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REPORT ON QUINOA
AROUND THE WORLD IN 2013



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CHAPTER 5.3.

QUINOA IN ECUADOR

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Abstract

Ecuador was the third country to undertake systematic and dynamic research into and development of the revival, promotion and use of quinoa in the Andean region. Efforts began in 1982, some 30 years after Bolivia and Peru, with the support of the *Instituto Nacional de Investigaciones Agropecuarias* (INIAP, the National Agricultural Research Institute), the Food and Agriculture Organization of the United Nations (FAO), the International Board for Plant Genetic Resources (IBPGR) and the Government of Canada (through the International Development Research Centre – IDRC).

Ecuador began by collecting germplasm at national level, exchanging with other countries and founding a national germplasm bank for Andean crops, presided over by INIAP. Following the characterization, documentation and evaluation of the germplasm, selective breeding was carried out and the first two high-yielding varieties, which have bitter grains, were released. The promotion of quinoa cultivation and consumption was thus initiated. At the same time, to establish a baseline, an analysis was performed of the crop's status within the country in terms of agriculture and socio-economics, and agronomic management, harvest and post-harvest

technologies were developed. During that period there were estimated to be 1 000–1 200 ha under cultivation in the north central Sierra of Ecuador, while it was considered to have disappeared in the south. In 1992, the first “sweet” varieties were released – varieties with a low saponin content – with the objective of reducing water use and washing time while increasing urban consumption.

Beginning in 2000, new research into quinoa was undertaken by the National Programme of Andean Legumes and Grains (PRONALEG-GA) of the Santa Catalina Experimental Station. A new early variety was released with improved cold tolerance and low saponin content. This gave impetus to research and development in the areas of harvesting, post-harvesting and agro-industry. In the same period, several universities contributed to knowledge in the field with undergraduate theses, and the private companies involved grew in size and number. In 2013, attention focused on two types of production: certified organic and agro-ecological (conventional), and it is estimated that together they account for an annual cultivated area of around 2 000 ha. Most of this production is for export to the United States of America and Europe. Domestic consumption in Ecuador is still very low, and the Government

is promoting the consumption of quinoa through food programmes, aimed mainly at children. Quinoa production in Ecuador can be made more sustainable, as it can be grown in rotation with other crops, such as potatoes, peas, maize (planted alone or together with climbing beans) and pasture, at altitudes ranging between 2 400 and 3 600 m asl.

Introduction

For around 7 000 years, quinoa has been cultivated in the Andean region, where it has been valued for its nutritional qualities and its adaptability to difficult environmental conditions. In Ecuador, quinoa cultivation has been considered of secondary importance: the cultivated area is relatively small and per capita consumption is low (Jacobsen and Sherwood, 2002).

Pulgar Vidal (1954, cited by Tapia, 1979) believed that the Chibchas and other tribes of the Cundi-Boyacense plateau in Colombia grew quinoa intensively, and he also suggested that the ancient inhabitants of Cuyumbe (Huila, Colombia) assisted in the spread of quinoa southwards, which would explain its distribution in Ecuador.

However, Estrella (1998), on the basis of historical documents, maintains that, due to its nutritional and medicinal qualities, quinoa was highly valued by the indigenous peoples of Ecuador. For example, during Pedro Cieza de León's travels through the Andes in 1548, he found evidence of quinoa cultivation and recorded its value in the local diet. The Cañaris grew quinoa before the arrival of the Spanish, and at the end of the sixteenth century it was still a preferred food. In the Order of Tambo (*Municipal Acts of Quito*, 1934), issued by the City Council of Quito in 1549, it appears that quinoa was one of the foods that the inhabitants of Tambo would sell to travellers. In the eighteenth century, the historian Juan de Velasco identified two types of quinoa: the white form, that is "grown in large fields and is eaten like rice", and the red form that "can only be eaten toasted because it bursts, fluffs up and has a lovely flavour".

Tapia (1979), citing Cardozo (1976) and Romero (1976), states that in Ecuador quinoa persisted among farmers in the provinces of Carchi, Imbabura, Pichincha, Chimborazo and Loja. He also notes

that quinoa plants are generally tall and produce small, very bitter grains. The estimated cultivated area during those years was 1 200 ha.

In 1967, INIAP reported the creation of the Programme for the Introduction of New Cash Crops in the Sierra. Observation and adaptation work was carried out with the aim of finding new sources of protein for human and animal consumption. In addition to work on rapeseed and *Lupinus mutabilis* (Alpine lupin or *chocho*), indigenous crops, such as quinoa, *Ullucus tuberosus* (melloco) and *Oxalis tuberosa* (oca), were observed and collected. This work was concluded in 1970 at the Santa Catalina Experimental Station.

The graduate thesis work of García (1984) involved the study of quinoa cultivation in eight provinces in the Ecuadorean Sierra. The principal findings were as follows:

The majority of quinoa producers are smallholders; they must seek other sources of income for their subsistence, since farming on its own does not meet their minimum needs.

Quinoa is generally grown in polyculture systems and very rarely as a monoculture. It is most frequently grown in association with maize, potatoes, oca and melloco. Very few farmers practise crop rotation.

The planting season varies from zone to zone and is associated with the rainy season. In the north it is in June - July, while in the centre and south it is in October–November. For late cultivars, harvest time is 7 - 8 months after sowing.

Weeding, hilling, thinning, fertilization and irrigation are not carried out for quinoa. However, it indirectly benefits when these tasks are performed for the primary crop. There is no pest or disease control.

Producers' yields range from 300 kg to 1 tonne per hectare. Production is intended solely for their own consumption, and it is rare for them to make exchanges or sell in the markets.

There is a total absence of institutional services and credit assistance. Consequently, farmers receive no information about the plant's agronomic and nutritional value.

Quinoa consumption is limited due to ignorance of its good nutritional qualities. It is also complicated by the need to wash the grain before it can be eaten.

Between the beginning of the 1980s and the end of the 1990s, significant advances were made in quinoa research and production, and the promotion of its consumption. Headway was made primarily through international cooperation and consultation with Bolivian scientists and, in Ecuador, through the work of INIAP, in conjunction with several universities and private companies. During this period: the national germplasm bank was established; four enhanced varieties (developed through selective breeding) were released; alternative technologies were developed for management, harvesting and post-harvest operations; food science studies and studies of agro-industrial applications were carried out; various ways of preparing and consuming quinoa were developed; and several private initiatives were created (with large and small producers) for production and commercialization, focusing on both domestic and international markets.

Since 2001, with the support of international partners (and, more recently, state funds), research into and development of quinoa and the other Andean grains has been resumed. International partners include the *Proyecto de Resistencia Duradera en Zona Andina* (PREDUZA, Durable Resistance Project in the Andean Zone), the International Fund for Agricultural Development (IFAD), the International Plant Genetic Resources Institute (IPGRI) and the McKnight Foundation. Through participatory processes, a new variety of quinoa is being released and the process of genetically enhancing it through hybridization (in consultation with PROINPA, Bolivia) is being initiated with the use of F6 lines and segregant populations in different descendants.

During this period, there has been a drive to increase the quality of selected grain, in conjunction with organizations of family farm producers. The use of threshing machinery has also been demonstrated, and various activities have been carried out to promote the nutritional value and diversify the consumption of quinoa and other Andean grains. In recent years, the Ecuadorean Ministry of Agriculture, Livestock, Aquaculture and Fisheries, with the support of FAO, has implemented quinoa development projects in various parts of the country.

During the International Year of Quinoa, the Fourth World Congress on Quinoa and the Andean Grains First Symposium were held in Ecuador. In this context, the Ministry of Agriculture, Livestock, Aquaculture and Fisheries launched a quinoa cultivation development programme, including, among other things, expansion of the planted area, improvement of productivity, promotion of the use of certified seed (relying on the standard for the certification of quinoa seed), organizational strengthening of producers, establishment of production incentives (subsidies by way of inputs, training and machinery), provision of technical assistance and support for storage and marketing.

Quinoa Research in Ecuador

From the beginning through to the 1990s

In 1967, INIAP created the Programme for the Introduction of New Cash Crops in the Sierra with the aim of finding new sources of protein for human and animal consumption, including the collection and observation of indigenous crops, such as quinoa, melo-loco and oca. The initiative came to an end in 1970.

During the 1970s and 1980s, at the *Universidad Central, Escuela Politécnica de Chimborazo* and the *Universidad Técnica de Ambato*, several theses addressed the cultivation, agro-industrial production and use of quinoa (Peralta and Vicuña, 1981; García, 1984). In 1982, quinoa was included as one of the Andean crops studied within the curriculum of the School of Agricultural Sciences at the *Universidad Central*.

An important milestone at the Santa Catalina Experimental Station of INIAP was the creation of the Andean Crops Section and the Plant Genetic Resources Section (1982), affiliated with the Cereals Programme. Quinoa is one of a number of crops and foods of Andean origin that was forgotten or under-used and heading towards extinction in Ecuador. The quinoa collection began to take shape as 271 accessions from every province of the Sierra were gathered together; by 1985 there were 334 entries. The selective plant breeding programme also began, with the key participation of the researchers: Carlos Nieto, Eduardo Peralta, Raúl Castillo, Jaime Tola and Alberto Ortega, and the Bolivian, Julio Rea. In 1986, the Andean Crops Programme was created.

In addition to the establishment of the germplasm bank, a guide was published on the management and preservation of plant genetic resources (Nieto *et al.*, 1983) and the six ecotypes of Ecuador were identified and characterized (Gandarillas *et al.*, 1989).

Currently, the germplasm bank of Ecuador, presided over by the National Department of Plant Genetic Resources of INIAP at the Santa Catalina Experimental Station, comprises 608 collections, of which 283 were gathered in Ecuador during the 1980s, while 325 came from the Andean countries and other donors (Mazón *et al.*, 2002).

During the 1980s, INIAP released the first enhanced varieties of bitter grain quinoa, obtained through selective breeding: 'INIAP- Cochasquí' and 'INIAP-Imbaya' (Nieto *et al.*, 1986).

In the same period, the first courses on quinoa cultivation were made available. In 1984, a course was offered to rural leaders of the Sierra, and in 1985 a technicians' course was organized with the support of engineer Humberto Gandarillas from Bolivia. In 1987, the Andean Crops Programme of INIAP published *Memorias de la Reunión Nacional sobre producción, uso y comercialización del cultivo de la quinua* (Proceedings of the National Meeting on the production, use and marketing of the quinoa crop).

Promotion also began of quinoa consumption. In 1984, INIAP presented 16 different quinoa-based dishes at the Traditional Food Contest organized by the Municipality of Quito and the Central Bank of Ecuador, winning first prize (Eduardo Peralta and Roxana Terceros). On the basis of this experience, the first quinoa cookbook was published in Ecuador: *La Quinua... un gran alimento y su utilización* (Quinoa... a great food and its uses) (Peralta, 1985).

In 1988, the Ecuadorean Institute for Standardization published the following quality standards: INEN 1671 for the identification of impurities and infestation levels in unprocessed quinoa grain; INEN 1672 for the identification of saponin content using the foam method; and INEN 1673, establishing the requirements that quinoa grain must meet. Carlos Nieto of INIAP was vice-president of the Technical Subcommittee.

In the mid- to late 1980s, efforts were made to organize quinoa production in Ecuador. In 1986, the

Asociación de Productores de Quinua (PROQUINUA, the Association of Quinoa Producers) was founded – to be disbanded a few years later having been relatively successful. In 1988, the *Escuelas Radiofónicas Populares del Ecuador* (now Fundación ERPE) in the province of Chimborazo began agro-ecological production activities, evolving in 1997 into the production of organic quinoa with small producers. In 1989, the Inagrofa company was founded to produce and sell quinoa; it does business to this day.

The Fundación ERPE made an important contribution. The 21 July 2012 issue of the newspaper, *El Comercio de Quito*, wrote in the agriculture and fisheries section that in Chimborazo, "quinoa is diversifying to find markets." It noted that, 15 years earlier, there had been little appetite for quinoa in rural and urban areas of Chimborazo, and that the situation had begun to change in 2000, when the producers of 90 municipalities in Colta, Guamote, Alausí and Riobamba decided to join forces to promote this Andean product, with the support of the *Fundación Escuelas Radiofónicas Populares del Ecuador* (ERPE). The report noted that the foundation had started out with 200 producer families and 100 ha under cultivation, and that by 2003 there were 900 family groups and 430 ha. "Currently," the report stated, "1 700 families are growing [quinoa] organically" on 700 ha, adding that 400 tonnes/year were exported to Europe and the United States of America.

The promotion of quinoa consumption continued during the 1990s. In the first year of that decade, the Andean Crops Programme of INIAP compiled and published a cookbook with 92 quinoa recipes (Muñoz *et al.*, 1990). That same year, Latinreco, Nestlé's research centre in Ecuador, published a book covering the five most recent years of quinoa cultivation and processing in Ecuador (Whali, 1990). In 1992, the 'INIAP-Tunkahuan' and 'INIAP-Ingapirca' varieties were released, both characterized by their low saponin content (Nieto *et al.*, 1992). A study of the harvesting and post-harvesting of quinoa in Ecuador was also published (Nieto and Vimos, 1992).

Of the four varieties of quinoa released during that period, only 'INIAP-Tunkahuan' is still produced. This variety, which is of Ecuadorean origin (figures 1 and 2), was collected in the province of Carchi in



Figure 1. Cultivation of the 'INIAP-Tunkahuan' quinoa variety.



Figure 2. Seeds of the 'INIAP-Tunkahuan' variety.

1985. It is a semi-early (150–210 days) valley variety adapted to altitudes of 2 200–3 200 m asl. The plant height is 90–180 cm. It is green when young and pinkish-yellow at harvest. The grain is white and opaque, of medium size, round and flat, with a low saponin content (0.06%). The yield varies between 1.5 and 3 tonnes/ha (Nieto *et al.*, 1992; Peralta, 2010).

In 1996, the Ministry of Agriculture and Livestock published *Zonificación potencial del cultivo de quinua en el callejón interandino del Ecuador* (Potential areas of quinoa cultivation in the inter-Andean corridor of Ecuador), which stated that there were 86 856 ha where quinoa could be cultivated without climatic or soil limitations (Yugcha, 1998).

This phase came to an end in 1997 when the Andean Crops Programme was closed, and responsibility for quinoa was transferred to the Cereals Programme. In 1998, Ecuador contributed the 'INIAP-Ingapirca' cultivar and the 'ECU-420' landrace to the list of 25 samples that participated in the American and European Test of Quinoa, facilitated by FAO, *Universidad Nacional del Altiplano* ☐ Puno (UNAP), *Centro Internacional de la Papa* (CIP, International Potato Center) and the Danish International Development Agency (DANIDA).

Quinoa research in the new millennium

In 2000, due to the demand from national and international institutions, INIAP resumed quinoa research within the framework of PRONALEG-GA, under the leadership of Eduardo Peralta.

It was necessary to identify quinoa accessions which satisfied consumer and producer expectations in terms of both morphological characteristics (plant type, colour and panicle) and agronomical characteristics (precocity, mildew resistance, grain quality, potential yield). The quinoa collection of INIAP was, therefore, characterized and the *Catálogo del banco de germoplasma de quinua del INIAP* (Catalogue of the quinoa germplasm bank of INIAP) (Mazón *et al.*, 2002) was subsequently published.

With the materials selected from the germplasm bank, a process of evaluation and participatory selection of quinoa lines began at the Experimental Station and with farmers in different quinoa production zones of the Sierra in Ecuador. International support was provided by PREDUZA, FAO and the International Centre for Tropical Agriculture (CIAT), and students working on master's and doctoral theses also participated (Jácome, 2002; Guambuquete and Purcachi, 2003; McElhinny *et al.*, 2007).

The 'INIAP-Pata de Venado' variety was subsequently released. It is of Bolivian origin (IBTA, E.E. Patacamaya, 1983, germplasm exchange) (Images 3 and 4), early (150–180 days), adapted to altitudes of 3 000–3 600 m asl (high, cold areas), with a plant height of 90–100 cm, and is green when young and pink at harvest. The grain is cream coloured, of medium size, round and flat, and has a low saponin content (0.05%). The average yield is 1.2 tonnes/ha (Mazón *et al.*, 2007).



Figure 3. Harvesting of the 'INIAP-Pata de Venado' quinoa variety.



Figure 4. Washed seeds of the 'INIAP-Pata de Venado' quinoa variety.

This selection method did not result in varieties of quinoa with large grains, better mildew resistance etc. For this reason, in 2008, with the support of the McKnight Foundation (United States of America) and the expert advice of Bolivia's *Fundación para la Promoción e Investigación de Productos Andinos* (PROINPA, Foundation for the Promotion and Research of Andean Products), PRONALEG-GA/INIAP initiated a programme for the enhancement of quinoa through hybridization. The programme's main objectives were to develop new varieties of early quinoa with large grains, resistance to fungal leaf diseases, and high yield potential, adapted to marginal climate and soil conditions, and accepted both

by farmers and in the markets. In 2013, F6 lines became available, with segregant populations in different descendants.

In order that farmers interested in producing quinoa and other Andean grains be aware of existing crop management alternatives, INIAP published the *Catálogo de variedades mejoradas de granos andinos: chocho, quinua y amaranto, para la Sierra de Ecuador* (Catalogue of enhanced Andean grain varieties: chocho, quinoa and amaranth, for the Sierra of Ecuador) (Peralta *et al.*, 2012), as well as an additional catalogue of Andean grain varieties (Peralta *et al.*, 2013). Fundación ERPE also published the *Manual de quinua orgánica* (Organic quinoa manual) (Raffauf, 2000).

The production of high quality selected seed, produced in non-conventional systems, is currently promoted in conjunction with organizations of family farm producers, and a guide has been published for the production and distribution of high quality seed (Peralta, 2010). On the basis of this experience, the Ecuadorean standards for the certification of quinoa seed were developed with the Ministry of Agriculture, Livestock, Aquaculture and Fisheries and with the support of FAO's "Andean Seeds" project.

In 2006, PRONALEG-GA/INIAP, together with the School of Biological Sciences of the *Pontificia Universidad Católica del Ecuador*, organized the Twelfth International Congress on Andean Crops. In 2013, the Fourth World Congress on Quinoa and the Andean Grains First Symposium were held in the city of Ibarra as part of the agenda of the International Year of Quinoa, in coordination with the Ministry of Agriculture, Livestock, Aquaculture and Fisheries, and the *Universidad Técnica del Norte*.

It is important to note that, within the framework of the International Year of Quinoa, and in view of growing national and international expectations, the Ministry of Agriculture, Livestock, Aquaculture and Fisheries is prioritizing quinoa, registering it in its list of strategic crops and giving it a strategic role in productive development and the makeover of the production matrix. Within the same context, the creation of new companies (e.g. URCUPAC) is being driven by the private sector. In addition, the *Consorcio Ecuatoriano de Exportadores de Quinoa* (Ecuadorean Consortium of Quinoa Exporters) has



Figure 5. Current and potential geographic distribution of quinoa cultivation in Ecuador.

been founded; most of its members are Ecuadorean companies and organizations involved in quinoa cultivation: MCCH, *Fundación Familia y Mujer Andina* (FUNDAMYF), URCUPAC, *Cereales Andinos*, and *Rogetore & Franco*.

The Importance of Quinoa in Ecuador

In Ecuador, quinoa can be produced in the ten provinces of the Sierra (Figure 5), with a potential area of 100 000 ha (Yugcha, 1998).

The Sierra of Ecuador is traditionally the country's primary producer of foods for domestic consumption. Until the end of the 1990s, quinoa was not one of the most important crops, but it was a product intended for local consumption (communities, parishes or cantons in the same region) (Nieto, 1997).

According to Nieto (1997), the cultivation of quinoa was of secondary importance in Ecuador, not just because of the relatively small cultivated area, but also because of its low annual per capita consumption (< 1 kg) and the apparently limited interest in increasing its production and consumption. However, various institutions, researchers and Ecuadorean entrepreneurs, with the support of international organizations and ultimately the Government, have done much to revive and promote native crops traditionally not widely grown, among them quinoa. Successful outcomes include the recovery and con-

servation of germplasm, the production of high quality seed, the development of technological recommendations for quinoa cultivation and its industrialization, and the promotion of domestic and international use and consumption (Jacobsen and Sherwood, 2002).

According to García (1984), quinoa production centres were located in specific areas in six provinces in the Sierra. The most important – in terms of frequency and extent of cultivation – were Chimborazo, Imbabura and Cotopaxi, while Tungurahua, Pichincha and Carchi produced smaller quantities. In Cañar and Azuay, quinoa cultivation had disappeared. As of 1984, the area under cultivation was estimated to be only 900–1 000 ha.

During the 1980s, INIAP and Nestlé played a vital role in saving Andean crops, and quinoa was the priority. When Nestlé established the Latinreco research and development department, the only quinoa in Ecuador was found in furrows planted among other crops; it was basically not sold at all. In 1990, the Inagrofa company began to produce and sell conventional quinoa for domestic and regional markets, and organic quinoa for Europe and the United States of America. In 1999, ERPE began to promote the organic production of quinoa for export to the United States of America. In 2002, total production in Ecuador was estimated to be 2 000 ha. The output from 500 ha was earmarked for export as certified organic quinoa (Jacobsen and Sherwood, 2002).

While the quality of the quinoa produced in Ecuador is well below that produced in Bolivia and Peru, average yield is 30–50% higher. The future competitiveness of Ecuador may depend on the ability not only to increase the area under production but also to increase the productivity, quality and recognition of this output (Jacobsen and Sherwood, 2002).

On the basis of the results of the Third Agricultural Census, carried out in 2000, Junovich (2003) reported quinoa had 2 659 registered agricultural production units (APUs), cultivated on about 900 ha. Of these, 636 ha were harvested, producing 226 tonnes, of which 180 tonnes were sold. The average yield for the Sierra was 0.4 tonnes/ha. The average area planted with quinoa was 0.3 ha/APU. The provinces with the greatest number of APUs

growing quinoa were Chimborazo, Cotopaxi and Imbabura; the main producer was Chimborazo, which produced about 80% of the total output in the census period.

In recent years, the area planted with quinoa in Ecuador fluctuated between < 500 ha and around 1 200 ha/year, producing volumes of no more than 500–600 tonnes (Figure 6).

After 2009, quinoa imports into Ecuador exceeded 500 tonnes/ year (Figure 7).

According to the Quinoa Development Project of the Ministry of Agriculture, Livestock, Aquaculture and Fisheries, quinoa exports from Ecuador do not exceed 500 tonnes/year (Figure 8). According to the Central Bank, Ecuador’s exports of quinoa have shown fluctuations since 1987. An analysis of the 8-year period from 2004 to 2012 reveals a substantial increase in exports (from 41 tonnes in 2000 to

422 tonnes in 2008). Between 2004 and 2005, exports remained relatively steady, then in 2006 there was a 18% decrease compared with 2005. The FOB price also increased, reaching its highest value per tonne (USD1 870.80) in 2008 (Figure 9).

During the 2000–08 period, the primary destinations of Ecuadorean quinoa were the United States of America (53%), the United Kingdom (29%), France (6%), Germany (4%) and Spain (4%); other countries accounted for the remaining 4% of total exports (Figure 10).

Quinoa Production in Ecuador

The vast majority of quinoa farming in Ecuador takes place on family farms. According to the Third Agricultural Census (Junovich, 2003), during the census period, 2 659 APUs were registered, with a planted area of approximately 900 ha. The average area planted with quinoa in the Sierra region was

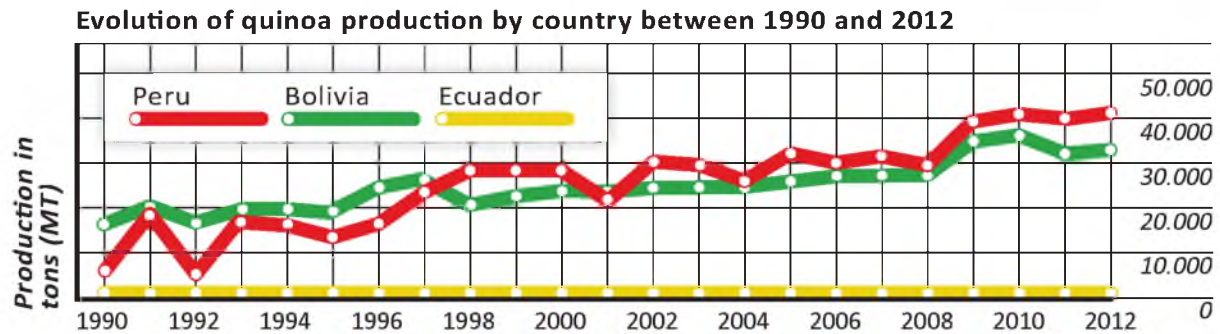


Figure 6. Evolution of quinoa production in Ecuador (Ministry of Agriculture, Livestock, Aquaculture and Fisheries: Project for the development of quinoa production in Ecuador, 2013).

Quinoa imports

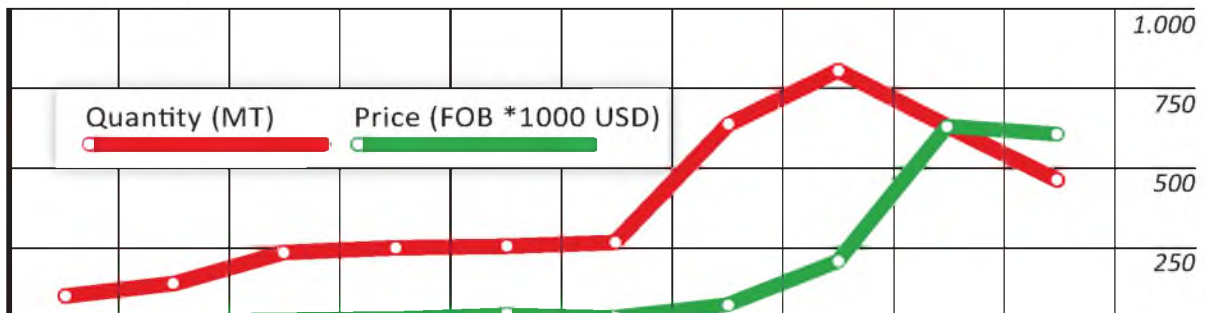


Figure 7. Imports of quinoa into Ecuador (Ministry of Agriculture, Livestock, Aquaculture and Fisheries: Project for the development of quinoa production in Ecuador, 2013).

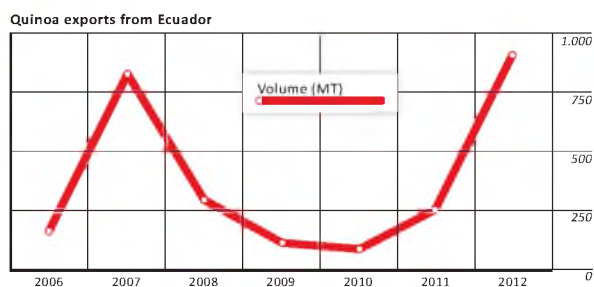


Figure 8. Exports of quinoa from Ecuador (Ministry of Agriculture, Livestock, Aquaculture and Fisheries: Project for the development of quinoa production in Ecuador, 2013).

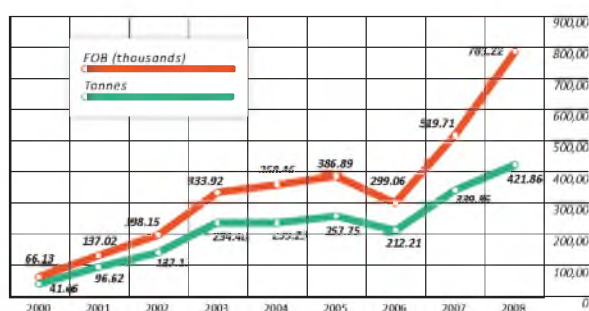


Figure 9. Annual demand for Ecuadorean quinoa, 2000–2008 (Central Bank of Ecuador, 2009).

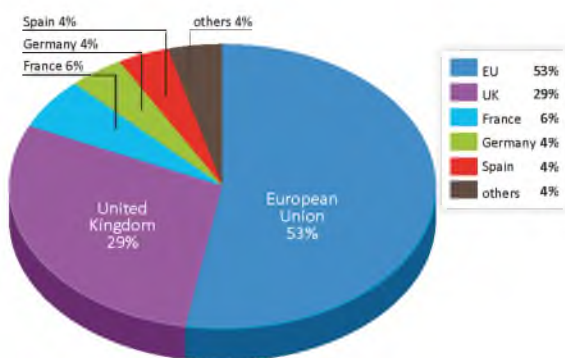


Figure 10. Primary countries of destination of Ecuadorean quinoa, 2000–08 (Central Bank of Ecuador, 2009).

0.3 ha/APU, indication that quinoa is cultivated on small farms. The provinces in which quinoa production is centred are Azuay, Cotopaxi, Chimborazo, Imbabura, Pichincha and Tungurahua. Of these, Chimborazo, Cotopaxi and Imbabura have the highest production.

In 2009, the areas under quinoa cultivation increased in the provinces of Chimborazo (mainly organic), Imbabura, Carchi, Cotopaxi, Bolívar, Cañar,

Pichincha and Loja. It is estimated that > 60% of the quinoa cultivated in Ecuador is of the 'INIAP-Tunkahuan' variety.

During the past 15 years, the varieties planted in the provinces of Chimborazo and Bolívar in organic systems certified for export, and produced by ERPE and the *Corporación de Productores y Comercializadores Orgánicos Bio Taita Chimborazo* (COPROBICH, Bio Taita Chimborazo Corporation of Organic Producers and Traders), are mixtures of native varieties with bitter grains (and high saponin content), from red, pink, green and brown plants (Images 5 and 6). Some organic producers separate their crops by colour, and it is not rare to see fields of only red or green plants. These are varieties with medium-sized grains that are opaque white or cream coloured. They are produced primarily in the provinces of Chimborazo and Bolívar.

In Ecuador, around 90% of quinoa is planted as a monoculture; 10% is in polyculture systems in association with maize (planted alone or together with climbing beans), potatoes, beans, peas etc.

In conventional systems, crops rotated with quinoa include potatoes, maize and climbing beans, barley, peas, *chocho* (also known as *tarwi*) and small tubers such as melloco, oca and mashua.

The planting season is from November to February, with a density of 12–16 kg/ha.

In manual sowing (or using small seed drills), the distance between furrows varies between 40 and 60 cm. In mechanical sowing with a tractor, 80 cm are left between furrows to facilitate weeding and hilling (Peralta *et al.*, 2012).

Organic Production

ERPE cultivates 400 ha of certified organic quinoa per year in five cantons of the province of Chimborazo, where climatic conditions vary. It mostly plants native varieties (with a variety of colours and growing cycles) and obtains yields of between 675 kg/ha and 1.35 tonnes/ha. The output is sold in the United States of America and Germany.

For family consumption, ERPE has internal rules of procedure governing producers, who must set aside 20–30% of their production for their own



Figure 11. Quinoa field with a mixture of native varieties.

consumption and use as seed. Depending on the climate, the average annual volume varies between 363 and 544 tonnes. ERPE sells all of the production in storage (363–456 tonnes). The remainder is for consumption by producers and their families (Juan Pérez, ERPE, personal communication).

COPROBICH produces 18–27 tonnes of certified organic quinoa in the province of Chimborazo. It is a corporation of producers legally recognized by Ministerial Accord No. 184 of 31 July 2003, issued by the Ministry of Agriculture, Livestock, Aquaculture and Fisheries. It is an autonomous, no-profit, private-law corporation providing services and social benefits to its members, who are Puruhá indigenous people from 86 communities in the cantons of Riobamba, Colta, Guamate, Guano and Penipe. At the time of writing, membership is $\geq 1\,632$ families. Since 2009, it has bought quinoa directly from them, exporting it as a fair trade product to France, Belgium, Germany and Canada.

FUNDAMYF cultivates an average of 400 ha/year of quinoa in the provinces of Chimborazo, Bolívar, Tungurahua and Cotopaxi, with a focus on certified organic produce. The variety grown is 'INIAP-Tunkahuan'. The average yield is 998 kg/ha. Its production is sold in both domestic and international markets (María Eugenia Lima, FUNDAMYF, personal communication).

The *Fundación Maquita Cusunich* (MCCH) cultivates about 15 ha in Chimborazo, with an average yield of 680 kg/ha. It is also active in other provinces of the



Figure 12. Field planted with a native, pure-bred variety of quinoa.

Ecuadorean Sierra.

Conventional Production

For the past 28 years, Inagrofa has been planting ≤ 600 ha/year with the 'INIAP-Tunkahuan' variety in the provinces of Carchi, Imbabura, Pichincha and Cotopaxi, with an average yield of 2 tonnes/ha. It also buys harvests in other provinces. It sells on the domestic market and exports to the United States of America (Rodrigo Arroyo, Engineer, Inagrofa, personal communication).

During the past 4 years, the Ministry of Agriculture, Livestock, Aquaculture and Fisheries has promoted the conventional cultivation of 'INIAP-Tunkahuan' quinoa in Imbabura, on 70–100 ha/year, obtaining yields of 1.5–2.5 tonnes/ha. It has worked with family farm associations and individual producers, offering training and technical monitoring; providing threshing services with stationary machinery; facilitating storage and processing operations; and promoting sales in the Ecuadorean and Colombian markets (José Manuel López, Engineer, Ministry of Agriculture, Livestock, Aquaculture and Fisheries, personal communication).

The Revelo Jara family conventionally produces an average of 80 ha/year of 'INIAP-Tunkahuan' in the province of Carchi, with an average yield of 1.13 tonnes/ha. Its reaches a national market and is used in government food programmes (Lourdes Revelo, economist, personal communication).

The *Asociación de Productores de Semillas y Alimentos Nutricionales Andinos Mushuk Yuyai* (APROSANAMY – Mushuk Yuyai Association of Seed and Nutritional Andean Food Producers) represents 14 members, 120 producers and 30 quinoa farmers. It agro-ecologically cultivates 7–11 ha/year in four cantons in the province of Cañar and one canton in the province of Azuay. Yield varies depending on climatic conditions.

The crop is produced on small plots with a relatively high number of families. They grow mainly the 'INIAP-Tunkahuan' variety and, to a lesser extent, 'INIAP-Pata de Venado'. They are losing interest in growing quinoa, due to the effects of climate variations on crop yield and also because no residue is generated for feeding livestock. The average yield from monoculture plantations is 1 350 kg/ha and the production is sold locally (at education centres, in towns and at community shops). The association promotes consumption by producer families and recommends that they store 10–15% of production for seed and their own consumption. Their average annual yield varies between 1.36 and 9 tonnes, depending on the climate. The producers sell 5.44 tonnes with added value per year, and they sell the remainder direct to consumers on local markets (Nicolás Pichazaca and the APROSANAMY technical team, personal communication).

CORPOPURUWA is a corporation with 62 founding members (47 men and 15 women) from the communities of San Miguel de Pomachaca, Asociación Mushuk Pakari, Pull San Pedro and Sacahuan Tiocajas in the canton of Guamote. It is legally recognized by Accord No. 38 of the Provincial Department of Agriculture of Chimborazo (Ministry of Agriculture, Livestock, Aquaculture and Fisheries, 2010). They produce small quantities of quinoa, in rotation with *chocho* and *tarwi*.

The Outlook for Quinoa in Ecuador

It is estimated that there are more than 80 000 ha in Ecuador with agro-ecological characteristics suitable for quinoa production: the country has the potential to intensify quinoa production and enhance productivity. In order to fulfil that potential, however, it must facilitate access to integrated crop management practices, quality seed, farm credit and threshing machines, while ensuring fair prices for producers.

Given the current agrarian structure in Ecuador, agro-ecological intensification is an option, especially for family farms where quinoa is a logical component of production (through crop rotations and associations) and where it is possible to gain access to alternative markets practising fair trade and selling organic products.

Given the international demand, the outlook for quinoa cultivation is favourable. For example, the *Consorcio Ecuatoriano de Exportadores de Quinoa* (Ecuadorian Consortium of Quinoa Exporters) has brought together major corporations and development organizations to boost production, generate added value and realize sales on international markets.

The Ecuadorean Government, through the Ministry of Agriculture, Livestock, Aquaculture and Fisheries, is launching a quinoa production development project that includes distribution of certified seed and basic inputs, access to credit, introduction of sowing and harvesting machinery, and provision of technical consultancy.

The Government is also promoting the inclusion of nutritious, locally produced products (including quinoa) in school food programmes.

Nevertheless, there are further challenges in the agricultural domain that need to be considered. Fostering quinoa production while improving productivity using the systems available is hindered by a lack of technicians with sufficient academic and practical training. Moreover, young people are becoming increasingly uninterested in agriculture, leaving agricultural production in the hands of older adults; as a result, it is difficult to implement food production development programmes and projects, such as those involving quinoa, whether for domestic consumption or for international markets.

Within the context of climate change, it is difficult to plan when to sow crops, and the risk of losing harvests is increasing. For this reason, there has been an increase in livestock production, which is viewed by farmers as a sounder investment: it entails fewer risks from the point of view of climate and it gives a more reliable source of income.

Ultimately, the demand for quinoa is based on expectations of high prices on the international market; this could change from one day to the next as

a consequence of the economic crisis in developing countries. In addition, the crop risks becoming overcultivated given the large number of countries and companies interested in quinoa production.

Conclusions

In Ecuador, in terms of area planted and per capita consumption, quinoa is a secondary crop; it is nevertheless very important for food security, especially for family farmers in the Sierra. Due to the high level of international demand and elevated market prices, many companies and organizations are now interested in increasing Ecuador's quinoa production. Initiatives are being backed by the Government through its productive development plan for quinoa; other government initiatives involve changes to the matrix of production and foreign trade.

Ecuador has the potential to meet this demand, since the agro-ecological conditions and technologies developed in the country (in terms of crop, harvest and post-harvest management, and the creation of added value) would allow the area under cultivation to be increased and productivity to be enhanced, thereby improving competitiveness in local, regional and international markets. However, challenges must first be overcome, the most important of which include: the poor partnership culture among producers; limited access to high quality seed and other inputs; difficulties in accessing machinery for soil preparation, and harvest and post-harvest operations; insufficient economic and infrastructure capacity for harvest storage; the dwindling interest in agriculture among rural populations, especially the young; and the need to develop technical assistance services, currently in their infancy.

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