and particularly on the relative importance of each type of information as it relates to pest control in the potato crop. Evidence includes information from prehispanic times, the colonial period, and the Republican era in Peru. The analysis suggests that changes have been occurring continuously throughout history but that the speed of such changes substantially distinguishes one period from the other. For example, during the prehispanic era the AKIS system was relatively stable and in a process of strengthening in response to policies oriented toward promoting agricultural development within the Inca Empire.[2] The situation changed drastically during the colonial era with the clash of two different cultural systems, and AKIS entered a period of instability and weakening. During the Republican era changes started to accelerate (although along an erratic path) and, particularly during the second half of the 20th century, AKIS was characterized by an increase in the number of components, by complexity and by instability. The effect of the acceleration of changes on local or indigenous knowledge has been pointed out by Bebbington (1994). They note that local knowledge may not be enough to face new and changing conditions. Therefore, although the three types of information are differentiated in Figure 1 to facilitate our analysis, local knowledge about pest control in modern times is evolving dynamically and includes a

mixture of indigenous and external knowledge introduced in the last century (e.g., chemical control and IPM), which come from various sources. This paper focuses on the different events that have influenced the dynamic.

Figure 1. The evolution of the agricultural knowledge and information system related to pest control on the potato crop (AKIS-potato) in Peru.

Historical references do not include specific evidence of the exchange of agricultural information generally or of potato pest control in particular. Nonetheless, the Peruvian economy and society has been (and continues to be) largely agrarian, this flow of information doubtless included agricultural topics. The discussion that follows, particularly that focused on the prehispanic and colonial eras, extrapolates from available historical sources.

Agricultural knowledge and information exchange in prehispanic times

Andean agriculture in the prehispanic era represented and responded to the accumulated knowledge of local people over centuries. The domestication of plants and animals and their adaptation to a variety of microclimates was one of the great achievements of prehispanic Andean cultures, and potatoes stand out as one of the main examples (Moseley, 1992). Andean peoples developed special technologies and knowledge to adapt agriculture to the highlands and to feed a growing population. For example, they understood a great deal about the relationship among crops, soil quality, and weather. They fertilized their fields with guano and developed a complex infrastructure for irrigation (Rowe, 1963; Guamán Poma de Ayala, [1613] 1980; Cobo, [1653] 1990). Donkin (1979) and Zimmerer (1996) note that the Incas had an empire-wide agricultural policy in keeping with their policy of colonization. When the Incas conquered a new territory, they maintained local subsistence production but also required the production of crops such as maize, potatoes, quinoa, and kidney beans as contribution to the State. Therefore, a combination of agricultural knowledge and information exchange between the Incas and the local people was required to make the system work. An example of this is the highly sophisticated system of terraces built at the time. There also is evidence that local inhabitants

kept high biodiversity in their gardens for home consumption, while specialized agriculture was conducted to produce for the Inca Empire (Zimmerer, 1996).

It seems logical to assume that agricultural systems during Inca times would have incorporated some form of information dissemination, either formal or informal. First, children in Inca society were taught by parents within extended family groups called *ayllus*; and from an early age, received practical information from their parents about domestic and farming activities (Cobo, 1990). Second, the *amautas* and the *mitimaes* provided for more formal information dissemination service. The former were knowledgeable people who were in charge of teaching, especially the nobles, while the latter were sent out to train the populations of newly conquered territories. In this way, the Incas spread their language, norms, and technologies (De la Vega, 1966; Cobo, 1979; Salaman, 1985). Christiansen (1967) indicates that the potato was presumably spread from the centers of origin in the southern highlands of Peru to other places in the Inca territory through the mitimae system, but Salaman (1985) indicates that such spread probably occurred even before the Inca time through migrants. Cobo (1990) adds that for the Incas, farming activities were important social mechanisms for labor exchange and mutual support. Groups of people participated in a number of agricultural activities at different times throughout the growing season. This work, as Cobo notes, was "one of the main forms of recreation and festivals that they had" (1990:212). Hastorf (1993) agrees that sharing, exchange, or reciprocity (including information) are important cultural methods for survival still being observed in modern Andean societies.

Recent studies on the methods of pest control used in traditional, Andean farming communities suggest that one of the main practices for managing pests was crop rotation for up to seven years. This kind of rotation can still be found in some parts of the central and southern highlands of Peru where farming communities manage communal land under a "sectoral fallowing system"[3] (Hastorf, 1993; Zimmerer, 1991; Chávez, 2000). In addition, the use of raised fields, that can be observed in the southern Peruvian highlands today are technologies that help to reduce frost effects and control pests (Thurston, 1992). Recent studies indicate that the damage caused by the Andean potato weevil (mostly *Premnotrypes* spp.) is significantly reduced in raised beds, called *waru warus*, than in normal potato plots (Ichuta, 1997). Currently, traditional farming communities in the Andes also use different species of plants to repel potato insects during storage (for example, some native herbs such as *muña* or *Minthostachys* spp.) and

also lime and ash to protect tubers and early harvest to prevent insect damage (Proyecto Andino de Tecnologías Campesinas (Andean Project of Farmer Technologies) -PRATEC, 1988; Ewell et al., 1990; Thurston, 1992; Ortiz, 1997). It is not possible to confirm that all these practices were used in the prehispanic era but evidence cited in the literature indicates that the "sectoral fallowing systems," including a seven year rotation period and raised beds were widely used at that time (De la Vega, 1966; Horton, 1987; Burga and Manrique, 1990; Thurston, 1992). It is reasonable to assume that the Incas used these and other practices to keep potato pests under control and that they exchanged information about them through formal and informal means.

It can be inferred that the Inca agricultural information system was maintained informally within the family and through interfamily reciprocal relationships and more formally by specialists who carried out the State's political and economic objectives. The informal component has prevailed over time and is still one of the main mechanisms for information transmission in the current AKIS in the Andes (Salas, 1991).

Agricultural knowledge and information exchange in the colonial era

The colonial era began in 1532, when Spanish conquerors arrived in the Andes and lasted until 1821 Peru achieved independence. Because the main goal of the Spanish colonists, at least at the beginning of this period, was to profit from mining, there is no evidence that the Spanish colonial government established any kind of support system to help settlers enhance agricultural production. However, there is evidence that the colonial government was aware of the importance of agriculture for feeding the local population, which they saw as an important source of labor. The government implemented policies to ensure that Inca descendents, called "Indians" by the European conquerors, could subsist and pay taxes. To facilitate the latter, the population was resettled into *reducciones*, or concentrated settlements of native Andeans who had formerly lived in dispersed communities. These resettlements, in turn, caused a disruption of the previously existing communal management of land (Zimmerer, 1991). While the concentration of people also made cultural indoctrination more efficient (e.g., conversion to Catholicism), it may have inadvertently facilitated informal exchanges among local settlers.

According to the literature, Spanish colonists had to learn appropriate agricultural techniques from the local people in the early years of the conquest (Cobo, 1990). At the same time, it is likely that they also taught the local population how to manage new crops and new types of livestock. New agricultural information and technologies, therefore, were probably spread informally, much as they had been during Inca times. Burga and Manrique (1990) point out that during the first decades of Spanish conquest different production systems, crops, and livestock were in conflict, causing an upheaval in the flow of agricultural information. On the one hand, Andean peoples were suddenly faced with European crops, livestock, and management techniques. On the other hand, Spanish settlers faced a new and fragile environment with different crops and livestock and unknown weather conditions. The Andean peoples and their descendants were able to assimilate the new agricultural information and technology more effectively than the Spanish settlers. Introduced crops and livestock were quickly integrated into Andean production systems (Caballero, 1981). This suggests that local peoples then, as now, were continuously testing, adapting and inserting new components into their systems.

Despite these changes, the agricultural economy was transformed into a mining economy. According to Stern (1982) the colonial government introduced policies that required the local population to work in the mines or in other extractive industries. These people, called *mitayos*, were required to work for two to four months away from their communities, though most took their families with them. This compulsory labor meant an intense temporary migration and with it the migration of local knowledge.

Although mainly based on exploitative working relationships between landlords and the "Indians," the role of haciendas in the economy increased over time.[4] Scholars point out that in the late 1500s and during the 1600s, migration intensified and in some parts of the colony, compulsory work was replaced by contracts made by land owners to attract labor. In some cases, these contracts not only defined an exchange of work and money or products, but also contained clauses that enabled Indians to learn a trade, which could be considered a type of private extension service (Burga and Manrique, 1990; Zimmerer, 1991). In addition, with the growth of haciendas, many landlords invested in improved technologies to cope with growing demands (e.g., irrigation, livestock breeds, seed). This is the first evidence of the importance of the hacienda as a mechanism for introducing agricultural information, a role that would intensify during the Republican era (see the next section). Within the haciendas, Indian workers were

involved in subsistence, but they also were engaged in commercial activities. Following hacienda rules, they used inputs and technologies provided by their Spanish landlords. Having access to these two different production systems facilitated the exchange of agricultural information. Again, according to Stern (1982), information exchange was facilitated by the *yanaconas*[5]. Yanaconas had the skills to combine Andean and Spanish knowledge and became very useful to their landlords. They served as intermediaries of information, brokers for the local population.

A critical factor influencing the Andean AKIS was the dramatic loss of the native population due to disease. Burga and Manrique (1990) indicate that the native population may have gone from nine million to about six hundred thousand during the first century of the colonial period. This substantial loss of human life took with it much valuable knowledge and contributed to a weakening of the indigenous agricultural knowledge system in the Andes.

During this period, potato production in the highlands was oriented toward subsistence and local markets. There is no specific evidence in the historical literature to suggest that potato management changed substantially or that those who survived the changes were still using traditional techniques. However, changes in land tenure and farming systems began to affect sectoral fallowing systems and this started the imbalance between potatoes and insect pests that is still prevalent today. Evidence of this is provided by Chávez (2000) who studied traditional communities in Bolivia. He reports that when sectoral fallowing systems are used, damage caused by the Andean potato weevil to potato tubers is under 5%. When farmers do not use this system of rotation and manage small pieces of land individually damage reaches 45%.

In summary, the AKIS in the Andes during colonial times was characterized by dramatic changes that resulted in a substantial weakening of the indigenous knowledge system. The growth of haciendas while significant in economic terms, was also a mechanism for the introduction and exchange of agriculture-related information – a role that continued to expand during the first part of the Republican era.

Agricultural knowledge and information exchange in the Republican era

The role of haciendas in providing agricultural information

The Republican era started in 1821 and, while it brought about political changes, it did not significantly change Peruvian agriculture. Haciendas continued to be powerful production units, providing food for both rural and urban areas. During the first fifty years of this era, agriculture remained stagnant. Then, during the second half of the 19th century, a growing European demand for agricultural products stimulated an interest in and the introduction of new technologies. As a result, Peruvian crops such as sugar cane and cotton, which had been cultivated since colonial times, were promoted more intensively for export, and supporting information and technologies were adopted. This was the result of private efforts led by hacienda owners, mainly in the coastal region (Thorp and Bertram, 1988). However, there is no evidence to suggest that these changes accelerated or otherwise changed the flow of information related to traditional crops, such as potatoes, produced mostly in the highlands for local and regional markets.

Nevertheless, during the Republican era some factors did favor an increase in insect pest populations. Big haciendas used the best land for more profitable crops and livestock, and the areas dedicated to potato production were under increasing pressure to intensify. This is a possible reason why the Andean potato weevil became an endemic pest in the highlands, particularly in areas where the sectoral fallowing system was replaced by the individual management of small plots (Chávez, 2000).

In the first decades of the 20th century, the hacienda system was strongly criticized because of the unjust and exploitative relationships it maintained between landlords and small tenant farmers, and because of their apparently stagnant production systems (Caballero, 1984). Taylor (1994), however, does not agree with the conclusion that haciendas in the highlands were stagnant farms. He maintains that they were the driving force for agricultural innovations at the beginning of the 20th century through the introduction of new breeds of livestock, new varieties of cereals and grasses, and new management techniques. Landlords, therefore, introduced new agricultural information and innovation to enhance the production efficiency and profitability of their haciendas. This happened on sugar cane haciendas on the coast where agricultural innovations (e.g., steam tractors) were introduced (Thorp and Bertram, 1988). It also occurred in the highlands, where some landlords experimented with new crop varieties and new breeds of livestock. Landlords, and small tenant farmers, therefore, had access to different sets of agricultural resources (including information). This caused significant differences in the yields

obtained by landlords and by small farmers. A hacienda, for example, could produce up to 25 t/ha of potatoes while a small farmer could produce only 5 t/ha. While some landlords began to consider the idea of implementing extension services within their own haciendas to provide new agricultural information to farmers, using methods such as talks, demonstrations plots, and model farms (Taylor, 1994), there is no evidence in the literature that such services were ever implemented.

The need to increase production within the haciendas influenced the establishment of sharecropping relationships in which small farmers provided labor and landlords provided land, seed, and oxen (Seifert, 1990). Taylor (1994) mentions the existence of mobile groups of landless farmers looking for opportunities to work on haciendas, a situation which helped them to observe and learn new technologies.

Sharecropping served as another form of informal information dissemination. Sharecropping persists today but with less intensity and serves mainly as a mechanism to access seed and agrochemicals (Godtland, 2001).

Haciendas played an important role in the introduction and exchange of agricultural information and technologies, particularly during the 19th century and first half of the 20th century when government interventions were not present yet.

Government interventions in the agricultural information system

Three stages can be identified in the evolution of government interventions. The first stage represents a period of origin of governmental agricultural institutions (1920s and 1930s). The second stage marks a period of stability and formalization of an agricultural extension and research system (between the 1940's and the 1960's). The third stage marks a period of instability and the weakening of governmental agricultural extension services after the agrarian reform in the late 1960's.

Period 1. Evidence of initial agricultural interventions is provided by Torres (1896), who mentions that the Peruvian government attempted to disseminate information and technologies through agricultural schools. For this purpose, Technical Schools for Arts and Trades (Escuelas Técnicas de Artes y Oficios) were created and included agricultural courses in their curriculum. In 1902, the National School of Agriculture and Veterinary (Escuela Nacional de Agricultura y

Veterinaria) was created (Olcese, 2002) and trained agronomists (Ingenieros Agrónomos) who worked in different government and private institutions throughout Peru. The school also conducted research. Olcese (2002) reports that during the early years of the last century the school introduced and evaluated methods to control potato late blight such as the use of Bordeaux mix with good results. This institution became the La Molina National Agrarian University of Peru (Universidad Nacional Agraria La Molina) in the 1960s.

During the first three decades of the 20th century, the Peruvian government decided to support agricultural production with the creation of the Office for Water and Agriculture (Dirección de Aguas y Agricultura). This later became the Ministry of Agriculture, which, while mainly oriented toward hacienda production systems, also created some agricultural research to promote the adoption of improved crop varieties and new breeds of animals (Seifert, 1990; Taylor, 1994).

Period 2. The period of stability and formalization with the creation of the Cooperative Food Production (SCIPA) (Servicio Cooperativo de Producción de Alimentos). This special project, established by the Peruvian government and the US Department of Agriculture (USDA), was designed to increase agricultural production and food self-sufficiency in Peru. The project continued until the early 1960s with external support and was complemented research services such as the Cooperative Agricultural Research Program (Programa Cooperativo de Experimentación Agrícola). The Peruvian government decided to continue providing this service until 1968 when agrarian reform was implemented in Peru (INIPA, 1986).

During this period (1943–1968), government interventions in agricultural research and extension contributed to the dissemination of information about new varieties, pesticides and fertilizers and machinery. For example, from 1930 to 1950, information and knowledge about the chemical control of potato pests began to be disseminated, and has been growing ever since, replacing traditional pest control practices and contributing to the dissemination of green revolution technologies (Franco, 1986; Cotlear 1989; Gligo, 1990).

Period 3. The period of weakening of government involvement in the disseminiation of agricultural information and technologies coincides with the agrarian reform beginning in 1968. This reform, implemented by the military, was seen as the solution to existing agricultural

problems. Its purpose was to change a highly inequitable land tenure system, and the government's agricultural institutions were restructured accordingly. Horton (1976) indicates that during the agrarian reform period the main function of the Ministry of Agriculture was estate expropriation and that technical assistance was severely reduced. Therefore, new land owners, formerly small farmers working on the haciendas, were organized into cooperatives. They were suddenly confronted with a new agricultural regime but with limited support from the government for accessing information about market competition or agricultural technologies.

In the early 1980s when a new democratic government was established, cooperatives were divided into small farms, which again passed into private hands. Private land ownership became the land tenure system in Peru in the 1990s (Burga and Manrique, 1990). Nevertheless, although the land tenure system had changed twice in less than 20 years, small farmers remained unassisted by the government. They had limited access to agricultural inputs, information and technologies in particular.

Throughout the 1980s and 1990s, government interventions in agriculture were erratic. The government's agricultural institutions were restructured in the early 1980s, and a new research and extension institute was created – the National Agricultural Institute for Research and Promotion (INIPA) (Instituto Nacional de Investigación y Promoción Agropecuaria). This Institute included both research and extension activities and established linkages with international agricultural research centers and US universities (Ganoza et al., 1990). A training and visiting (T&V) system was implemented between 1980 and 1985 with the support of the World Bank, its goal being to improve the dissemination of information and technologies. However, according to Ramírez (1991) this system was limited due to the lack of suitable agricultural technologies adapted to highly variable Andean agro-ecosystems. Despite these limitations, the T&V system introduced information on chemical control of potato pests to some parts of the Peruvian Andes. However, Franco (1986) argues that introducing external information and technologies was not the solution and that the needs of small farmers should have been included in the research. There were attempts to involve farmers in agricultural research in the 1980s. One of these was the approach called "farmer-back-to-farmer" developed by anthropologists at the International Potato Center (Rhoades and Booth 1982). But, despite a few attempts (e.g., the Potato Program of INIPA), this approach did not significantly affect institutionalized policy on a national level (Thiele et al., 2001).

Government's agricultural sector was again restructured in 1985, and the agricultural research institute became the National Institute of Agrarian Research (INIA) [Instituto Nacional de Investigación Agraria]. The extension service was housed in the Ministry of Agriculture, but did not have the necessary resources for training or supporting extension workers. Tapia (1996) notes that, between 1985 and 1990, the government created institutions and special projects to provide subsidize inputs, including pesticides (e.g., no interest loans through the Agrarian Bank of Peru). However, appropriate information did not accompany these subsidized inputs, which led to the indiscriminate use of agrochemicals particularly on the potato crop (Gomero, 1991).

The presence of the "Shining Path"[6] in highland Peru during the 1980s, also contributed to the reduction of extension programs in Peru. Many government and non-government extension workers had left farming communities because of the risk (Burga and Manrique, 1990), and this contributed to a weakening of the agricultural information systems at that time.

In the late 1980s, a severe crisis in the Peruvian economy caused a lack of financial resources for government intervention in agriculture. In response, INIA initiated a media project called Communication for Technology Transfer (CTTA) (Comunicación para Transferencia de Tecnología) to disseminate agricultural technology and information. Despite its success in promoting soil analysis for making decisions about fertilization or correct soil preparation for planting potatoes (Mata, 1992), the scope of this project was limited to a few places in Peru and was not replicated after 1999.

In the early 1990's, as Bebbington et al. (1993) note, the trend towards privatization began in Peru. The government structural adjustment on the Peruvian economy caused a drastic reduction in the formal agricultural sector. During the 1990s the agricultural policy in Peru addressed the reduction of subsidies, the promotion of free market relationships, and the participation of the private sector in research and provision of information. The role of the state, therefore, was reduced to providing only basic services such as certain types of agricultural information (e.g., prices) to support farmers' decision making.

In summary, during the last century the government's role in providing agricultural information has been erratic. It has gone from assuming a strong position in the 1950s and 1960s to a rather weak one in the 1990s. Nonetheless, the government has played a crucial role in the introduction and use of new technologies, agrochemicals especially, on the potato crop in the Andes. By 2004, the government was trying to rebuild the country's research and extension

system, but the trend has been to privatize services and cofinance investment. Government services have become reduced and new organizations (mostly private NGOs) have increased their importance as sources of information on agricultural technology. The erratic path the government has followed in promoting agricultural information since the middle of the past century demonstrates a lack of any long-term policy for agricultural development. Changes in the sector have responded more to political interest and external factors than to the real needs of the agricultural sector in Peru.

Special projects promoted by the government as a strategy to improve the provision of agricultural information

The introduction of agricultural information and technologies by international sources has been a governmental priority since the beginning of the 20th century and has grown more pronounced after 1950. For example, the Vicos project between the Peruvian government and Cornell University (USA) was implemented in 1951 to undertake social and agricultural research in Ancash, in the northern Peruvian highlands. It sought to introduce modern technologies like pesticides and fertilizers to improve potato production (Tapia, 1996). Some special projects, by contrast, have tried to develop technologies especially suited to highland agricultural systems. The High Andes Program (Programa de los Andes Altos) was one of these. Implemented between 1972 and 1979, it attempted to integrate indigenous and modern management practices, which included pest control. There have also been attempts to promote soil conservation (Vasquez, 1994) and private extension services (Chang-Navarro et al.,1995) through special projects, although with limited results.

Haudry de Soucy (1990) indicated that a total of 39 special projects were financed and implemented with support from international agencies such as the World Bank, Inter-American Development Bank, International Fund for Agricultural Development, United Nations Development Program and FAO between 1972 and 1984. These special projects, I would argue, lacked critical analyses and evaluations in terms of their contribution to agricultural development. In other words, the lessons learned were not documented and could not (and did not) contribute to the design and implementation of new and more efficient projects.

Private companies and NGOs as providers of agricultural information

Public extension is gradually becoming a private service in many countries (Ameur, 1994). However, in Peru there is evidence that private research and extension services promoted by the National Agrarian Association [Sociedad Nacional Agraria] have existed since the 1890's. This Association had a strong influence on the creation of the new national agricultural school in the early 20th century (Olcese, 2002), and also created an agricultural experimental station in 1927, which conducted research mainly on the high value crops cultivated on haciendas (e.g., cotton, sugar cane, coffee, cacao, and rubber). Later, the Association of Haciendas of Cañete also created and supported an experimental station on the central coast, which is still working with the support of the farmers of that area.

During the second half of the century particularly, several groups of private institutions began to play an important role as providers of agricultural information. The first group was, and for the moment still is, composed of agrochemical companies that have been very active in carrying out research and agricultural technologies. This group has made a crucial contribution in disseminating information about chemical pest control in general, including that related to the potato crop. The second group of private institutions includes the non-governmental organizations (NGOs) that became very active in the late 1970s. This group includes international and national NGOs such as CARE and the Proyecto Andino de Tecnologías Campesinas (Andean Project of Farmer Technologies)-PRATEC respectively. Paz and Puiggros (1985) mention a third group of private institutions involved in extension. These were several large cooperatives created as a result of the agrarian reform of the 1970s. The project Innovación and Competitividad en el Agro(Innovation and competitiveness in the agrarian sector)-INCAGRO (2002) indicates that during the 1990s some agroindustrial companies provided technical assistance to farmers who also shared the cost of the extension.

Carrol et al. (1991) and Bebbington et al. (1993) describe the evolution of NGOs in Peru, and state that religious, social, and political groups founded such organizations in the 1960s. Initially, these NGOs had political goals, but, through time, their approach changed from political and ideological to "more pragmatic and more concerned with providing concrete solutions to the problems of the poor in the 1980s" (Carrol et al., 1991: 98). The same authors mention that some

300 NGOs were created in the 1980s in Peru. In 1996, there were 614 NGOs registered at national level in the Peruvian Office of the Secretary of International Technical Cooperation [Secretaría de Cooperación Técnica Internacional] (SCTI, 1996). Most of these organizations were agriculture-related and worked in the Andean region of Peru. Short-term, locally-oriented activities have been common features in their interventions. Most NGOs disseminated information on pesticide use on the potato crop during the 1980s and 1990s.

The promotion of sustainable agriculture, however, raised new issues and challenges for NGOs, although few of them had a clear idea of how to achieve this goal. In the Andes, most NGOs working in agriculture worked with potatoes, initially promoting the use of external inputs (improved varieties and agrochemicals), and later working with IPM. Some IPM interventions contributed in a limited way by reducing pesticide use or optimizing production for potato farmers (Chiri et al., 1996). In addition, during the 1980s, there was a growing concern among NGOs regarding the importance of indigenous or local knowledge and they began to document local technologies, including pest control practices on the potato crop (PRATEC, 1988). These institutions sought "...to promote technologies grounded in indigenous knowledge" (Bebbington et al., 1993: 81), and to some extent helped to reduce its erosion. Franco (1986) also mentions the need to include research on farmers' perceptions, but criticizes some NGOs for their bias in favor of indigenous knowledge which began to be seen as the only solution for problems. This extreme position did not contribute to the reassessment of indigenous knowledge for solving real problems and, according to Salas (1991), limited the synergy between local, indigenous knowledge and external, technical knowledge, a synergy needed to strengthen AKIS in the Andes.

The approaches of NGOs have evolved from paternalistic, to technically-oriented interventions and, in recent years, to entrepreneurial approaches prioritizing access to markets. However, little attention has been given to the implications of these changes on the farmer's need for new information, knowledge, and technologies. For example, analyzing which technologies are needed to respond to specific market requirements is not the same as addressing subsistence production. Improved potato varieties required for the chip industry can serve as a case in point. Improved varieties require different agronomic management (i.e., spacing) to suite market standards than do local varieties.

A number of NGOs have worked on issues related to agricultural development in the Andean region. They have become an important source of agricultural information for farmers, but each has pursued its own objectives and used its own approaches. The existence of diverse extension approaches (Bebbington et al., 1993) has led to disarray as there is a lack of common, rural development policies to guide NGO activities (Ameur, 1994). The government has played only a limited role in helping these heterogeneous organizations work toward common principles.

The disarray mentioned above also applies to pest control within potato production. Here institutions have promoted different approaches, some of them based on chemical control, others on natural control or IPM, in some cases providing contradictory messages to the same group of farmers. Commercial pesticide companies have provided the only consistent (albeit incomplete and biased) information over the last few decades. This is one reason why pest control is still largely based on chemical use in the Andes (Crissman et al., 1994; Ortiz, 1997).

To summarize, private agrochemical companies and NGOs have played a key role as information providers in the AKIS, although with very limited guidance from the government. They have contributed to the introduction and use of information related to chemical control, IPM and to a lesser extent to traditional control practices for pest control in the potato crop.

Inter-institutional interactions for information exchange: Initial attempts to harmonize the system

The previous sections of the paper presented evidence of continuous changes in agricultural services to Peruvian farmers and demonstrated the complexity of the system. The number of information providers has increased in the last two decades, including governmental, non-governmental, and private organizations. Because of this complexity, some institutions have started to interact, although still in a limited way, with the goal of providing information to farmers more efficiently. This section will focus on IPM within the AKIS related to potato production.

The use of IPM on the potato crop in Peru began in the 1970s, when the International Potato Center (CIP) established its headquarters in Lima. In the early 1980s, CIP began to work on insect control and took up IPM-related research as one of its tasks, focusing particularly on insects of worldwide importance. In the late 1980s, the Andean potato weevil, an endemic potato

pest, was included as one of CIP's research priorities for the Andes. Both the National Agricultural Research Institute (INIA) and CIP established collaborative links and by the early 1990s this collaborative work began to pay off when IPM alternatives[7] for controlling the weevil started to be tested and disseminated in the southern highlands of Peru (CIP, 1995).

In the early 1990s IPM information for potato pest management was introduced to Andean communities, mainly through inter-institutional cooperation. The structural adjustment of the Peruvian economy and the reduction of governmental apparatus were the forces underlying the establishment of these inter-institutional relationships. Fano et al. (1996) describe the collaborative activities between the CIP and extension organizations as an alternative way to facilitate farmers' access to information and technologies. Since 1992, CIP has established several contacts with NGOs in order to disseminate its research results to potato growers, usually resource-poor farmers in the Peruvian Andes. For example, a collaborative project was implemented between CARE-Peru and CIP in order to train farmers in IPM (Chiri et al., 1996; Ortiz, 1997). However, this effort gave priority to the technical aspects of IPM, and paid little attention to the use of participatory methods for training farmers. In other words, extension workers tried to teach IPM using methods that they had used in the past for promoting chemical pest control. Both extension workers and researchers realized that new methods were needed and in 1997, CARE-Peru and CIP initiated the testing and dissemination of participatory research and training approaches based on the farmer field school experience (FFS) (Nelson et al., 2001). FFS was shown to be an effective way to enhance information exchange, learning, and the adoption of IPM (Godtland et al., 2004; Ortiz et al., 2004). The CIP and CARE partnership was the starting point for a special project coordinated by FAO and the Peruvian Government to use FFS for IPM training on a wider scale. This experience showed that it is possible to disseminate IPM information using this method, but that efficient organizational and inter-institutional cooperation is needed to ensure suitable training content and logistic support (Groeneweg et al., 2004).

While IPM-related information has been disseminated in Peru through many institutions and approaches since 1992, it still has not been widely adopted by potato growers in the Peruvian highlands. Some of the reasons relate to the fact that, as mentioned earlier, most of the efforts have focused on the technical components of IPM, and not enough effort has been devoted to the design and evaluation of more efficient vehicles for delivering this type of information and

knowledge, particularly through inter-institutional interventions (Ortiz, 1997). On the other hand, the highly complex agricultural sector, and the diversity of information providers, particularly as they relate to potatoes, makes it difficult to coordinate a wider effort to promote IPM.

Current farmer knowledge regarding pest control in potatoes is the result of the coexistence and dynamic evolution of information based on indigenous knowledge, chemical use, and IPM. Each has been promoted by different institutions and sets of institutions over time. The relative importance of each type, particularly of chemical control and IPM, depends on the farmer's access to institutional sources of information (Fano et al., 1996). Chambers (1997) points out that society and nature are constantly changing. Farmers' knowledge affects these changes, but it is also the result of evolution. There is a need, then, to promote a synergy between indigenous and external knowledge (especially scientific knowledge) to generate locally-adapted alternatives that contribute to solving new problems (Quiroz, 1999). This synergy could be facilitated by more efficient inter-institutional interaction within the AKIS.

Concluding remarks

Peru's AKIS has evolved continually and sometimes erratically, especially in response to government, NGO, and donor policies. These changes have influenced the type and availability of information for pest control, potatoes serving as a case in point. In general, three main types of information and knowledge can be identified to explain pest control strategies on this crop: the first relates to indigenous knowledge, the second to chemical control, and the third to IPM.

Figure 1 outlines major eras and changes within Peru's history and their influences on the three types of information. During the prehispanic era, the system appears to have worked with relative stability and was growing stronger in response to clear policies from the Inca Empire. With the arrival of the Spanish, the type and amount of agricultural knowledge and information exchanged in the system varied, ultimately with a decrease in the importance of indigenous knowledge. During the colonial time, a number of political and structural changes tended to disrupt the knowledge system and to further reduce the importance of indigenous knowledge. During the first part of the Republican era, things did not change substantially, but during the 20th century, changes started to accelerate with the participation of a growing number

oforganizations related to agriculture. During the second half of the century, the information system evolved very rapidly, although following an erratic path. Each of these changes has influenced the introduction and dissemination of new types of agricultural information for the potato crop.

During the Republican era the government has played an important role in the creation and dissemination of agricultural information. Unfortunately, there has been a lack of a guiding policy, particularly during the last two decades when approaches related to sustainable agriculture first emerged. More recently, institutions have begun to interact and negotiate alliances related to potato pest management. Evidence suggests that inter-institutional cooperation will be the main form of intervention in the coming years, although institutions still have to learn how to interact and use their comparative advantages in a synergic way.

The challenge will be to promote a more efficient interaction among the diverse actors, particularly institutions, and to generate, disseminate, and use agricultural information and knowledge in a way that contributes to the dynamism of farmers' innovative processes.

Acknowledgements

I am grateful to Professor Maurice Rolls from the University of Reading, UK for his comments on the chapter of my PhD thesis that contributed to this paper, to Jesús Alcázar who assisted me with several references related to potato pest control, and also to the librarians of the National Agricultural Library [Biblioteca Agrícola Nacional] and of the International Potato Center who helped to locate historical references. Nevertheless, the views expressed here are my own.

Notes

1. Integrated pest management (IPM) involves the use of a range of pest-control alternatives, such as the use of natural enemies of pests, pest-resistant or tolerant varieties of crops, cultural practices, legal control, and the suitable use of insecticides, in order to reduce pest damage to acceptable levels in sustainable way (Smith et al., 1976)). Such combination of

control methods should have enough flexibility to be applied by farmers under many different agro-ecologic and socioeconomic conditions.

2. "Inca" refers to the rulers of Tawantinsuyo, also called the Inca Empire, which existed prior to the Spanish conquest in 1532.
3. "Sectoral fallowing system" is a crop rotation strategy through which an Andean farming community makes decisions about the use of communal land, identifying which areas should be cultivated in a given year and which should be under fallowing for sufficient period of time (usually about seven years) to allow soil fertility to recover and reduce risk of pests (Hastorf, 1993; Zimmerer, 1991).
4. Remy (1990) defines hacienda as a production unit organized by a private owner (i.e., a family or a religious congregation) that combines two basic resources – land and people – to obtain marketable agricultural surplus. Its main feature was land concentration.
5. Yanaconas were "Indian" workers who learned Spanish culture (language and customs) and technologies and were servants of Spanish landlords. They performed as intermediaries in the relationships between the Indian population and the landlords, and facilitated communication between the Spanish and Indian worlds.
6. The "shining path" was a terrorist group with radical communist ideas, which was very active in rural areas of Peru during the 1980s and early 1990s. They were opposed to any type of external intervention, including technological innovations, assassinated a number of staff members of agricultural institutions and destroyed infrastructure.
7. Alternatives to control the Andean potato weevil include elimination of volunteer plants, nocturnal hand-picking of adult weevils, turn-over of soil in infestation sources, use of sheets to pile potatoes during harvesting and sorting, harvest on time, use of chickens as larva predators, use of diffused light stores, trenches around stores or fields, biological control agents, and vegetative, chemical, or physical barriers (Alcazar et al., 1994).

References

Alcázar, J., W. Catalán, K. V. Raman, F. Cisneros, H. Torres, and O. Ortiz (1994). *Control integrado del gorgojo de los Andes (Integrated control of the Andean potato weevil)*. Lima, Peru: International Potato Center.

Ameur, C. (1994). *Agricultural Extension. A Step Beyond the Next Step*. World Bank Technical Paper No. 247. Washington DC: The World Bank.

Bebbington, A. (1994). "Farmers' federations and food systems: Organisation for enhancing rural livelihoods." In I. Scoones and J. Thompson (eds.), *Beyond Farmers First. Rural People's Knowledge, Agricultural Research and Extension Practice* (pp. 220–224). London, UK: Intermediate Technology Publications.

Bebbington, H., G. Thiele, P. Davies, M. Prayer, and H. Riveros (1993). *Non-governmental Organizations and the State in Latin America. Rethinking Roles in Sustainable Agricultural Development*. New York, New York: Routledge.

Burga, M. and N. Manrique (1990). "Rasgos fundamentales de la historia agraria peruana, siglos XVI-XX (Fundamental characteristics of the Peruvian agrarian history)." In A. Chirif, N. Manrique, and B. Quijandría (eds.), *Proceedings of SEPIA III. Perú: El problema agrario en debate (Peru: The agrarian problem in debate)* (pp. 23–61). Lima, Peru: Seminario Permanente de Investigaciones Agrarias and Centro de Estudios Rurales Bartolomé de las Casas (Permanent Seminar of Agrarian Research and Rural Study Center Bartolomé de las Casas).

Caballero, J. (1981). *Economía agraria de la sierra peruana antes de la reforma agraria de 1969 (Agricultural economy in the Peruvian highlands before the agrarian reform of 1969)*. Lima, Peru: Instituto de Estudios Peruanos (Institute of Peruvian Studies). IEP Ediciones.

Caballero, J. (1984). “Agriculture and the peasantry under industrialization pressures. Lessons from the Peruvian experience.” *Latin American Research Review* 19: 3–42.

Carrol T., D. Humphreys, and M. Scurrah (1991). “Grassroots support organizations in Peru.” *Development in Practice* 1: 97–108.

Chambers, R. (1997). *Whose Reality Counts? Putting the First Last*. London, UK: Intermediate Technology Publications.

Chang-Navarro, L., A. de los Ríos, E. Peralta, and R. Vergara (1995). “Experiencia del proyecto de fomento de la transferencia de tecnología en comunidades campesinas de la Sierra del Perú (Experience of the project of promotion of technology transfer in peasant communities in the Peruvian highlands).” In *Seminario regional sobre iniciativas y sistemas privados de transferencia de tecnología para el desarrollo rural (Regional seminar about initiatives of, and private systems for, technology transfer oriented to rural development)*. October 16 and 17. Lima, Peru: IICA.

Chavez, C. (2000). *Actividad migratoria y daño del Gorgojo (Premnotrypes spp.) en dos comunidades altiplánicas del Departamento de la Paz (Migratory activity and damage caused by the Andean potato weevil (Premnotrypes spp.) in two communities located in the Altiplano of la Paz Department)*. BSc dissertation [Ingeniero Agrónomo]. Universidad Técnica de Oruro. Facultad de Ciencias Agrícolas y Pecuarias (Technical University of Oruro. Faculty of Agricultural Sciences) – Oruro, Bolivia.

Chiri, A., H. Fano, F. Cama, and W. Dale (1996). *Final Evaluation of the Integrated Pest Management for Andean Communities (MIP-Andes) Project*. Internal Report. Lima, Peru: CARE.

Christiansen, J. (1967). *El cultivo de la papa en el Perú (The potato crop in Peru)*. Lima, Peru: Editorial Jurídica S.A.

International Potato Center - CIP (1995). *Annual Report*. Lima, Peru: International Potato Center.

Cobo, B. (1979). *History of the Inca Empire* [1653]. (R. Hamilton, translator, editor.) Austin, Texas: University of Texas Press.

Cobo, B. (1990). *Inca Religion and Customs* [1653]. (R. Hamilton, translator, editor.) Austin, Texas: University of Texas Press.

Cotlear, D. (1989). *Desarrollo campesino en los Andes: cambio tecnológico y transformación* social *en las comunidades de la Sierra del Perú (Peasant development in the Andes: technological change and social transformation in Peruvian highland communities)*. Lima, Peru: IEP. Instituto de Estudios Peruanos (Institute of Peruvian Studies).

Crissman, C., D. C. Cole, and F. Carpio. 1994. "Pesticide use and farm worker health in Ecuadorian potato production." *American Journal of Agricultural Economics* (August): 593–597.

De la Vega, G. (1966). *Royal Commentaries of the Incas and General History of Peru* [1609–1617]. (H. Livermore, translator, editor.) Austin, Texas: University of Texas Press.

Donkin, R. A. (1979). *Agricultural Terracing in the Aboriginal New World*. Tucson, Arizona: University of Arizona Press.

Engel, P. (1997). *The Social Organization of Innovation. A Focus on Stakeholder Interaction*. Amsterdam, The Netherlands: Royal Tropical Institute.

Ewell, P., H. Fano, K. V. Raman, J. Alcázar, M. Palacios, and J. Carhuamaca (1990). *Farmer Management of Potato Insects in Peru*. Lima, Peru: International Potato Center.

Fano, H., O. Ortiz, and T. Walker (1996). “Peru: Inter-institutional cooperation for IPM.” In L. A. Thrupp (ed.), *New Partnerships for Sustainable Agriculture* (pp. 85–98). Washington DC: World Resources Institute.

Franco, E. (1986). “Cambios tecnológicos en la agricultura (Technological change in agriculture). ” In Gómez, B. Revesz, E. Grillo, and R. Montoya (eds.), *Proceedings of SEPIA I Perú: El problema agrario en debate (Peru: Agrarian problem in debate)* (pp. 217–242). Lima, Peru: ITDG.

Ganoza, V., G. Norton, C. Pomareda, R. Evenson, and E. Walters (1990). “Evaluating agricultural research and extension in Peru.” In R. G. Echeverría (ed.), *Methods for Diagnosis Research Systems Constraints and Assessing the Impact of Agricultural Research. Vol. II, Assessing the Impact of Agricultural Research* (pp. 175–196). The Hague, The Netherlands: ISNAR.

Gligo, N. (1990). “Agricultural development systems in Latin America: A historical perspective.” In M. Altiery and S. Hecht (eds.), *Agroecology and Small Farm Development* (pp. 73-81). Boca Raton, Florida: CRC Press.

Godland, E. M. (2001). *Reducing Poverty in the Andes with Genetically Improved Potato Varieties: The Importance of Knowledge and Risk*. PhD dissertation. Agriculture and Resource Economics Department. University of California, Berkeley, California.

Godtland, E., E. Sadoulet, A. de Janvry, R. Murgai, and O. Ortiz (2004). “The impact of farmer-field-schools on knowledge and productivity: A study of potato farmers in the Peruvian Andes.” *Economic Development and Cultural Change* 53(1): 63–92.

Gomero, O. (1991). “Características del consumo de agroquímicos en el Perú (Characteristics of the use of agrochemicals in Peru).” In L. Gomero (ed.), *Agroquímicos problema nacional.*

Políticas y alternatives (Agrochemicals, national problem, policies and alternatives) (pp. 27–58). Lima, Peru: Instituto de Desarrollo y Medio Ambiente. Servicio Alemán de Cooperación Social-Técnica. Red de Acción en Agroquímicos y sus Alternativas (Institute for Development and Environment. German Service of Social and Technical Cooperation. Action Network on Alternatives to Agrochemicals).

Groeneweg, K., A. Versteeg, and J. Chavez-Tafur (2004). *Más nos han enseñado mucho hemos aprendido. El proyecto GCP/PER/036/NET Manejo integrado de plagas en los principales cultivos alimenticios en el Perú y el impacto logrado en los agricultures (The more you have taught us, the more we have learned. The project GCP/PER/036/NET on integrated pest management for the main food crops in Peru and the impact at farmer level).* Lima, Peru: FAO-Peru.

Guamán Poma de Ayala, A. (1980). *Nueva crónica y buen gobierno (New chronicle and good government)* [1613]. Lima, Peru: Instituto de Estudios Peruanos (Institute of Peruvian Studies).

Hastorf, C. A. (1993). *Agriculture and the Onset of Political Inequality before the Inka*. Cambridge, UK: Cambridge University Press.

Haudry de Soucy, R. (1990). "Proyectos de inversion en la Sierra y políticas de desarrollo rural (Investment projects in the highlands and rural development policies)." In A. Chirif, N. Manrique and B. Quijandría (eds.), *Proceedings of SEPIA III Perú: El problema agrario en debate (Peru: The agrarian problem in debate)* (pp. 253–272). Lima, Peru: Seminario Permanente de Investigaciones Agrarias and Centro de Estudios Rurales Bartolomé de las Casas (Permanent Seminar of Agrarian Research and Rural Study Center Bartolomé de las Casas).

Horton, D. (1976). *Haciendas and Cooperatives: A Study of State Organization, Land Reform and New Reform Enterprises in Peru*. PhD dissertation. Latin American Studies Program. Faculty of the Graduate School of Cornell University, Ithaca, New York.

Horton, D. (1987). *Potatoes: Production, Marketing and Programs for Developing Countries*. Boulder, Colorado: Westview Press.

Ichuta, A. (1997). *Comportamiento del gorgojo de los Andes (Premnotrypes* spp.*) en el cultivo de papa amarga en Waru Waru en diferentes edades en Puno (Behavior of the Andean potato weevil (Premnotrypes* spp.) o*n bitter Potato varieties in Waru Waru system of different ages in Puno*). BSc dissertation [Ingeniero Agrónomo]. Facultad de Ciencias Agrícolas. Universidad Nacional del Altiplano, Puno, Peru (Faculty of Agricultural Sciences. National University of Altiplano).

INCAGRO (2002). "Fondo de tecnología agraria (Agrarian technology fund)." *Boletín INCAGRO, Innovación y Competitividad para el Agro Peruano (INCAGRO Bulletin, Innovation and competitiveness for the Peruvian agriculture).* Year I, No 2. December 2002. Lima, Peru: Ministerio de Agricultura (Ministry of Agriculture).

INIPA (1986). *Lineamientos generales sobre el servicio de extensión agropecuaria 1986–1990* (*General guidelines about the agricultural extension service 1986-1990).* Lima, Peru: Instituto Nacional de Investigación y Promoción Agropecuaria (National Research Institute for Agriculture and Promotion).

Mata, J. (1992). *CTTA, un método para transferir tecnología a los agricultores: una guía para planificación e implementación. Proyecto de Comunicación para la Transferencia de Tecnología en Agricultura (CTTA, a method for technology transfer to farmers: a guideline*

for planning and implementing. Project of Communication for Technology Transfer in Agriculture). Washington DC: Academy for Educational Development.

Moseley, M. (1992). *The Incas and Their Ancestors: The Archaeology of Peru*. London, UK: Thames and Hudson Ltd.

Nelson, R., J. R. Orrego, O. Ortiz, M. Mundt, M. Fredrix, and N. Vien (2001). "Working with resource-poor farmers to manage plant diseases." *Plant Disease* 85(7): 684–695.

Olcese, O. (2002). *Enfrentando la adversidad, camino a la Gloria: 100 años de historia de la Universidad Nacional Agraria la Molina (Facing adversity, a road to glory: 100 years of history of the National Agrarian University La Molina)*. Lima, Peru: Universidad Nacional Agraria la Molina (National Agrarian University La Molina).

Ortiz, O. (1997). *The Information System for IPM in Subsistence Potato Production in Peru: Experience of Introducing Innovative Information in Cajamarca Province*. PhD dissertation. Department of Agricultural Extension and Rural Development. The University of Reading, Reading, UK.

Ortiz, O., K. A. Garret, J. J. Heath, R. Orrego, and R. Nelson (2004). "Management of potato late blight in the Peruvian Highlands: Evaluating the benefits of farmer field schools and farmer participatory research." *Plant Disease* 88(5): 565–571.

Paz, J. and J. Puiggros (1985). *Potencial y posibilidades de la investigación y extension agropecuaria privada (Potential and possibilities of private agricultural research and extension).* Manuscript. Biblioteca Agrícola Nacional (National Agrarian Library) Lima, Peru.

Proyecto Andino de Tecnologías Campesinas (Andean Project of Farmer Technologies) - PRATEC (1988). *Saber Campesino Andino. I Taller regional sur andino de tecnologías*

campesinas (Indigenous Andean knowledge. I workshop in the Southern highlands about farmer technologies). Lima, Peru: Proyecto Andino de Tecnologías Campesinas (Andean Project of Farmer Technologies).

Quiroz, C. (1999). "Local knowledge systems in Latin America. Current trends and contributions towards sustainable development." In. F. Pichon, J. Uquillas, and J. Frechione (eds.), *Traditional and Modern Natural Resource Management in Latin America* (pp. 212–232). Pittsburgh, Pennsylvania: University of Pittsburgh Press.

Ramírez, J. (1991). *Análisis de la aplicación del método Capacitación y Visita en la Agencia de Extensión de Huancané (Analysis of the use of the training and visit system in the extension agency of Huancane).* MSc dissertation. Escuela de Post Grado. Especialidad de Producción y Extensión Agrícola (Graduate School. Specialty of Crop Production and Agricultural Extension). Universidad Nacional Agraria La Molina (National Agrarian University La Molina). Lima, Peru.

Remy, M. (1990). "Historia agraria Cusqueña. Balance y perspectives (Cusco agrarian history. Balance and perspectives)." In A. Chirif, N. Manrique, and B. Quijandría (eds.), *Proceedings of SEPIA III Peru: El problema agraria en debate (SEPIA III Peru: The agrarian problem in debate)* (pp. 63–85). Centro de Estudios Rurales Andinos Bartolomé de las Casas, Seminario Permanente de Investigación Agraria (Andean Study Center Bartolomé de las Casas, Permanent Seminar of Agrarian Research). SEPIA, Lima, Peru.

Rhoades, B. and R. Booth (1982). "Farmer-back-to-farmer: A model for generating acceptable agricultural technology." *Agricultural Administration* 11: 127–137.

Röling, N. (1990). "The Agricultural research-technology transfer interfaces. A knowledge systems perspective. " In D. Kaimowits (ed.), *Making the Link. Agricultural Research and*

Technology Transfer in Developing Countries (pp. 1–41). Boulder, Colorado: Westview Press.

Rowe, J. H. (1963). “Inca culture at the time of the Spanish conquest.” In J. H. Steward (ed.), *Handbook of South American Indians* (pp. 183–330). New York, New York: Cooper Square Publishers.

Salaman, R. (1985). *The History and Social Influence of the Potato*. Cambridge, UK: Cambridge University Press.

Salas, M. A. (1991). Extension and indigenous knowledge systems in conflict: Strengthening the Andean Knowledge Systems in Peru. *Journal of Extension Systems* 7: 18–29.

Secretaría de Cooperación Técnica Internacional-SCTI (1996). “Cooperación internacional y ONGs (International cooperation and NGOs).” *El Comercio* (Lima), September 23, 1996: 6.

Seifert R. (1990). *Cajamarca: vía campesina y cuenca lechera (Cajamarca: the peasant way and dairy cattle production)*. Lima, Peru: CONCYTEC and Centro de Apoyo a la Producción Lechera en Cajamarca (Support Center for Dairy Cattle in Cajamarca).

Smith, R., J. L. Apple, and D. G. Bottrell. 1976. “The origins of integrated pest management concepts for agricultural crops” In J. L. Apple and R. I Smith (eds.) Integrated Pest Management. New York, USA: Plenium Press.

Stern, S. J. (1982). *Los pueblos indígenas del Perú y el desafío de la conquista española: Huamanga hasta 1640 (The indigenous people of Peru and the challenge of Spanish conquest: Huamanga until 1640)*. Madrid, Spain: Alianza Editorial.

Tapia, M. (1996). *Ecodesarrollo en los Andes Altos (Eco-development the high Andes).* Lima, Peru: Fundación Friedrich Ebert.

Taylor, L. (1994). *Estructuras agrarias y cambios sociales en Cajamarca, siglos XIX-XX (Agrarian structures and social change in Cajamarca, XIX-XX centuries).* Cajamarca, Peru and Liverpool, UK: Institute of Latin American Studies and University of Liverpool.

Thiele, G., E. van de Fliert, and D. Campilan (2001). "What happened to participatory research at the International Potato Center?" *Agriculture and Human Values* 18(4): 429–446

Thorp, R. and G. Bertram (1988). *Peru: 1890-1977. Crecimiento y políticas en una economía abierta (Peru: 1890–1977. Growth and policies in an open economy).* Lima, Peru: Friedrich Ebert Foundation, Universidad del Pacífico (El Pacifico University), Mosca Azul Editores.

Thurston, D. (1992). *Sustainable Practices for Plant Disease Management in Traditional Farming Systems.* Boulder, Colorado: Westview Press.

Torres, J. L. (1896). *Cartilla de Agricultura del Perú (Agricultural Guideline of Peru).* Lima, Peru: Imprenta El Comercio.

Vásquez, A. (1994). *Reforma del estado y política agraria. Logros y perspectives (State reform and agrarian policies. Achievements and perspectives).* Lima, Peru: Ministerio de Agricultura (Ministry of Agriculture).

Zimmerer, K. (1991). "Agricultura de barbecho sectorizado en las Alturas de Paucartambo: luchas sobre la ecología del espacio productivo durante los siglos XVI y XX (Sectoral fallowing system in the high Andes of Paucartambo: encounters of ecology and productive space between XVI and XX Centuries)." *Allpanchis* 23: 189–226.

Zimmerer, K. (1996). *Changing Fortunes: Biodiversity and Peasant Livelihood in the Peruvian Andes*. Berkley, California: University of California Press.

Address for correspondence: Oscar Ortiz, Division Leader, Integrated Crop Management, International Potato Center, Apartado 1558, Lima 12, Peru
Phone: 51-1-3496017; Fax: 51-1-3175326;
E-mail: o.ortiz@cgiar.org