Skill Acquisition in “High Tech” Export Agriculture:  
A Case Study of Lifelong Learning, Using the Example of Peru’s Asparagus Industry

by

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To achieve sustained economic development, countries and regions need the knowledge capacity to adopt new technologies and train their labor force to use them. In the context of today’s global economy, with its economic competition, mobility of capital, and greatly expanded information and communication on a global scale, this presents an unprecedented opportunity and challenge for many countries in Latin America.

The private sector is the main engine of economic growth in Latin America, and private firms are the main adapters and adopters of new technology. They decide how and where to invest in new products and new markets. Yet the public sector also has an important role to play, primarily in investing wisely in the physical and human capital infrastructure to support such new possibilities, investing in basic research in new technologies, and in helping to expand market and trade opportunities for private entrepreneurs. Latin American states can therefore improve their private sectors’ chances of seizing new knowledge-based economic opportunities. A major way states can do so is to provide opportunities for individuals to develop general skills that make them more trainable on the job and specific skills that contribute to higher productivity in specific occupations. In this general framework, the notion of lifelong learning suggests that these opportunities are not restricted to younger age groups, but are made available throughout a person’s life.

In this study, we examine how new skills are acquired in a rapidly growing new production sector in Latin America—high-value export agriculture—and the implications of such skill acquisition for lifelong learning policies. High-value export agriculture is an important element in the transformation of Latin America’s economic growth strategy from import-substitution industrialization to competing in a global economy. This type of agricultural production shares with “high tech” industrial production a focus on innovation, skilled labor intensity and local conditions that favor price competitiveness.

¹ The authors would like to thank the Minister of Agriculture, the staff of the Ministry of Agriculture, especially Delia Ezeta and Miguel Alayza, the Instituto Peruano del Espárrago, especially Beatriz Tubino, and all the growers and educators we interviewed.
Countries such as Chile have been especially aggressive in moving into high value agricultural and aqua-cultural exports such as cut flowers, wine, and cultivated salmon. Colombia, Ecuador, and Costa Rica produce cut flowers for U.S., and European markets. Mexico has long produced fruits and vegetables for the U.S. market—now it has expanded these exports and introduced new products requiring more sophisticated techniques. High value agricultural exports not only require a relatively high level of skills in producing the raw output, but also require skills in bringing these products to market quickly and in such a way that maintains high quality. With new information technology, it is possible for Latin American countries to become major players in distant markets. But this requires the capacity to take advantage of such opportunities.

A good example of the new export agriculture is asparagus cultivation in Peru. Peru is blessed with advantageous climatic and soil conditions for vegetable and fruit production. Yet, given these climatic and soil conditions, asparagus production is still complex. It requires skills in combining irrigation, fertilization, and pest control in a way that increases yields at a competitive price. Shipping the product fresh, or processing it to meet international quality standards, and finding new markets for asparagus also require developed country level skills. Despite this complexity and the skills it requires to compete internationally, Peruvian asparagus production increased enormously in the past 20 years.

We argue in this essay that much of the specific skill development for export agriculture in Peru takes place in production settings and is provided by private industry on the job. Thus, most lifelong learning in the case of the new agriculture has come from private initiative rather than from public institutions responding to new needs. However, those who are most likely to receive such private training have relatively high levels of (mainly public) formal education. Small farmers who have learned or are learning how to produce asparagus to sell to processing plants also seem to have relatively high levels of education. Even many of those working in asparagus processing plants doing what can only be described as highly repetitive tasks at low wages, have completed secondary schooling. Only asparagus pickers, usually migrant workers from the Sierra, have lower levels of formal schooling. Furthermore, export agriculture, at least in Peru, has benefited from a pool of highly trained agricultural engineers educated in one key public institution, the University of La Molina. This agricultural research university is not only the source of many young, skilled specialists, but also of basic research on growing fruits and vegetables in Peruvian conditions. La Molina scientists also conduct research in pest and disease control and help processors solve problems in meeting international standards for agricultural exports.

We studied lifelong learning in Peru’s asparagus industry by conducting interviews with agro-industrialists, managers, engineers, workers, small farmers, and educators over a two-week period in December, 2002 and January, 2003. In the pages that follow, we describe the industry and how it grew, describe the main relevant aspects of Peruvian education, our method for studying lifelong learning in the sector, and the results of our interviews.
BACKGROUND

The Expansion of Asparagus Production in Peru

Historically, asparagus production in Peru has been part of an overall movement by agronomists to foster vegetable and fruit growing on the coastal plain—an area of sandy soil and varying (low) amounts of precipitation but with a year-long growing season. Peruvians themselves are not major consumers of these vegetables (for example, broccoli, artichokes, avocados, and asparagus), so that from the 1960s, when these efforts began (well before the meltdown of import-substitution industrialization), vegetable and fruit growing was already part of a strategy to foment agricultural export activity.

By 1980, there were already 7,000 hectares of white asparagus in the coastal valleys of the La Libertad region, six hundred kilometers north of Lima (around the city of Trujillo), in an area that was and still is Peru’s major sugar producer. The white asparagus produced there was processed and exported to European markets. In 1985, a major Spanish asparagus grower and processor moved from Spain to La Libertad. Prices and profits were high, and white asparagus cultivation began to increase rapidly. The area planted in La Libertad grew to 10,000 hectares in 1990 and 22,000 hectares in 2000. Productivity also increased with better fertilizing and irrigation.

The mid-1980s also saw the introduction into Peru of green asparagus into the areas of Ica and Cañete, about 200 kilometers south of Lima. Whereas the asparagus growing region in La Libertad is coastal desert, with irrigation coming from wells and water brought from the mountains by constructed aqueducts, Ica has rivers, some rainfall, and somewhat colder weather in the winter months. The green asparagus was introduced by a United States Agency for International Development project that brought Peruvian agronomists to California to study different varieties. The Ica region rapidly became one of the world’s largest producers of green asparagus.

Asparagus production in a non-temperate climate is complex. In Peru, growers plant asparagus in desert areas, where temperatures are never excessively high. Growers use irrigation to produce an asparagus crop in the same manner as in a temperate area, and even use the irrigation system (causing the leaves of the plant to die from lack of water rather than cold weather) to simulate lower temperatures needed by the asparagus plants to regenerate growth. This technique permits two or more crops per year and allows harvesting at any time of the year because of the near constancy of the climate, but it does require well-managed irrigation systems, including sophisticated pumps (many imported from Israel along with irrigation technology). Peru’s sandy soil also provides advantages because of its porosity, but that soil requires the right mixture of fertilizers, since it contains few of the nutrients needed to grow asparagus and other crops. In sum, Peru has many of the right natural conditions for asparagus production, but these natural conditions require the right “technology” to take full advantage of them.

Proper post-harvest handling is vital to ensuring asparagus quality on export markets and also requires a high degree of quality control. Asparagus needs to be kept at
low temperature once harvested, and needs to be shipped rapidly. Conserving asparagus in jars for export is yet another process requiring yet other skills. European and American standards for both fresh and conserved asparagus are high. So Peruvian exporters need the skills to meet these standards. Our interviewees told many stories of processors going out of business because of mistakes in quality control.

By 1994, Peru shared the title of world’s largest asparagus producer with the United States, each country harvesting about 100 thousand metric tons. Approximately 95 percent of total Peruvian production goes to export (both fresh and processed), making Peru the largest asparagus exporter in the world. Peruvian exports to the rest of the world grew from 10 million pounds in 1980 to 187 million pounds in 1996 and continued to expand until 2000, when it peaked at about 220 million pounds. Peru produces both green (preferred in the United States) and white (preferred in Europe) asparagus. Peru competes with Mexico as the largest source of imported asparagus to the U.S. In the mid-1990s Peru supplied 31 percent of all U.S. asparagus imports. Today, one in four pounds of asparagus consumed in the U.S. comes from Peru.

A Ministry of Agriculture census of the asparagus industry, taken in 1998 (near the height of the asparagus boom in Peru),\(^2\) shows a total of 2,134 asparagus farms in the country, about 54 percent in the provinces of La Libertad (main city, Trujillo), and another 13 percent in Ica. These farms employed more than 20,000 workers, almost one thousand of them professionals, and, of those, more than four hundred agricultural engineers (MINAG, 1998, tables 46 and 47). More than 70 percent of the industry’s employment is in La Libertad and Ica. Almost one-half of all employment as reported by the census is on large (more than 50 hectare) farms in those two provinces.

Thus, this important new source of foreign exchange involving a significant number of Peruvian agricultural, industrial, and service workers provides excellent material for a case study of how the skills needed to produce and distribute a high value agricultural crop were developed in a low/middle-income country such as Peru.

**Peru’s Educational Context**

Peru has a relatively highly developed education sector by Latin American standards. The net enrollment ratio in primary schools in 1980 was 87 percent and had risen to 95 percent in 1990 (UNESCO, 1993). Gross enrollment ratios in secondary education rose even more in the past 20 years, from 59 percent in 1980 to 67 percent in 1990 and over 70 percent in 1997 (UNESCO, 1993; World Bank, 2000). Although the repetition rate is high in secondary education, in the late 1990s, about 50 percent of secondary school age young people were enrolled in that level of schooling, close to the Chilean rate of net enrollment, which is one of the highest in Latin America. Similarly, Peru has one of the highest rates of gross enrollment in Latin America in tertiary education. The gross enrollment rate was about 30 percent and net enrollment, more than

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15 percent of the age group in the late 1990s (World Bank, 2000), again close to the levels in countries such as Chile and Uruguay, and much higher than in Mexico, all countries with higher GNP per capita than Peru.

Public spending on education dropped precipitously in the late 1980s but then rose again in the 1990s. Peru’s public spending on education has been historically low, reaching a high of only 3.7 percent of GDP in 1972, dropping to 2.2 percent in 1988, and rising back to 3 percent in 1997. Today it is about 3.2 percent. Since the 1990s were a period of rapid economic growth, this increase in educational spending relative to GDP translated into even more rapid absolute increases of funds going into education during the 1990s. According to the World Bank, spending per student in real (?) dollars increased on primary education from US$107 in 1990 to $201 in 1997, secondary, from $152 to $260, and university, from $282 in 1990 to $1,225 in 1997. Even so, this spending per pupil compared to GNP per capita remains lower than average in the Latin American context. A major explanation for the large increase in public spending per student at the university level in the 1990s is the declining enrolment in public universities and the resultant shift in enrollment from public to private universities (World Bank, 2000).

Thus, Peru has enrolled high proportions of young people in school, but spent relatively little on their education both as a fraction of GNP and in absolute terms. It is logical to conclude that a major explanation for Peru’s ability to expand educational access at such low cost is the result of relatively low teachers’ salaries, even though these salaries appeared to have increased relative to GNP per capita in the 1990s (World Bank, 2001), but not as rapidly as professionals’ salaries in the private sector (Saavedra, 2002). It is also true that third graders in Peru score lower than in most other Latin American countries (LLECE, 1999). We cannot make a causal connection between low spending per pupil and low test scores, but the fact is that Peru may spend relatively less public funds on education per student than, for example, Chile, but the quality of primary education (and presumably secondary) in Peru is also lower, at least according to student scores on and an international test conducted in 1997.

An important question for our study of the new agriculture is whether and how relatively low quality primary and secondary education influenced the amount of out-of-school training needed by workers moving into this expanding sector. Peru has a relatively high quantity of formal education in its workforce. Was educational quality a factor?

A similar issue emerges at the university level, except that the supply of new university graduates declined in the 1990s. One reason for enrolment in public universities declining in the 1990s could have been the crowded conditions, low professorial salaries, and resultant low quality of education in those universities in the early part of the decade. Even so, rates of return to university education remained high and even rose in the 1990s. According to a recent World Bank study, estimates based on household survey data suggest that private rates of return to university education rose in the 1990s, and rose relative to both rates of return to secondary and non-university
tertiary education (World Bank, 2001, Figure 24). By 1997, the private and public rates of return to university were higher than to both secondary and tertiary non-university for men and women, and higher than to primary rates of return to women (see Table 1). Thus the decline in university enrolment took place in an environment where rates of return were increasing.

Table 1. *Urban Peru: Rates of Return to Public Education, 1997* (percent per year of schooling at each level)

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private</td>
<td>Public</td>
</tr>
<tr>
<td>Primary education</td>
<td>5.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Secondary education</td>
<td>10.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Non-university tertiary</td>
<td>12.1</td>
<td>10.4</td>
</tr>
<tr>
<td>University education</td>
<td>13.9</td>
<td>12.4</td>
</tr>
</tbody>
</table>

Source: World Bank, 2000, Table 2

Although we are more interested in rural rates of return to education for this proposed study of the new agriculture, we can presume that the urban rates are an indicator of the payoffs in rural areas. The rates to primary education investment may be higher than in urban areas, but the hierarchy of returns at the secondary and tertiary levels is probably similar. The relatively low rates to secondary education suggest that there is a relatively large supply of secondary school graduates, and that there must be considerable pressure to continue on to higher education, driven by the higher rates of return to university graduates. Given that enrollment decreased in higher education in recent years, we speculate that in addition to problems of quality in many of the public universities, there are also capital constraints that prevent all those who would like to attend from investing in higher education.

What do these rates imply for recruitment of workers and professionals into asparagus production? They mainly suggest that workers would have relatively high levels of formal education in this sector. In part this should be the case because asparagus sector profits were relatively high in the 1990s, allowing the sector to attract the better educated. The data from the asparagus sector census (discussed below) indicates this trend. Indeed, as we shall show, a non-government organization, the CTTU, was able to find a steady stream of recruits from university (mostly non-completers) to train to be asparagus farmers in the Trujillo area.

The role of vocational education may also be important in understanding how the public sector has reacted to new opportunities in Peruvian agriculture. As in other Latin American countries, vocational education in Peru is in relative decline (Carnoy, 2002). If we assume that vocational education is mainly secondary education, the proportion of enrolment in vocational education declined from 12.7 percent of total secondary education in 1990 to 9.6 percent in 1997 (World Bank, 2001). This suggests that as secondary education expands in Peru, students shift into more general education. This may reflect lower rates of return to vocational education due to changes in labor market
demand, or possibly a decline in the quality of vocational education due to changes in government priorities. In our study of Mexican preparatory education (Ramsey et al., 2000), we found that despite increasing state priorities for technical education as a means of incorporating lower income groups into higher-level secondary education, general education was still expanding more rapidly.

In summary, Peru has a high proportion of pupils that complete primary and take at least some years of secondary education compared to most other Latin American countries. It appears that this expansion is driven in part by rising rates of return to successively higher levels of schooling. The lower rates to secondary education also reflect the fact that there is probably a relatively high supply of secondary school graduates compared to available opportunities in the labor force. The quality of this education, at least as measured by international test scores is relatively low compared to other Latin American countries. Thus, we would expect that the average levels of education in the asparagus industry may be higher than in agro-industry in many other countries. The combination of a relatively large supply of secondary educated labor, and perhaps the relatively low knowledge levels of primary school graduates, might induce employers to hire secondary school graduates for jobs held by primary school graduates in other countries.

It also appears that Peru has a relatively large supply of young people with at least some years of university education even though this number may have declined in the 1990s. As we will show, this creates a favorable situation for the asparagus industry, which requires a high proportion of professionals and relatively well-educated farmers to successfully solve production complex production problems and achieve high levels of productivity.

The Educational Context of the Asparagus Industry

The census of asparagus growers and the asparagus canning/jarring industry (Ministry of Agriculture, 1998) gives a detailed snapshot of growers’ education, the distribution of human capital across size of farm, and the nature of employment in the canning/jarring industry.

Less than 10 percent of the farms surveyed in 1998 were larger than 50 hectares, but they employed 76 percent of the full-time non-professional paid workers, 54 percent of the part-time non-professional workers, and 70 percent of the professional full time workers. Smaller farms were much more likely to hire part-time workers and employ fewer professional workers, although mid-size farms had a slightly higher ratio of professional to non-professional workers (ratio for the larger farms is 5 percent, and for mid-size farms, about 6 percent).

We do not have information on the education of these employees, but we do have data on the education of farm owners (productores individuales). Table 2 shows that the
the education of producer/owners rises with size of farm. Even among smaller farms, 35-
45 percent of the producers have secondary education or more. This suggests that
asparagus growing is a human capital-intensive form of agriculture in terms of those who
own and manage the farms. It is important to point out that many of these producers are
not the actual managers of the farm, and this is true of small as well as large farms,
although the percentage increases markedly for the very large farms (60 percent in that
case are not directly on the farm). Yet, from our interviews and observations in the
asparagus-growing regions, farm owners even of relatively large *fundos* are heavily
involved in innovations and decision-making regarding raising productivity, expanding or
contracting production, and solving week-to-week problems.

Table 2. *Peru: Individual Asparagus Producers, by Level of Education, 1998 (percent)*

<table>
<thead>
<tr>
<th>Farm size</th>
<th>Total Producers</th>
<th>No education (percent)</th>
<th>Primary (percent)</th>
<th>Secondary (percent)</th>
<th>Higher (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1,961</td>
<td>2.2</td>
<td>47.7</td>
<td>32.4</td>
<td>17.6</td>
</tr>
<tr>
<td>&lt;1.0 ha.</td>
<td>32</td>
<td>6.2</td>
<td>43.8</td>
<td>43.8</td>
<td>6.2</td>
</tr>
<tr>
<td>1.0-4.9 ha</td>
<td>815</td>
<td>2.4</td>
<td>60.7</td>
<td>29</td>
<td>7.8</td>
</tr>
<tr>
<td>5.0-9.9</td>
<td>611</td>
<td>2.8</td>
<td>49.8</td>
<td>39.6</td>
<td>7.8</td>
</tr>
<tr>
<td>10.0-49.9</td>
<td>421</td>
<td>1.2</td>
<td>29</td>
<td>32.8</td>
<td>37</td>
</tr>
<tr>
<td>&gt;50.0</td>
<td>82</td>
<td>0</td>
<td>1.2</td>
<td>7.3</td>
<td>91.5</td>
</tr>
</tbody>
</table>


The 1998 census also surveyed asparagus processing plants. Of the 37 plants
surveyed, 31 began production after 1990. Most workers in these plants (61 percent) are
part-time and most (72 percent) are women. The proportion of men and women who are
full time workers is similar; women actually have a slight edge, with 40 percent full time.

**The Universidad Nacional Agraria de La Molina**

It is not possible to understand the development of new agricultural products and
processes without taking account of the role played by the foremost agricultural
university in Peru, La Universidad Nacional Agraria de la Molina, located in Lima, and
known throughout the country simply as La Molina. La Molina was founded in 1902 with
the help of Belgian agronomists, but has, since the early 1960s, functioned on the model
of the large land grant universities in the United States, combining undergraduate and
graduate studies in one institution, with considerable agricultural research closely
associated with the development of new seeds and new methods, and linked to agro-
industry. In the late 1960s, La Molina also began research and training in food industries,
and recently, has begun to produce its own line of plant-based medicines. In the 1990s,
La Molina has also responded to increasing need in export industry to combat pests and
plant diseases by developing non-chemical responses and producing increasing numbers
of graduates who specialize in such methods. The university has three regional research
centers, one on the coast, one in the sierra, and one in the jungle. Peru’s three ecological
divisions. These centers have six thousand hectares of land used for experimental farming
where students receive practical training and the university’s scientists conduct their
research.

Thus, the La Molina graduate is research trained, and La Molina graduates
agronomists in a wide variety of fields. In addition, the university has close contacts with
agro-industry both through its graduates and through the consulting work done by its
faculty. The university also provides services to “the community,” which, according to its
brochure, includes consulting to companies, short refresher courses, technical and
professional “recycling,” training courses for secondary teachers, and courses that bring
biologists and laboratory technicians up to date on the latest methods.

In our interviews and visits to companies that grow and process asparagus, we
found a high percentage of CEOs and young agronomists working as managers who had
been trained at La Molina (four of the agricultural engineers and almost every CEO we
interviewed indicating they had graduated from La Molina—this number is surely an
underestimate because the question on university attended was not part of our survey).
The most impressive aspect of our conversations with these graduates was their
innovativeness and their practical approach to problem solving. We had the impression
that La Molina is to Peru’s agro-industry, particularly the more high-tech sectors of agro-
industry such as asparagus, as Stanford University is to Silicon Valley or M.I.T. to Route
128 in Boston. By turning out generations of technically oriented, research trained
agricultural engineers, La Molina provides the highly skilled human capital for the
production of new products and new techniques. In effect, many of the entrepreneurs of
the new agriculture were trained at La Molina. There they received the technical training
needed to start successful agro-industries competitive in world markets.

According to the Ministry’s census, about 100 of the farms surveyed reported
undertaking R&D activities. The census does not indicate the nature of these activities,
but our interviews suggest that they include experimenting with the viability of other
export crops and controlling plant diseases. About two-thirds of the farms surveyed as
doing R&D were in La Libertad and Ica, most—as we would expect—on large farms.
About one-half of the farms larger than 50 hectares in La Libertad were engaged in
research. In Ica, much of the research was being done with universities and individual
specialists, but in La Libertad, most was being done my non-governmental organizations
and individual specialists (MINAG, 1998, table 51).

The interviews with young agricultural engineers working in the asparagus
industry revealed other similarities with the innovation culture in other “high tech”
regions, such as Silicon Valley (see Saxenian, 1996). These engineers believed that they
were “an innovative elite” ready to start their own enterprises as soon as the opportunity
presented itself. They also shared information with each other and worked long hours—
they were passionate about their work, and this formed the central focus of their lives.
The next high profit agricultural export was just around the corner. One producer told us
that as soon as they solved the medfly problem in Peru, and this solution was imminent, citrus and avocado exports would quickly be the next agricultural boom.

La Molina graduates are not only central to understanding asparagus export production in Peru, they are also central to providing on-the-job training to others with less education. Indeed, much of the “lifelong learning” that fueled the asparagus boom was generated by the technical skills developed in La Molina agronomists and engineers.

In summary, asparagus growing is characterized by relatively high levels of farmer education, in part because the average level of education on the coast of Peru is high, and in part because asparagus growing pays well and requires technical skills to be successful. The industry is also managed by a well-educated group of engineer-entrepreneurs who went into asparagus production in response to rising prices in world markets. Many of these agricultural engineers had been trained at one university in Lima, La Molina, characterized by a strong research-based type of training, and seemingly carrying this research-based education into innovative approaches to asparagus production (and the production of other potential export crops). Since the asparagus census data did not identify education of non-farmers, we had to turn to our own survey to get information about employees of asparagus growers, processors and shippers.

THE STUDY

Methodology

To get a more accurate picture of the role of education and training in Peru’s asparagus industry, we studied the types of education and training taken by workers and management in the industry by conducting interviews with management and workers in Trujillo/Virú and Ica/Cañete, Peru, the two centers of the industry, and conducted interviews at Frio Aereo (Lima), the largest shipper of fresh asparagus. In our research, we attempted to document how workers and managers in this agro-industry acquired the skills they needed to work in their jobs. We covered the three main aspects of the industry: growing and harvesting the asparagus, conserving the asparagus for shipment as a processed food, and shipping fresh asparagus to foreign markets.

We hypothesized the following model to assess the provision of skill training in the industry:
Our questionnaires focused on how workers and managers of various ages received their training, the degree to which the training is conducted by the asparagus producing/exporting firms themselves (autonomous skill acquisition), and on the role of the Peruvian state in assisting the development of the industry through investments in education and training (general formal education and state response, respectively). We assessed whether the state’s training institutions (formal vocational education, for example) reacted over the past decade to the new opportunities offered by the growth of this industry by adjusting the kinds of training offered to school age youth.

In addition to individual managers and workers, we interviewed heads of companies, officials in the Ministry of Agriculture, Ministry of Education, university (both private and public) officials, officials in the Ministry of Labor, and we spent a day with an NGO that for the past ten years has been training university dropouts and small farmers to enter into asparagus cultivation. From the interviews, we analyzed the combination of formal education, training, and learning-by-doing that produced the knowledge base needed for the expansion of the industry. We were able to reconstruct the relative importance of general formal education (the public good base of general skill production), the role of autonomous skill acquisition (the private lifelong learning component of specific skill production), and the role of state response through specific vocational education and training (the public lifelong learning component of specific skill production).

Results

The Survey. During a two-week period in December, 2002 and January, 2003 we surveyed both non-professional- and professional-level workers at nine firms operating at various stages of the asparagus industry chain of production. Six of these firms are in Ica/Cañete, two are in the La Libertad region, and one, which receives, refrigerates, and ships fresh green asparagus to foreign markets, is located at the international airport in Lima. We also interviewed nine small farmers working with an NGO called El Centro de Transferencia de Tecnologia a Universitarios, or CTTU (see description below), in the La Libertad region. None of the samples was selected “randomly,” but those of managers and workers are probably representative. The sample of small farmers cannot be considered representative, since it is the product of interviewing farmers who underwent a particular training experience.

We administered two types of questionnaires: one for non-professionals (referred to as workers in tables below) and one for professionals (referred to as managers). The
manager questionnaire included the same questions that we asked workers, along with nine additional questions regarding the recruitment, hiring, and training of workers. We further divided these groups into those working in processing plants and in the fields. In total, we interviewed 33 plant workers, 20 field workers, 16 plant managers, 14 field managers, and 9 small farmers. In the tables below, we have divided plant workers into male and female to examine gender differences in various characteristics and attitudes. This was the only group in which women, who made up 60.6% of respondents, outnumbered men. In the remaining groups, there were not enough women to make meaningful comparisons (3 field workers, 3 plant managers, 1 field manager, and no small farmers).

Formal Education. Table 3 reports the education levels of each category of worker interviewed. Overall, levels of formal education are relatively high, with only four respondents (two female plant workers and two field workers) having less than complete primary education. Among plant workers, 92.4% of men and 65% of women had completed secondary education or higher. In fact, 24.2% of plant workers had completed some sort of higher education degree: among men, many of these workers had studied computing, while women had degrees in education or nursing (see Table 4). When asked why they had chosen to take jobs in asparagus plants, many of those who had completed higher education responded that they simply could not find good jobs in their chosen careers; for them, the asparagus industry represented a steady source of income in difficult economic times. One former nurse, who worked as a line supervisor in a processing plant near Ica, simply replied that she enjoyed working with asparagus more than nursing.

Table 3. Level of Education Completed among Asparagus Workers Surveyed

<table>
<thead>
<tr>
<th>Level of Education (%)</th>
<th>Plant Workers</th>
<th>Field Workers</th>
<th>Plant Managers</th>
<th>Field Managers</th>
<th>Small Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete Primary</td>
<td>0 5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Complete Primary</td>
<td>0 10</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Incomplete Secondary</td>
<td>7.7 20</td>
<td>50</td>
<td>0</td>
<td>7.1</td>
<td>33.3</td>
</tr>
<tr>
<td>Complete Secondary</td>
<td>46.2 25</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>22.2</td>
</tr>
<tr>
<td>Incomplete Tertiary</td>
<td>30.8 10</td>
<td>10</td>
<td>0</td>
<td>14.3</td>
<td>22.2</td>
</tr>
<tr>
<td>Complete Tertiary</td>
<td>15.4 30</td>
<td>5</td>
<td>100</td>
<td>78.6</td>
<td>22.2</td>
</tr>
</tbody>
</table>

Total # 13 20 20 16 14 9

In our sample, educational levels are lower for field workers than for plant workers: 75% of field workers reported having less than complete secondary education. In addition to having lower levels of education, these workers tend to be more migratory, traveling to follow harvests of different crops. As a result, several managers reported high turnover rates in key positions such as pre-harvest cutting of asparagus foliage and harvesting of asparagus shoots.
Regardless of whether they work in plants or fields, most of our respondents who had attended secondary school did so at an academic or general school, as opposed to a vocational/technical school. In fact, when asked what type of secondary school they had attended, many workers were not sure what a vocational/technical school was. A manager overhearing one interview remarked, “Unfortunately, that type of school doesn’t exist here.”

A clear educational barrier divides workers and managers in the Peruvian asparagus industry; in most cases, that barrier is a university degree in agronomy or engineering. All plant managers we interviewed had completed higher education; furthermore, 31.3% had studied agronomy and 50% had received non-agricultural engineering degrees. Among field managers, 92.9% had either incomplete or complete tertiary education and 71.4% had studied agronomy.

The small farmers we interviewed in the La Libertad region reported a variety of educational levels, but 66.6% had completed secondary education or higher. A third of these small farmers had studied either agronomy or engineering. Although this sample is quite small (9), these findings are in line with the results of the 1998 asparagus industry census discussed earlier, indicating that educational levels among managers and owners tend to increase with acreage.

Table 4. Subjects Studied in Secondary and Tertiary Institutions

<table>
<thead>
<tr>
<th>Subjects studied (% of total respondents)</th>
<th>Plant Workers</th>
<th>Field Workers</th>
<th>Plant* Managers</th>
<th>Field* Managers</th>
<th>Small Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocational/technical</td>
<td>15.4</td>
<td>10</td>
<td>5</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Academic/general</td>
<td>84.6</td>
<td>75</td>
<td>65</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>
Tertiary Subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>0</th>
<th>5</th>
<th>5</th>
<th>31.3</th>
<th>71.4</th>
<th>11.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture/agronomy</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>31.3</td>
<td>71.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Business/management</td>
<td>7.7</td>
<td>5</td>
<td>10</td>
<td>12.5</td>
<td>0</td>
<td>11.1</td>
</tr>
<tr>
<td>Computers/technology</td>
<td>38.5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Education/health</td>
<td>7.7</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Engineering (non-ag.)</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>50</td>
<td>7.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6.3</td>
<td>14</td>
<td>0</td>
</tr>
</tbody>
</table>

*Plant and field managers were not asked about secondary education*

**Training.** Most of the training in the firms we surveyed is performed by the private sector at sites of production and processing. When we asked workers where they had learned the most important skills for their jobs, 60.6% of plant workers identified their current firm and 12% indicated another firm (Table 5). Moreover, 80% of field workers reported “this firm” and 10% said another firm. Curiously, many professional workers—31.3% of plant managers and 21.4% of field managers—reported that they had learned their most important skills at home. These respondents usually identified personal traits such as responsibility, honesty, and punctuality as the most important skills for their jobs (Table 7).

Although plant and field managers were more likely than workers to attribute their training to technical schools and universities, these professional workers also reported high levels of on-the-job training. Based on our sample, it appears that managers in the field are more likely to acquire their skills on the job than plant managers. In the case of field managers, 64.3% reported that they had acquired their skills in their current firm or another firm, compared to 37.6% of plant managers. In contrast, 31.4% of plant managers reported acquiring their skills in a technical institute or university, compared to 14.2% of field managers. These results suggest that tertiary institutions may play a greater role in preparing managers on the processing side of the asparagus industry, whereas field-level work requires more crop-specific knowledge that is not taught in educational institutions.

The results of our survey underscore the dominant role of the firm in training workers (Table 5). Asked if their firms offered training programs, 84.8% of plant workers and 60% of field workers responded affirmatively. When asked what these programs consisted of, most workers described “charlas,” or talks, in which engineers periodically spend about an hour with workers going over workplace safety, hygiene, or new techniques. Most plant workers we interviewed had received an orientation charla in which they learned the basic operation of the plant floor, while field workers generally went straight to work and learned from their co-workers or supervisors. In contrast to the high percentages of workers reporting workplace training programs, only 18.2% of plant workers and 5% of field workers knew of any local public sector training programs. This suggests that most of the training is specific to the processes and production of the particular firm, although like on-the-job training elsewhere, this necessarily imparts general skills useful in other firms and other production processes.
Workers with less than secondary education were more likely to (1) report job-specific skills, like harvesting, cleaning, or measuring asparagus as the most important skills (rather than honesty, responsibility, etc.) and (2) all but 2 of the 25 said that they learned their skills on the job, mostly as a result of "charlas" by the engineers. Five of them also said that they learned from other workers. In contrast, the workers with secondary education or more were more likely to say they learned the most important skills at home or in school. They were also less likely to say they learned from other workers. The one field manager with less than secondary education did not vary much from other managers in his responses.

High percentages of managers reported the existence of firm-level training programs, but they were also more likely to identify programs offered by the public sector: 50% of plant managers and 42.9% of field managers reported some type of public sector training program. Plant managers in the La Libertad region identified the Ministry of Labor’s Pro-Joven program (discussed below) that offers apprenticeship training to plant workers, while field managers often mentioned the Ministry of Agriculture’s Servicio Nacional de Sanidad Agraria (SENASA) program (discussed below), which sends personnel to the fields to train workers in non-chemical methods of pest control.

Almost all of the content of charlas is generic, such as hygiene, safety, and basic operations. Managers are more likely to share pass-through knowledge when implementing changes in the production process, such as a processing plant that was experimenting by combining two separate production lines (one for sorting and the other for packing) into a single line. In contrast, the amount of pass-through knowledge that SENASA-trained field supervisors share with workers is probably (although we don’t have data to confirm this) much higher because both supervisors and workers on average know little about biological pest control and any on-the-job training in this area is likely to represent new knowledge for both.

Table 5. Training of Workers in Asparagus Industry

<table>
<thead>
<tr>
<th>Where were most important skills learned?*</th>
<th>Plant Workers</th>
<th>Field Workers</th>
<th>Plant Managers</th>
<th>Field Managers</th>
<th>Small Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>This firm</td>
<td>46.2</td>
<td>70</td>
<td>80</td>
<td>31.3</td>
<td>28.6</td>
</tr>
<tr>
<td>Another firm</td>
<td>0</td>
<td>20</td>
<td>10</td>
<td>6.3</td>
<td>35.7</td>
</tr>
<tr>
<td>Private technical school</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6.3</td>
<td>0</td>
</tr>
<tr>
<td>Public technical school</td>
<td>23.1</td>
<td>0</td>
<td>0</td>
<td>6.3</td>
<td>7.1</td>
</tr>
<tr>
<td>University</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>18.8</td>
<td>7.1</td>
</tr>
<tr>
<td>Home/family</td>
<td>30.8</td>
<td>10</td>
<td>5</td>
<td>31.3</td>
<td>21.4</td>
</tr>
<tr>
<td>Specialized training (% responding yes)</td>
<td>76.9</td>
<td>45</td>
<td>25</td>
<td>81.3</td>
<td>71.4</td>
</tr>
</tbody>
</table>
Experience. Considering the average age of most workers in the asparagus industry (Table 6), the time they have spent working in this sector tends to be relatively low. For example, although male plant workers average over 32 years of age, they have only spent 4.2 years on average working with asparagus. Women plant workers, who are roughly the same age as their male counterparts, have on average over two more years of experience in the asparagus industry. Field workers, who are younger as a group, have 5.5 years of experience, but only 3.4 in their current positions. In contrast, plant managers average almost 10 years of experience in working with asparagus, while field managers average almost 7 years. Our sample of small farmers reported an average of 3.5 years working in the asparagus industry, but over 10 years in their current positions. This reflects the group’s extensive experience as small farmers prior to becoming involved in the asparagus industry.

Table 6. Experience of Workers in Asparagus Industry (AI)

<table>
<thead>
<tr>
<th></th>
<th>Plant Workers</th>
<th>Field Workers</th>
<th>Plant Managers</th>
<th>Field Managers</th>
<th>Small Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Average age (std. dev.)</td>
<td>32.2 (7.9)</td>
<td>32.4 (9.1)</td>
<td>29.7 (8.1)</td>
<td>35.5 (7.0)</td>
<td>36.5 (6.3)</td>
</tr>
<tr>
<td>Average time in AI (std. dev.)</td>
<td>4.2 (2.9)</td>
<td>6.6 (4.7)</td>
<td>5.5 (5.4)</td>
<td>9.7 (5.2)</td>
<td>6.9 (3.2)</td>
</tr>
<tr>
<td>Average time in current position (std. Dev.)</td>
<td>2.9 (2.3)</td>
<td>4.9 (4.4)</td>
<td>3.4 (4.5)</td>
<td>3.8 (2.8)</td>
<td>3.7 (1.6)</td>
</tr>
<tr>
<td>How hired (%)</td>
<td>Friend</td>
<td>Family contact</td>
<td>Other contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.7 (15)</td>
<td>30.8 (10)</td>
<td>15.4 (10)</td>
<td></td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>20</td>
<td>5</td>
<td>6.3</td>
<td>42.9</td>
</tr>
</tbody>
</table>

*Question: “What are the most important skills for this job? Where did you learn these skills?”*
Direct application | 46.2 | 65 | 25 | 43.8 | 21.4 | 66.7
Internship | 0 | 0 | 0 | 12.5 | 14.3 | 0
Recruited | 0 | 0 | 0 | 12.5 | 0 | 0

 Previous job (%)

None | 0 | 5 | 10 | 6.3 | 0 | 33.3
Self-employed | 7.7 | 0 | 5 | 12.5 | 0 | 0
Agricultural | 7.7 | 40 | 50 | 37.5 | 57.1 | 33.3
Manufacturing | 7.7 | 5 | 5 | 18.8 | 0 | 22.2
Commercial | 53.8 | 25 | 10 | 18.8 | 0 | 0
Other | 23.1 | 25 | 20 | 6.3 | 42.9 | 11.1

Attitudes of Workers and Managers. One question in our survey asked workers what skills were most important in performing their jobs successfully (Table 7). Most of the workers in the plants and fields reported that job-specific skills, such as peeling or bunching asparagus in the plants, or harvesting asparagus shoots in the fields, were most important. Additionally, 88.9% of small farmers reported job-specific skills to be most important. In contrast, managers in both the fields and plants often emphasized more general personality traits, such as responsibility and honesty.

When responding to the question above, managers identified the most important skills to succeed in their own jobs. However, in an extra set of questions that we applied only to managers, we also asked about the traits they look for when hiring workers. Not surprisingly, they identified many of the characteristics they demanded of themselves, such as responsibility, honesty, and punctuality. While most managers also looked for workers with previous experience in the asparagus industry, most agreed that as long as a worker had a requisite level of personal integrity, then managers could do the rest in terms of training. When asked whether previous education mattered, many managers responded that since all workers could read, write, and do basic math such as weighing and measuring the asparagus, education was not a significant determinant in workers’ success.

Plants in La Libertad that bottle and can white asparagus use a similar approach for the workers who peel the asparagus. As one manager observed, the peelers are the “engine” of the production process, driving the work of those who sort, jar, and label the asparagus. At one large plant we visited, only the peelers were paid a piece rate, while the rest were paid hourly. Additionally, managers told us that due to the agility required to peel the white asparagus, only women were usually able to perform this task well.

In the asparagus fields, managers reported that the workers who actually picked the asparagus shoots were the most critical and difficult to find and retain. This process is considerably more difficult in the case of white asparagus, because workers must search for and cut asparagus shoots that are hidden under mounds of dirt. Yet managers in the fields stressed that, more than filling any one position, the most difficult thing, given the migratory nature of field workers, is retaining workers from season to season.
Table 7. *Attitudes of Workers in the Asparagus Industry*

<table>
<thead>
<tr>
<th>Most Important Skills (%)</th>
<th>Plant Workers</th>
<th>Field Workers</th>
<th>Plant Managers</th>
<th>Field Managers</th>
<th>Small Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility/honesty</td>
<td>46.2</td>
<td>10</td>
<td>5</td>
<td>43.8</td>
<td>42.9</td>
</tr>
<tr>
<td>Punctuality</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>7.1</td>
</tr>
<tr>
<td>Cleanliness/hygiene</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Quickness/agility</td>
<td>23.1</td>
<td>25</td>
<td>5</td>
<td>0</td>
<td>7.1</td>
</tr>
<tr>
<td>Job-specific</td>
<td>0</td>
<td>55</td>
<td>80</td>
<td>56.3</td>
<td>42.9</td>
</tr>
</tbody>
</table>

*Frio Aéreo: The Final Link in the Chain of Production.* The above results include responses of three managers and three workers of one firm that concentrates on the shipping end of the chain of production. Frio Aéreo, which receives and ships fresh green asparagus from the international airport at Lima, is an association of 10 *socios,* or partners, all of whom are members of the Instituto Peruano del Espárrago (IPE). Frio Aéreo exports 70% of the fresh asparagus that leaves Peru and employs 100 people who work in three 8-hour shifts, seven days a week. One of Frio Aéreo’s principal concerns is maintaining the critical “cold chain:” they receive asparagus at about 3.8 degrees Celsius and must load it on to airplanes at no less than 4 degrees.

Workers we interviewed at Frio Aéreo reported that they must develop a number of high-level skills, such as knowledge of different types of airplanes, managing perishable cargo, maintaining high levels of security within the plant, and recognizing and classifying products to be shipped. Of the three workers we interviewed, two had completed secondary education and one had reached incomplete tertiary. All three managers we interviewed had completed university studies, one of them in engineering at La Molina in Lima. Frio Aéreo also sponsors 20 to 30 interns in quality control from La Molina per year, from which it usually hires two or three. Additionally, managers we interviewed identified La Molina as the primary source of new professional recruits.

Perhaps as a result of the high-level skills required of workers, Frio Aéreo has developed a much more formal in-house training system than the asparagus producers and processors we interviewed. Every Saturday in May—when asparagus shipments reach their slowest pace—Frio Aéreo gives formal training to its workers in topics such as management of perishable cargo, hygiene, and security. At the same time, the airlines that ship Frio Aéreo’s asparagus train workers in recognizing different types of airplanes and the cargo capacity and conditions of each.

*Instituto Peruano del Espárrago.* The IPE is a growers’ association that helps promote Peruvian asparagus in world markets and gathering information about competition in other countries and the latest technological innovations in the industry worldwide. IPE is probably the main marketing mechanism for smaller growers, but
larger growers, such as Agrokasa, have their own marketing office in Lima. Our interviews in Trujillo also suggested that the larger firms have their own contacts abroad. IPE also helps lobby for the growers in the Peruvian legislature and in the Ministry of Agriculture, with which it has close ties. *The IPE is a crucial form of collective organization where private knowledge gets transformed into collective payoffs. Hence, these organizations can be considered a form of social capital and even an important locus of LLL for small and medium growers.* Forming associations among growers of other potential export crops is probably one of the most important forms of developing knowledge of markets and transmitting market requirements to growers.

At the moment, then, the marketing of export crops such as asparagus is handled privately, some through IPE and otherwise directly by the individual firms themselves. Since small growers sell mainly to local processors and distributors (controlled, such as Frio Aereo, mainly by larger growers), we deduce that much of the marketing is handled by large growers, who, in turn, are contacted directly by importers in the developed countries. Our interviews with growers suggest that quality of product is important, and that grower-processors have gone out of business because of their inability to deliver consistent quality product. Thus, quality control at the processing stage is important.

**Relevance of Local Educational and Training Institutions to Asparagus Production.** Our interviews with producers and managers in the Ica and La Libertad regions suggest that, aside from the agronomists trained at La Molina, some research initiatives by La Molina, and two examples discussed below (SENASA and Pro-Joven), responsiveness by public sector educational and training institutions to the needs of new, agro-export industries have been mixed. To the contrary, the two local educational institutions mentioned by our interviewees as relevant to their skilled labor needs—Valle Grande Rural Institute in Cañete and the Universidad Privada Antenor Orrego (UPAO) in Trujillo—are both private. Two other public institutions, the Universidad Nacional San Luis Gozanga in Ica, and the Universidad Nacional de Trujillo (U.N.T.) also train agricultural engineers. U.N.T.’s agronomy department responded late to local demands, only starting up in the mid-1990s. San Luis Gozanga began producing agronomists much earlier, and supplies significant numbers to the asparagus industry, although SLG graduates get mixed reviews among growers in the Ica region.

The UPAO is an important case because the development of its school of agronomy, which produced its first graduates in the early 1990s, was largely a response to asparagus production and other more technical agro-industry replacing traditional sugar cane farming in the region. Thus, UPAO was a private sector educational initiative to create more high-level technicians and managers for a growing local industry. Local industry—especially Talsa’s Rafael Quevedo—was, in turn, directly connected to this effort. UPAO makes a major effort to place their agro-engineering students as interns in local companies. The students from UPAO intern in various agro-industries in Trujillo and many end up working for them (not necessarily the same ones where they interned). Talsa takes four or five of them as interns each year, and hire one or two. At UPAO and in their internships, the students learn the technology of irrigation mechanics, asparagus production, ecological pest control, etc. Indeed, our interviews in both Trujillo and Ica
suggest that the relationship between agro-industry and university training programs is primarily expressed in internship opportunities for students during their studies. Producers take on these interns, and, as in most cases of internships in firms, the firms use them—among other things—as a low-cost, high information form of selecting employees (provided they have positions to fill). The census of the asparagus industry in 1998 showed 152 internships for agricultural engineers and other professionals in asparagus production in that year, divided mainly among La Molina (39), UPAO (30), the Universidad Nacional de Piura (20), and the Universidad Nacional San Luis Gonzaga (56). UNT did not provide interns until after 1998.

The Universidad Nacional of Trujillo (UNT)did not begin its agro-engineering program until 1996, which means that the first graduates of that program did not enter the labor force until quite recently, when asparagus production growth had already slowed down. Nevertheless, the UNT students also intern at local agro-industries, and they compete with UPAO students. Agro-engineering is an expensive program, both because of its typically small size (UPAO, for example, only has 25 students studying agro-engineering) and the amount of lab equipment and specialized teaching required. It is difficult for a private university to sustain because tuition fees needed to recoup costs are higher than most students can pay . UPAO officials we interviewed told us that the rest of the university had consistently been subsidizing agro-engineering in the hope that enough students could eventually be attracted to the program to realize economies of scale. However, with the competition from UNT, that was now unlikely, so UPAO was seriously considering phasing out the program. Yet, had UNT never developed a competing program, it is unclear that UPAO would have ever had enough students to make agro-engineering an economically viable department, given that students do have to pay tuition fees (albeit lower than the full cost of their education).

Our interviews in the Ica region suggest that local public university agricultural engineering programs such as SLG’s may suffer from low quality in addition to slow response to changing production, although we got different signals from different firms. One grower was very critical of the university, saying it was disorganized and the diplomas were meaningless. He wanted to see more technical institutes and more practical training. A field manager we interviewed at another large firm in told us that he wants San Luis Gonzaga to interact more with industry and complained that the engineers they produce don't meet the requirements of industry. The field director at that same firm told us that the company doesn't allow university interns to work there; however, he didn't relate this policy to the quality of the university. And the plant manager in this firm had his agronomy degree from SLG. To add to the contradictory signals, yet a third firm employed a lot of interns from SLG, and both the field manager and field engineer earned their degrees in agronomy there. They agreed that the university gives too much theory and not enough specific technical practice, and that the professors are not always well informed of current agricultural practices or crops. Thus, there was considerable

3 Agricultural engineering programs require experimental agricultural stations as teaching laboratories in addition to the range of highly qualified teachers required by other engineering fields. Nor do most agricultural engineering programs attract large numbers of students, so they are characterized by diseconomies of low scale.
agreement that SLG graduates could be better trained, but the bottom line is that six of the managers in our Ica sample graduated from there—three plant managers and three field managers (two of the field managers studied economics, not agronomy).

This poses an important dilemma: A local private university such as UPAO with support from local growers may respond rapidly to local needs and produce relatively high quality graduates but has difficulty sustaining the high per student costs associated with agricultural engineering and/or attracting enough students given tuition fees. Public universities can subsidize such high cost fields on the grounds that they are associated with social benefits beyond the earnings accruing to graduates, but may produce relatively low quality graduates and may respond slowly to local needs. The UPAO/University of Trujillo/SNG Ica example shows, on the one hand, the possible advantages of a private university (rapid response to a market need and relatively high quality education) and, on the other hand, the possible advantages of a public university (ability to produce sufficient graduates to respond to regional or national needs, where social benefits exceed private).

There are several possible alternatives open to public policy. One is a public subsidy for certain programs, such as agricultural engineering, in existing local private universities, such as UPAO. Another is to raise the quality of such programs in local public universities, nearer to the level of La Molina, for example, and, like La Molina, recover part of the costs of higher quality programs with ability-to-pay tuition fees. Although these policies are not directly associated with issues of lifelong learning, it might be argued that “good” public policies in formal education are related to more opportunities for lifelong learning—thus, that lifelong learning and higher quality formal education may be complements. Our discussion of internships in Ica and Trujillo provides some indication that this may be the case. Some growers are reluctant to take interns from SLG because of the low quality of the preparation there, whereas growers in Trujillo are generally positive about interns from UPAO. And La Molina graduates have many opportunities for steep learning curve jobs.

El Centro de Transferencia de Tecnologia a Universitarios (CTTU)

One important example of private, non-profit educational intervention that helps young people take advantage of the opportunities in export agriculture is the CTTU. The project was begun by a Jesuit priest in 1991 as a response to the guerrilla movement that beset Peru at that time. CTTU was aimed at university students with little prospects of gainful employment in the Trujillo area. This group of young people were the main recruits of guerrilla groups. CTTU was organized to offer an alternative.

With Dutch funding, CTTU trained students that responded to CTTU ads in asparagus cultivation. CTTU found the parcels of land needed and divided them into one

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4 Apparently, the high cost of agricultural engineering programs is not matched by salaries higher than for other engineering graduates, suggesting relatively low private returns were students made to pay the true cost of their education through tuition. Yet, the external benefits to each region may be high.
hectare plots, one per student. The name of this program is Unidades Agroindustriales con Riego Tecnificado, or UART. It is based on training young people to be individual owner-farmers working in association with other, similarly trained owner-farmers cultivating adjacent or nearby plots of land. For every 50 students who entered the program only about 5-6 made it to actually cultivating a plot of land. Once the land was secured, CTTU helped the students who had made it through to this point of the program to get loans from banks to finance the land purchase and working capital (the asparagus take 18 months to mature and begin producing and require considerable investment in irrigation equipment). CTTU also helped the young farmers to negotiate with processing plants, to improve their irrigation systems (with the help of Ing. Quevedo at Talsa) and to begin cultivating other crops as prices for asparagus fell.

Several years later, in the mid-1990s, CTTU began a second training program, this one for small farmers who already own plots of land, and who wanted to learn how to get into asparagus production. The program is called Asociaciones de Productores Agrícolas con Riego Tecnificado, or APART. This type of program is much less costly and less complicated, since acquiring land is time consuming, and CTTU was not able to find land for a high proportion of university students who began the earlier program. Thus, CTTU spent time and money on training many more university students than they could ultimately turn into small farmers. In the small farmer training program, the land is already available, and the proportion of trainees that ended up producing asparagus is much higher. Our interviews with farmers currently taking CTTU training suggest that these trainees also have relatively high education (but lower than that of the UART trainees), usually some secondary school, and are the farmers’ children who have inherited all or part of their father’s land.

We visited two of the early groups of CTTU graduates (both UART, or university student, groups) at their agricultural sites. The first site, CTTU’s initial project, located south of Trujillo, consisted of about 12 hectares, largely planted in asparagus, and in existence since 1993. The second site we visited was north of Trujillo. The CTTU trainees there came from the most recent group and began asparagus production only last year. The model is still the same as in the first site.

The original group of CTTU trainees, consisting entirely of former University of Trujillo students, had the good fortune to begin producing asparagus when prices were still very high and exports of white asparagus were expanding rapidly. They told us that they had been able to pay off their bank loans in three years. Although their one hectare plots were owned individually, they managed their books collectively—the group of 12 had an office with a computer in which they kept their records, a single main irrigation pump, and had begun a small livestock farm and some experimental planting of chili peppers. They also negotiated the purchase of inputs and sale of their output collectively. Yet, they also told us that given declining asparagus prices, the scale of their production was now too small to be profitable. They have used their track record with the banks and

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5 As with many such programs, motivation and “hanging in” was the main selection device in the program. It usually took several years to find the land and secure loans for UART participants. CTTU only had anecdotal information on dropouts from the program.
accumulated profits to purchase an additional 40 hectares in an area north of Trujillo. The current CTTU director told us that a second group of trainees that started in 1995, had also purchased additional land to expand production.

Because of the much higher costs and the change in the country’s political situation, CTTU is discontinuing the university student training model and shifting all its remaining resources over the next three years to the farmer training model. It will also put greater emphasis on recruiting and training young women farmers. The one drawback of the farmer training model is that it is more difficult to get farmers who already own their land, to pay back loans, since the land is not held as collateral.

All in all, over the 14 years, CTTU expects to have operated in the Trujillo region (1991-2005), it will spend one million dollars and have put about 300 farmers into export agriculture production. At about $33,000 per new farmer, the investment is relatively low. The effectiveness of both training models depends on the holistic nature of the approach: intensive training, cooperation of private agro-industry leaders in the region willing to share technological assistance, the provision of sufficient capital, and the continued mentoring of trainees for years after they begin production. CTTU represents a successful model of lifelong learning seeking to produce entrepreneurs in profitable industries that require technological training, some capital, and technological assistance.

**SENASA**

Although we found few examples of public sector training during our interviews in the Peruvian asparagus fields, many field workers and managers did mention the work of the *Servicio Nacional de Sanidad Agraria* (SENASA), a branch of the Ministry of Agriculture concerned with the sanitation and health of agricultural plants and animals. Since 1998, SENASA has sent personnel to the fields to promote and train workers in the use of biological pest control methods as an alternative to chemical pesticides. These methods include the use of predatory insects and fungus, which SENASA develops at its research facilities in Lima and sells to Peruvian farmers.

SENASA currently has 37 *promotores*, or promoters, who specialize by regions and crops and travel widely to train field managers and workers. Currently, SENASA has *promotores* in the departments of Piura, Lambayeque, La Libertad, Ancash, Lima, Ica, Arequipa, Moquegua, Tacna, and San Martín, all important centers of agriculture. SENASA also offers 15-day workshops in Lima for field supervisors and has plans to develop similar workshops in agricultural regions. Several of the field managers we interviewed identified the use of biological pest control methods as among the most important skills for field workers to know. At the same time, managers reported that it was very difficult to find workers who had these skills. Consequently, the continued expansion of SENASA’s field training programs should facilitate the growth of the Peruvian asparagus industry.
Valle Grande Rural Institute

About two hours north of Ica in the city of Cañete, the Valle Grande Rural Institute is a good example of a post-secondary institution that offers both career formation and opportunities for lifelong learning. The private institute has approximately 90 full-time students (all male) who study for three years alternating between class work and work in the field, either at an agricultural firm or a family farm. Courses range from soil management and pest control to accounting and computing. Students who graduate from the institute earn the title of “Professional Technician in Agrarian Production.” Many go on to manage their own farms or take jobs as field managers and supervisors in agricultural firms.

Ninety percent of the students at Valle Grande come from in and around Cañete. The rest come from nearby towns, including Chincha (about 40 miles away) and Pisco (about 60 miles away). About 200 local farmers participate in the intensive programs every year.

Due to assistance from Valle Grande’s domestic and international donors, which include La Molina University in Lima, the Interamerican Development Bank, and the European Union, students at Valle Grande pay only 48% of their actual educational expenses. On average, students pay 2,160 soles (approximately $US 625) in annual tuition, which covers food and lodging for two weeks out of every month, as well as textbooks and equipment.

The Valle Grande Rural Institute also offers intensive week-long courses for local farmers and the general public. The purpose of these courses is to upgrade the skills and knowledge of small farmers who have already worked for years in agriculture and to train others who may want to begin agricultural careers. Topics of the intensive courses include “Integrated Management of Pests and Correct Use of Pesticides,” “Soil Management,” “Avocado Cultivation,” and “Raising Queen Bees.”

According to asparagus growers we interviewed in both Ica and La Libertad, the Valle Grande Rural Institute is known across Peru for its excellent preparation of agricultural technicians. In contrast, a nearby public technical institute is not as well-regarded; critics told us that instruction at the public institute is weak and the curriculum is too rigid, not responding to the conditions of local crops and the needs of industry. When asked why students choose to pay to attend Valle Grande, rather than receive a free education at the public institute, the director of Valle Grande offered several reasons. Not only is the quality of training much better, the teaching approach also allows students to work while they attend school. In contrast, the public institute has a conventional schedule in which students attend class every day of the school year. Finally, the director cited the “complementary development of other skills and abilities inherent in agricultural activity” that prepares students for successful careers in agriculture.
The Valle Grande Rural Institute is unique for a number of reasons. To begin with, instructors are often current agricultural practitioners and curriculum is informed by the practices and demands of local industry. Additionally, the institute offers both initial preparation and mid-career training for current and potential farmers. Unfortunately, there is little asparagus farming in Cañete, so Valle Grande has not played a significant role in the development of the industry.

**Pro-Joven**

At the other end of the spectrum from CTTU, which is a privately financed program providing a holistic package of entrepreneurial preparation, Pro-Joven is aimed at youth needing training for entry-level jobs. In Trujillo, the main employers of Pro-Joven trainees is agro-industry, and the jobs are usually asparagus or other vegetable processing and packing. Pro-Joven subcontracts the short course part of the training to local educational institutions that are required, as part of their contract, to place the youth into three months jobs at minimum wage pay. According to the director of Pro-Joven, whom we interviewed in Lima, a high fraction of the youth are employed by the firms they work for in their three-month internships.

It is difficult to characterize this training as lifelong learning, since it is more transitional training for those with some secondary education between school and jobs, but strictly speaking, the model could also be used for older workers.

On average, Pro-Joven spends about US$400 per student nationwide for the training and the post-training firm internship. The cost of the training in Trujillo is less, at about US$375. Asparagus processing jobs pay about US$0.60 per hour, or, assuming 1200 hours of work per year, $720 per year. If the Pro-Joven trainee has a fifty percent probability of getting a job, that job would have to pay $200 per year more than other available work for six years in order to realize a discounted value of additional income equal to the cost of the training. Although this estimate is hypothetical, it suggests the level of wage gain necessary for young people taking the training to result in a benefit-cost ratio equal to one.

**IMPLICATIONS FOR LIFELONG LEARNING**

The growth of new industries using new technologies is essential to the economic development of today’s low and middle-income countries, just as it has been the engine of growth in the developed world. Since these new industries depend on developing new knowledge in and applying available knowledge to local environments, we would expect that they involve considerable development of new skills and adaptation of existing skills in the work force. We would also expect that this development and adaptation is aimed largely at adults already working in related activities. In this sense, such new activities are intimately related to a process of learning called lifelong learning.
The question we try to answer in this study is whether these forms of lifelong learning are mainly situated in public (state) activities or in the private sector, and on who is likely to get access to lifelong learning and how they get access to it.

We learned that lifelong learning can take place in the form of formal transfers of technology from one country to another, of on-the-job training, of formalized entrepreneurship training by an non-governmental organization, and, to a much smaller extent, vocational education in government institutions.

The growth of asparagus exports in Peru has been built on a well-developed formal educational base that, at the highest skill levels, is the source of the technology-based entrepreneurship driving production growth and is also the source of much of the lifelong learning that occurs as part of production growth. At the core of the formal educational system is a public agricultural university, the Universidad Nacional de la Molina, in Lima. Most of the entrepreneurs in the asparagus industry were trained at La Molina. These entrepreneurs, in turn, learned new techniques in asparagus growing and processing in part from U.S. (green) and Spanish (white) asparagus growers. Peruvian entrepreneurs were brought to the U.S. by USAID to learn these new techniques. Spanish investors, on the other hand, came to Peru to take advantage of lower wages. In both cases, nevertheless, technology transfer took place and was adapted to Peruvian conditions—clearly, a type of lifelong learning. Further, Peruvian entrepreneurs learned (and continue to learn) advanced techniques of irrigated desert agriculture by taking courses in Israel, a country that has advanced desert agriculture technology more than any other. The newest irrigation equipment and irrigation equipment in Peru also comes from Israel. In addition, La Molina produces research on new export crops and pest and disease control that is available to asparagus producers and is being constantly adapted to local conditions and taught to technicians and small farmers by larger growers. Again, this represents an important type of lifelong learning with high payoffs for economic development.

In addition to the high level skills represented by the agro-engineering graduates and researchers of La Molina, Peru’s formal education base includes a relatively high percentage of secondary school and university (non-agronomy) trained young people, many of them sons and daughters of farmers, who have the childhood background and agricultural experience to cultivate new agricultural products and to work more generally in agro-industry at the technical level. These secondary and university trained individuals are trainable into new forms of agricultural production. The existence of “lifelong learning” training opportunities, especially on-the-job training in the private sector, combines with well with these relatively high levels of formal education, to raise yields on capital investment in products such as asparagus, and to enhance the value of the human capital investment represented by formal education.

One question is whether secondary and even higher education in Peru is partly a substitution of more years of schooling for low-quality primary and secondary education. In other words, a secondary education graduate in today’s Peru has similar skills to primary graduates in, say, Chile. The evidence on test scores suggests that this argument
has some validity. But it is highly likely that secondary educated workers in Peru have higher levels of cognitive skills than primary educated workers anywhere in Latin America (with the possible exception of Cuba). The availability of secondary educated workers for factory and technician jobs in asparagus production has almost certainly made training less costly.

Most of the lifelong learning activity we found in the asparagus sector takes place in the private sector, and most of that, in the form of on-the-job training, usually organized by managers who select workers on the basis of trustworthiness and general work habits to train into responsible technical jobs. This training takes place at the job site mostly informally. In factories, some workers are designated to train others. Those who learn in the two-week probation period are kept on and the others, let go.

Besides informal and semi-formal on-the-job training, we found other important private sector initiatives. A private university, the Universidad Privada Atenor Orrego, founded in 1988, and committed in part to producing agronomists for Trujillo’s emerging export agriculture, develops locally trained engineers and agro-scientists to work in agro-industry. Agro-industry, in turn, does its part by providing summer internships for these young agronomists as practical training and rapid incorporation into employment. We did not interview in the Universidad Nacional de Trujillo, but that university has also begun an agronomy faculty and is also placing its students into local internships in agro-industry. The Ica region only has a public university that produces a relatively large number of interns for local asparagus production, but these interns get mixed reviews from local growers. Nearby Cañete has a private technical school that produces high quality technicians for agro-industry in that region. Apparently, the public technical school in the same region does a relatively poor job of preparing technicians for agro-industry.

This poses a policy dilemma for the public sector: should the public sector let private initiative take care of specialized educational needs at the local level, or should the public sector subsidize such private initiatives to assure sufficient graduates in, say, agrio-engineering, or should the public sector be entirely responsible for producing high-cost specialties? Our study suggests that the private sector does a better job of producing such specialized education, but may not produce sufficient graduates to meet local needs. A mixed approach may be optimal.

The most impressive (and expensive) formal lifelong learning effort in the asparagus sector we found is the CTTU, a non-governmental organization effort to form successful agricultural entrepreneurs. This is a complex model of lifelong learning because it not only includes training but also the financing, technical assistance, and mentoring of university and secondary school educated young people with the potential to become successful independent small farmers engaged in producing high tech crops. The success of CTTU stems in part from the profitability of asparagus production, but it is also successful because of the holistic and long-term nature of the model employed.
Finally, we found some short-course training programs run by the Labor Ministry that fit the more typical models of vocational training for employing young people into first jobs. This public sector effort is, again, not generalized to the new export agriculture, but is only found in Trujillo. In turn, the traditional vocational education in Trujillo is not at all aimed at forming young people to enter technical jobs in export agriculture, whereas the main public vocational institution in the southern coast asparagus area is producing graduates who enter the agro-industrial sector. This mixed response to the new agriculture on the part of the public sector suggests an almost serendipitous (and also very slow) public reaction with formal training to new job opportunities.

In terms of who gets access to lifelong learning opportunities in the new export agriculture in the Peruvian case, we conclude that it is largely, if not almost entirely, those with relatively high levels of education. Whether this is because a very high proportion of younger people on the Peruvian coast have high levels of education, or whether there is a real selection of younger people with higher levels of education to get access to these further education and training opportunities is impossible to tell from our survey and interviews. We suspect that there is a relatively high level of education in the asparagus regions, but that there is also considerable selectivity into this high yield sector.

We conclude that the following factors combine to provide lifelong learning opportunities in the asparagus industry:

- The existence of a core of research trained scientists and engineers (agronomists) trained at national and, subsequently, local universities, mainly public but also private. These agronomists and other scientists form the entrepreneurial core of the industry, and, at the same time, are the major providers of lifelong learning to young engineers and technicians on the job. Further, this core of research-trained scientists and engineers generate much of the new technology that comes out of the practice of production and creates higher productivity in the industry, new products, and solutions that increase quality and exportability of these new products.

- This learning environment extends to other private initiatives, such as CTTU, that build on the lifetime education culture in the industry and create new formalized and holistic forms of lifetime education, but again focused on those with relatively high levels of traditional formal education.

- Finally, the public sector has not been particularly responsive in creating new forms of training opportunities. La Molina faculty and graduates provide consulting and are responsive in doing new forms of research. But beyond that, public education has not been very responsive in institutionalized training. Pro-Joven is a flexible public response that seems to be working well, but is mainly a school-to-work transition form of training. SENESA is another example of a successful government training program, bringing the latest knowledge on pest control to workers and managers in agro-industry through extension services.
Neither of these programs is particularly expensive, but we do not have estimates of their benefits, so cannot evaluate them properly.

IMPLICATIONS FOR PERUVIAN GOVERNMENT STRATEGIES

This study is mainly concerned with understanding skill acquisition in a rapidly growing, “high tech” industry such as asparagus production for export. One of our main conclusions is that private initiative, either in the form of for profit companies providing training to employees, or non-profits engaged in local development activities, has been chiefly responsible for developing the specific skills needed in the rapid expansion of asparagus exports in Peru. As a general conclusion, then, one could argue that the public sector in Peru should focus on providing quality primary and secondary education and continue to invest in the high quality higher education and research as represented by the La Molina model.

The government can also help in organizing growers’ associations that market agricultural products abroad and, indeed, at home, since some crops, such as sweet potatoes, that are going through enormous productivity gains, need expanded domestic consumption.

Public policy regarding investment in local universities’ agro-engineering and in specialized post-secondary technical education is more ambiguous. We found evidence that private universities and private technical institutions are successful in preparing highly skilled labor for further training in the asparagus industry. Public universities also do so, but perhaps not as well. But at least at the university level, the high cost of educating an agronomist or agro-engineer makes it difficult for private universities to sustain an agronomy department without considerable subsidies. Should the public sector subsidize existing local private universities to maintain or expand production of high skilled labor for export agriculture? Or should the public sector improve the quality of local public agro-engineering departments to achieve the same goal?

We were able to note several other positive actions by the Peruvian government in educating and training workers and managers for export agro-industries, and a number of opportunities for improving public support for lifelong learning in the new agriculture.

✓ Pro-Joven appears may be a reasonably cost-effective intervention to help young people obtain short-term training to enter agro-industry jobs. Agro-industry in Trujillo appears to value the training Pro-Joven provides through its educational subcontractors. It may make sense to expand Pro-Joven, creating training centers in other agro-exporting areas that have adequate production to employ significant numbers of Pro-Joven graduates. However, the program needs to be evaluated on a cost-benefit basis before expanding it.

✓ SENASA is another government training program that works. It has had a major impact on controlling asparagus infestations in both Ica and Trujillo. SENASA, too, maybe worth expanding, with particular emphasis on funding
it adequately to help growers control pests with alternatives to chemical pesticides. Again, however, the cost-benefit of SENASA needs to be evaluated.

✓ The relations between local universities and export agro-industry need to be strengthened, so that the universities can develop and expand programs that more directly complement the high level technical and managerial requirements of new export agriculture. University programs also need to be more flexible to respond more quickly to new types of production and the new general skills required for that production. We have suggested that it may be more effective to subsidize current private initiatives, such as UPAO, rather than expanding public university programs.

✓ Private initiatives such as the Valle Grande Rural Institute and CTTU should be studied and probably expanded with some form of public funding and possibly duplicated in other export agricultural regions. Apparently, these efforts are not well known in Peru, but they are examples of very effective efforts to train people in the technology required for export agriculture.

✓ The public sector could be involved in other activities, such as promoting agricultural exports through vigorous marketing campaigns, or even promoting domestic consumption of healthy substitute products now not being consumed, such as yams.

✓ Peru already has an effective R&D program at the Universidad Nacional La Molina. Increasing the research budget of La Molina, for example in finding solutions to the medfly problem in Peru, would have high payoffs for export agriculture—Peru could become a major exporter of avacados and citrus fruits.

None of these recommendations should require major resources, and they could be very effective. Any public investments should also be designed to be flexible; that is, they should, like Pro-Joven, or investment in agricultural R&D, be able to adjust quickly to changes in demand.
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