

Exploration on the feasibility of A Dutch quinoa chain

"Quinoa, the most nutrient-dense 'grain' in the world", Fautapo, La Paz, Bolivia

A report for:



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Main points

- In this study, the feasibility of a Dutch (gluten-free) quinoa chain is investigated.
- The cultivation of quinoa for human consumption in the Netherlands does not yet exist; quinoa is now imported from South America.
- the cultivation of quinoa in the Netherlands and surrounding countries is possible. In addition to growing risks the high cost, low yield and the small grain size should be taken into account.
- the cultivation of quinoa will have more perspective when yield increase by further breeding and cultivation measures are achieved as has already occurred with regular cereals.
- the market for quinoa is a small market (niche market) and developing a market takes time but the market is growing annually (glutenfree as well as outside the gluten-free market segment).
- The biggest potential can be found by looking for connections at themes such as health, authenticity, and high quality diet and (gluten-free) medications, medicinal uses based on biotechnology and exploitation of components in such grain.
- Further scientific research on the ingredients and quality of Dutch quinoa (compared to Andean quinoa) is recommended.
- Quinoa is still fairly unknown to a wider audience. By cooperation, chain parties could bring quinoa and its use jointly to the attention in a larger group of (potential) consumers.

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Summary

Quinoa is originally from the Andes region in South America and is seen as the most nutrient-dense 'grain' in the world, because of its protein quality (amino acids pattern), minerals and vitamin content. Other great features of quinoa are: gluten-free and low glycemic index. The FAO, signed on 2013 as the year of quinoa proclaimed by its potential contribution to a sustainable food supply of the growing world population.

The aim of this research was to find out if a sustainable quinoa-chain for human consumption in the Netherlands is feasible, in what way and what important points of attention are.

For this a literature review is combined with interviews of growers, processors, an export organization and non-profit organizations that focus on quinoa in France, the Netherlands, Canada and Bolivia.

The growing global demand for quinoa in recent years has led to a high international price of quinoa, despite a production growth of around 35% in the same period. Bolivia is the largest manufacturer and exporter of quinoa.

Despite that quinoa in the Netherlands in particular was previously available in health food shops, since 2012 also the larger supermarkets offer quinoa to the general public. This has been accompanied by an extension of, in particular, the gluten-free market and consumers' increasing interest in 'healthy' food. In the U.S., quinoa even has the image of 'superfood'. Thorough marketing with the aim of increasing awareness of quinoa, its favorable properties and application in food can significantly increase the size of the (niche) market. Quinoa of Dutch origin can contribute to the 'local for local' principle and a better availability of this relatively scarce product. Given the global scarcity Dutch quinoa will have no significant impact on the income of South American farmers.

Cultivation experiments in the Netherlands in the past 12 years have shown that some (free of/ or containing saponins) quinoa breeds in the Netherlands are to grow with reasonable success. Excessive humidity and precipitation during the harvesting period are seen as the largest risk factor. In addition, the small grain size ensures large harvesting and cleaning losses up to 50% for the time being. Yields are relatively low and range from 1,500 to over 4,000 kg. Nevertheless, the cultivation of quinoa in the Netherlands is expected to compete with summer cereals on the basis of current market prices. Probably breeding still offers great progress in terms of yield, growth days and grain size. It is important that the nutritional value is preserved. There is still little known about the quality of Dutch quinoa compared with quinoa from the Andes region, which is an important recommendation for follow-up research.

All chain parties for a gluten-free Dutch quinoa chain are already present. Preventing cross-contamination with gluten presents a major challenge and increases costs.

It can be concluded that the establishment of a Dutch quinoa chain has chance of success based on the current cultivation experiences, market trends and presence of the necessary chain parties.

1. Introduction

1.1 General introduction

"Kieno-‘What’?". "No, quinoa, to pronounce *keenwa* of *keenowa*". I have already often clarified what quinoa is, but I imagine that over 99% of the people in my area there was not familiar with it. But I am convinced that this will change in the future.

My first encounter with quinoa was in 2001 when I was tipped by a seed producer, in the framework of practical research to alternative forage crops for cattle. We decided to grow quinoa 0.5 hectares



Photo 1: Pilot field Dutch quinoa, 2001

(GPS). It stayed with a one-time experiment, because in our opinion quinoa could not compete with established forage economically. Though we were under the impression of the development and physical characteristics of the crop. Almost 10 years later my interest in quinoa got a boost. On the one hand because of an article about the positive attributes of quinoa, especially the protein quality. But also by the increasing public discussions and reports about sustainable food supply for the

world's population (for example, the FAO report "World Livestock 2011"¹, which mentions that the world population in 2050, about 9 billion people, that consume about 65% more animal protein than in 2011). On the other hand, from my personal observation that the food pattern of many Western people could be much better in view of the relationship with health.

Could (communication and consumption of) quinoa contribute to a more sustainable food supply and healthier food style? And would a sustainable business in Dutch quinoa, with continuity for involved chain parties, in the Netherlands be possible?

After I studied more and more publications and orientated on the market for quinoa, Nuffield Netherlands came on my path with the ability to do independently international research. Immediately I decided to write a concise project plan and to apply for a scholarship.

This report is one of the products of my Nuffield Scholarship. It is a view of the research on the feasibility of a quinoa-chain for human consumption in the Netherlands and provides insight into the market of quinoa in international perspective.

¹ McLeod, A., World Livestock 2011, Livestock in food security, Food and Agriculture Organization of the United Nations, Rome, 2011

1.2 Objective of the research

The purpose of the study is to find out if a sustainable quinoa-chain (from cultivation to marketing) for human consumption in the Netherlands is feasible and how. Is quinoa interesting for the Dutch farmer, processor, retailer and consumer? Can Dutch quinoa compete regarding costs with South American quinoa and to what extent is this important? What is the influence of Dutch quinoa on the already existing chain in South America?

It is interesting to find out how such a chain is already given stature elsewhere. Thus the investigation may also be seen as a translation of existing foreign quinoa-chains to Dutch circumstances.

The research does not aim to analyze the technical side of the cultivation of quinoa in detail. Though some cultivation aspects that likely are of interest for Dutch circumstances are described.

Because a one-year research will not be able to give answers on all important questions, it is important to build an (international) network in the future of parties that can contribute to the ultimate objectives: establishing a sustainable Dutch chain and delivering healthy nutrition.

1.3 Research method

The basis of a research under a grant from Nuffield Scholarship is roughly as follows:

1. Draw up a plan of action
2. Participation in the CSC (Congress), then tightening of vision and plan of action
3. Research abroad
4. Reporting

The plan of action contains parts as: (main) questions that should be answered, orientation on available knowledge and knowledge holders, to deliver products, communication plan, planning holidays, cost budget and financing.

The CSC gives scholars the opportunity to come into contact with each other (networks) and inspiration through mutual exchanges of views, excursions and lectures by leading entrepreneurs (f.e. in the field of sustainability or entrepreneurship).

Knowledge and insights during the holidays are obtained by interviewing stakeholders and to visit the points of interest, as cultivation areas, a factory and shops. Stakeholders are consumers, growers, processors as well as governments and (producer/sales) organizations, involved in quinoa.

Finally, literature review is essential part of the research, because of the relatively extensive amount of information available.

2. Background information on quinoa

2.1 History

Quinoa is a South American plant, which is grown on the high plains of the Andes for more than 5000 years. The crop belongs to the genus goosefoot species within the family of the amaranten which also includes beet. The genus goosefoot (*Chenopodium*) also includes spinach which is common in the Netherlands. In former times the quinoa seeds were grounded to bake bread or were used fermented with bacteria into a kind of sour pap².

At the Incas the plant had a religious status. It was called 'mother-grain' and people were convinced that the seed gave special powers. This ensured that the Spanish, who controlled the area from about 1500 for a long time, discouraged the cultivation of it actively. So the cultivation of quinoa remained confined to small areas and small quantities. Because in parts of the Andes almost nothing else was to grow successful, quinoa remained the main crop there. In the last century there were two factors more involved: in the poor South American countries heavily subsidised North American wheat flour was imported and the local farmers were encouraged to say their traditional crops goodbye and instead of that to grow more common products³.

Over the past decade, however, a sea change has taken place, especially in Peru and Bolivia. Agronomic and nutritional benefits are identified and more and more new markets in Europe and North America for quinoa are tapped.



Photo 2: Quinoa in Bolivia

2.2 Crop and product information

The plant can be one to three metres tall and the growth cycle lasts 90 to 150 days, depending on variety, climate, fertilization and geographical location. Quinoa can grow in the cold, dry and sometimes salt rich Highlands of South America and a relatively high yield can be obtained without intensively cultivating the land. Quinoa is pretty resistant to frost (at least -2 – 0) and can grow in a very poor soil.

Quinoa seeds are formed in the plume of the plant and are found in the colours white, red and black. During the maturing of the crop, it gets a wonderful variety of colours. Despite that the harvest in South America mainly happened manually, regular combine harvesters can be deployed.

² www.wikipedia.org/wiki/Quinoa

³ www.food-info.net/nl/national/verslag-quinoa

During the processing of the seed steroidal saponins should be removed. These are glycosides which cause a bitter taste and some types can be toxic. They are located mainly in the seedcoating². Steroidal saponins are seen as a natural defense of the plant against insects and bird feeding. Removing steroidal saponins can be done by removing the seed skin mechanically and/or by the to rinse the seeds with water. There are also sweet varieties that contain little or no more steroidal saponins. Thus, the PRI (Plant Research Institute of the LEI Wageningen UR) developed a sweet breed⁴.

2.3 Area and production numbers

Quinoa is mainly grown in Bolivia, Peru and Ecuador. In addition to a lesser extent in Chile and Argentina. On a small scale (100-1000 ha) we find quinoa in France, USA and Canada. In a larger number of countries like Netherlands, Australia and Egypt very small-scale cultivation experiments are applied. In Figure 1 is showed what the main growing areas of quinoa in Bolivia are.

The FAO reports annual acreage and yields of quinoa in Peru and Ecuador, Bolivia. The table⁵ below shows that the area is relatively small, but since 2005 a clear growth is shown, a total of ca. 69.000 ha in 2005 to ca. 100.000 ha in 2011. In comparison in the Netherlands approx. 150.000 ha wheat is grown⁶. The corresponding quinoa production amounted approx. 58.500 tons in 2005 and 78.000 tons in the year 2011.

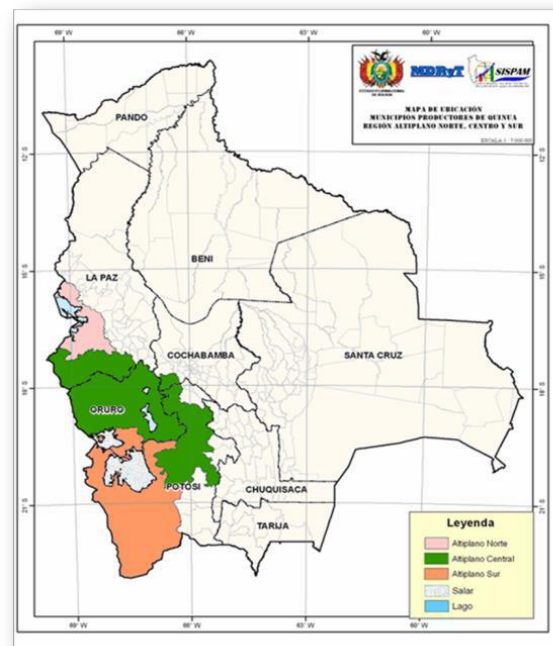


Figure 1: Quinoa areas in Bolivia

Source: MDRyt, R. Michel, 2012

⁴ www.wageningenur.nl/nl/show/Quinoa-voor-babys

⁵ www.fao.org / Janssens, B., Van den Berg, I., Van Leeuwen, M., Jukema, N., Verkenning haalbaarheid glutenvrije keten, Rapport 2008-034, LEI Wageningen UR, Den Haag, augustus 2008

⁶ www.cbs.nl

Table 1: Development acreage and quinoa production on a global scale (FAO and LEI Wageningen UR, 2008 nr. 034)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Area (hectares)									
Peru	28326	27676	28632	29947	30381	31163	34026	35313	35461
Bolivia	38289	38649	39302	42431	45454	46369	59924	63010	64789
Ecuador	1000	918	929	950	980	1000	1100	1176	1277
World	67615	67243	68863	73328	76815	78532	95050	99499	101527
Production (tons)									
Peru	30085	26997	32590	30429	31824	29867	39397	41079	41168
Bolivia	24936	24688	25201	26873	26601	27169	34156	36106	38257
Ecuador	519	641	652	660	690	741	800	897	816
World	55540	52326	58443	57962	59115	57777	74353	78082	80241
Production (kg per ha)									
Peru	1062	975	1138	1016	1048	958	1158	1163	1161
Bolivia	651	639	641	633	585	586	570	573	590
Ecuador	519	698	702	695	704	741	727	763	639
World (average)	744	771	827	781	779	762	818	833	797

Incidentally sources in Bolivia (e.g. Cabolqui, Association of quinoa exporters) indicate that production of quinoa in 2012 is ca. 45.000 tonnes, of which ca. 20.000 tons is exported. It is estimated that this is produced by ca. 70.000 growers. The yield per ha in Bolivia is at a relatively low level, 500 to 600 kg per ha. Main customers for Bolivian quinoa are USA, France and the Netherlands⁷. Cabolqui together with local Ngos try to increase the yield, through cultivation optimization. The objective is to achieve a yield of 1,200 kg per ha in 2015, including 30% harvest losses.

2.4 The year of quinoa

The year 2013 is the 'stage' year for quinoa. The United Nations has accepted the proposal of Bolivia's leader Evo Morales, to appoint 2013 as the year of quinoa, given the potential contribution that quinoa can make to the fight against hunger and malnutrition.

The Bolivian government seizes this opportunity to promote quinoa, especially the 'Quinoa Real' worldwide through international fairs (e.g. Netherlands, Floriade 2012), conferences and websites.



Figure 2: Logo 2013
Internationale jaar of quinoa.
www.quinuainternacional.org.bo

⁷ Michel, R., Produccion y exportaciones de quinoa, MDRyt, 2012

3. What makes quinoa special for consumers?

3.1 Nutritional value

Quinoa is the most nutrient-dense 'grain' in the world! Quinoa seeds contain about 14% protein, 6% fat, 57% starch, 4% ash, 6% fiber and 13% water^{2,3,5,8}. Quinoa-starch contains approximately 12% amylose and has a gelation temperature of 57-64 °C³. The protein fraction in quinoa is very balanced:



Photo 3: Quinoaseeds in het shop

all the essential amino acids are present, in an almost perfect balance. Especially the levels of the amino acid Lysine and (to a somewhat lesser degree) Methionine are high. The Protein Efficiency Ration (PER) of quinoa is almost identical to that of milk protein (casein)³. Quinoa is therefore a potential (partial) replacer or completion of/on animal protein sources like meat or dairy.

Compared to other cereals quinoa is rich in the vitamins B2 and E and the minerals phosphorus, calcium, iron, copper and magnesium⁸. The content of phosphorus and iron is even more (phosphorus: factor 2, iron factor 3.5) than in beef steaks⁹. Quinoa contains mostly unsaturated fatty acids.

In addition to the seeds, also the leaves of the quinoa plant are suitable for human consumption. The leaves are generally (in countries like Bolivia) cooked and served as a side dish, similar to spinach.

A striking reference mentioned by sources and websites is a NASA publication from 1993 of authors Greg Schlick and David I. Bubenheim: "Quinoa: An Emerging" New "Crop with Potential for CELSS". According to the NASA quinoa would be one of the components in the diet that is very suitable for long term space travel.

3.2 Glutenfree

Celiac Disease, also known as gluten intolerance, is an auto-immune disease. The bowel gets damaged by eating gluten. Gluten is a protein that occurs naturally in wheat, rye, barley and spelt. Gluten is also present in products made of these cereals, such as bread, crackers, pizza, pasta, cakes and pies. It's also hidden in products where you don't expect it directly, such as in soups (binder, vermicelli or meat), in sauces, beer.

Celiac disease is the most unknown epidemic of the Netherlands: 1 out of 100 people has it, only 1 out of 800 people know they have it. In the Netherlands 160,000 people live with this disease. About 135,000 people are unaware of having it. At the moment there is one treatment for celiac disease: a strict and lifelong glutenfree diet¹⁰.

⁸ El Hafid, R., Quinoa ... The Next Cinderella Crop for Alberta?, Alberta Agriculture, Food and Rural Development, June 2005

⁹ www.voedingswaardetabel.nl

¹⁰ Dutch Coeliaki Association

Quinoa is naturally free of gluten. To be able to offer the consumer a gluten-free product and to ensure it, it's very important to prevent contamination with gluten. This requires extra attention from cultivation to packaging of the finished product. A gluten-free chain, from start (cultivation) until the end (the shelf) should be completely separated from non-gluten-free chains. Small scale, preventing contamination and distribution increases costs.

Some examples of places in the chain where the risk to mixing can occur¹¹:

- on the field where wheat (storage) grows between gluten-free grain;
- combine harvester: a combine harvester that is used exclusively for the harvest of gluten-free crops;
- in mills where gluten free grains are grounded, no regular grains are allowed to be crushed;
- gluten free bread at the grocery store should be separated from regular bread;
- bread crumbs: a separate butter dish on the table for celiac disease patients;
- breaded products, soups and sauces.

3.3 Glycemic index

The glycemic index indicates how fast diet let rise blood sugar (compared to 100% glucose). This depends on the food source, but for example also the method of preparation and digestion of the individual. Food with a low GI may have a positive impact on, a.o. obesity, diabetes mellitus and heart disease¹². A GI less than 55 is seen as low¹³. Publications mention GI values of quinoa between 35 and 53. Therefore quinoa belongs to the class of foods with a low GI.

In comparison with quinoa, for example, mashed potatoes and honey are converted to glucose and included into the bloodstream rapidly. They have a glycemic index of about 85. Apples and yogurt take much more time before they increase the blood sugar. They have a glycemic index of 35. Peanuts have a very low glycemic index, so a long conversion time: 15¹⁴.

Table 2 Overview of glycemic index and - load of different products

	Carbohydrate (g/100g)	GI	Partie (gram)	GL
White wheatbread	48	75	35	13
Volkoren wheatbread	39	74	35	10
Banana	20	51	120	12
Apple	13	36	120	6
Potato cooked	17	78	200	27

Source: International tables of glycemic index and glycemic load values: 2008. Atkinson et al, Diabetes Care, 2008.
Carbohydrate values: NEVO 2011.

However the blood sugar peak after a meal depends even more on the amount of carbohydrates you eat than what type of carbohydrate. That is also a reason that besides the GI another code is used: the glycemic load (GL). It's a measure of the total 'load' by carbohydrates of a meal. Because only

¹¹ Janssens, B., e.a., Verkenning haalbaarheid glutenvrije keten, LEI Wageningen UR, augustus 2008

¹² www.voedingscentrum.nl

¹³ www.mendosa.com

¹⁴ www.diabetesfonds.nl

the glycemic index of a source does not say much if you don't take the size of the meal into account¹². The practical application of the GI and glycemic load is complicated. The consumer or patient must learn to cope with it and must be very motivated.

3.4 Other nutritional aspects

Quinoa has even more striking fertile breeding/product properties. It has a distinctive nutty taste compared to grain and seed-like 'bite'. As a result, for example, it's better suited to use it in salads than cereals like wheat or rice.

A totally different aspect is described in publications about so-called ecdysteroïds in quinoa and the beneficial effect of these on the human body¹⁵. These plant hormones belongs to the so called group of glycosides as well as saponins. Sciencedirect.com mentions that chemists analysed samples of quinoa and found a large amount of ecdysteroïden in it, as this is also shown in spinach. If these researchers extrapolate the beneficial effects of ecdysteroïds, shown in animal studies (effects on the skin, bones and muscle mass but break down fat), to people and then look to the content of ecdysteroïds in quinoa, they suspect that people who eat quinoa regularly become healthier¹⁶.

3.5 History and origin

Having regard to the fact that quinoa was grown already thousands of years BC, quinoa can be called a prehistoric (pseudo)grain with right. The South American Andes region is seen as the place where quinoa grew originally on thousands of meters height. The history and origin of this 'primal pseudo-grain' as described earlier makes quinoa also interesting in terms of experience. Experience is an aspect which may be underestimated in importance for consumers and can contribute in the promotion of Dutch quinoa.



Photo 4: Quinoa in Bolivian Andes

¹⁵ www.sciencedirect.com/science/article/pii/S0308814610012860

¹⁶ Food Chemistry 125 (2011) 1226–1234

4. What does the current market of quinoa look like?

4.1 Development of the Bolivian market

Quinoa is on the menu for thousands of years in countries such as Bolivia and Peru. Logical because quinoa is an important native crop, from which one was much dependent on in the Andean region. In addition, many applications with quinoa are known as porridge, soup and basis of the main course, to compare with cereals as pasta in Western countries.

The last decades quinoa has become less popular in these countries for several reasons. Washing of quinoa to remove saponins took a lot of time, what till 15 to 20 years ago had to be done manually by the lack of a mechanized process. In addition, more and more quinoa got the image of 'food for the poor' and this was increasingly supplanted by 'Western' products such as wheat and rice. In addition the current generation is little aware of the high-quality properties, what has prompted the current Bolivian leader Evo Morales to start projects which have to polish the image of quinoa. For example, there are programs in which pregnant and lactating women get donated quinoa.

Finally the global demand from the Western countries has grown much stronger than the production, which has led to a price hike. Convenient for the quinoa-farmers and their families, but for many local people quinoa have become almost unaffordable. Only non-export worthy quinoa is still somewhat affordable, but this is probably only 10-20% of the total production.

4.2 The current market in Netherlands and other Western countries

The import and consumption of quinoa in the Netherlands and Western Europe (especially Germany and France) has slowly increased since the 90's. In the Netherlands in particular through natural food stores and webshops. The consumers or 'early adapters' were in particular people who actively searched for gluten free and/or biological products.

The market for gluten-free products is a strong developing niche market. On the one hand because celiac disease is diagnosed increasingly. On the other hand, because gluten free is gradually seen as a general characteristic of healthy food supply. In US and Canada, this trend is very clearly noticeable. Both visually in supermarkets as in the results of market research. The number of gluten-free products in the US has doubled between 2005 and 2010 and now has a turnover of 1.5 trillion, according to figures from market researcher Packaged Facts¹⁷.

Since 2012, the sales of quinoa in the Netherlands got in a light flow because the larger supermarket chains implemented quinoaproducts in their range, meeting the same growing consumer group and the trend towards more diversity and demand for 'healthy' products.

This trend in the Netherlands follows that of countries such as Germany and France. But a stronger growth in consumption of quinoa is seen in the United States in recent years. Quinoa has here been given a more prominent position as 'super food' because of properties as gluten free, favourable

¹⁷ nl.odemagazine.com/exchange/22555/glutenvrij_dieet_is_nieuwe_hype

glycemic index and good protein quality. The offer of quinoa products, in addition to the countries where quinoa has its origin, is much more diverse in the United States and Canada than currently is the case in the Netherlands. In the Netherlands the current offer is not much beyond quinoa seeds and flour, while outside Europe e.g. complete pasta lines are produced for years. It is expected that the range of quinoa products also will broaden here. With the increasing fame (and promotion) of quinoa and growing range of quinoa products consumers are expected to include more quinoa in the Dutch kitchen. Because quinoa is still relatively unknown in the Netherlands, it's important to inform the consumer about its use or to offer ready-to-use products.

5. Is a successful cultivation of high-quality quinoa possible in the Netherlands?

5.1 Cultivation of quinoa in the Netherlands

Cultivation experiments have shown over the past 10-15 years that quinoa can be successfully grown in the Netherlands. The author of this report is one of the experts, in addition to some farmers and researchers who have experienced in recent years that some varieties, co-developed by Plant Research International (PRI), germs and grow fine here. The yields are estimated at an average of ca. 3,000 kg per hectare. Logically, the potential yield is higher, given the limited cultivation experience in the Netherlands and limited breeding in Europe till now.

There is limited experience with risks caused by weeds and bacteria, viruses and insects because of the small-scale experiments. More cultivation experience on a larger scale is therefore required in order to obtain a good picture of yield and risk factors such as pests and diseases. This can also give insight in the possibilities for organic cultivation of quinoa. In this research little attention has been given to organically cultivation. Organic cultivation is a preference, but set subordinate by the author to aspects such as regional production, nutritional and gluten free.

An important risk factor is the weather influence in the period of rise and harvest. In countries like Canada and France huge crop losses up are reported to 100% due to abundant precipitation (during rise and harvest) and high air humidity (harvest). In order to avoid problems during attendance a



Photo 5: Quinoa harvest in Canada

good dewatering of the plot is important. At the end of the maturation, quinoa is sensitive to shot (germination of the seeds) and formation of mold because the plume with its many small seeds dries up badly. In addition, these weather conditions affect the threshing and harvest losses for the same reason. Thus, sunny and dry weather and acting accurate during the harvesting period is very important. Therefore sowing timely is important, probably no later than mid-May, based on

information from growers in France and Canada. A timely harvest in september and sufficient chance of dry and sunny periods seems to limit harvest risks.

5.2 Quality of Dutch quinoa

There is still little known about the quality of Dutch quinoa. A publication on the feasibility of a gluten-free chain in the Netherlands mentions that processors expected problems with the small size of the grains and bitterness of Dutch quinoa¹². On inquiry the format of quinoa grown in Europe and Canada is indeed smaller than the 'Quinoa Real' from the Andes region. Regarding the application of quinoa possible solutions for these small quinoa grains can be found in alternative destination where this size is less important or even offers an advantage. With regard to the bitterness the question is whether in this case saponin-containing or – free breeds are used. In case of saponin-containing varieties, the seed skin of the grain has to be stripped before processing in which most steroidal saponins are present. In the Netherlands the process of mechanical saponin-cleaning is as far as known, not yet applied. In case of application of saponin-free varieties this act is redundant.

No information is found about the exact nutritional value or content of nutrients of Dutch quinoa compared with quinoa native to the South American Andes.

Further studies on the above aspects are desired, but it can be said that with the right knowledge about growing and processing with today breeds a successful cultivation already may be possible. With sufficient budget for further breeding another great progress may very likely to be made in order to yield and grain size. Nevertheless, attention to quality or nutritional value of quinoa is very important, what should not be subordinate to the other aspects.

6. Is a profitable and competitive quinoa cultivation and processing attainable in the Netherlands?

Because mainly the cultivation and first processing steps of quinoa are unique in the Netherlands, this chapter focuses mainly on these parts of the chain. The world market price of fine (white) quinoa is hereby taken as a reference, which in 2012 was approximately 3,000-3,200 USD (approx. 2,300 euros) per ton F.o.b. (Free On Board) (ref. Cabolqui). It is important to mention that depending on the quality of imported quinoa from South America sometimes an extra cleaning due to saponins is needed. Normally, this will be shifted to the consumer by mentioning the need to wash the product before the kitchen preparation on the pack. For the ease of use a fully cleaned product is preferred. Because in the Netherlands no useful processing lines for the attention of saponins exist as far as known, saponin-free breeds seem to be preferred. This makes any investment in this technology, unnecessary treatment and an extra drying process redundant.

The costs of transport, storage, cleaning and brokerage of quinoa are estimated on approx. 1,300 euros per ton. These costs are likely to be significantly higher compared to cereals, due to the small scale of gluten-free products. This results in an estimated revenue of 1,- per kg cleaned quinoa excl. harvest cost, or 750 to 1,750 euro per hectare, assuming 50% crop/cleaning losses and a gross yield of resp. 1,500 kg and 3,500 kg per hectare. This means that in an 'average' year quinoa could compete moderately with summer or winter grain. Producer prices of wheat can of course vary greatly (100 – 240,-/ton). On the other hand the strong variation in crop yields of quinoa, gives a larger cultivation risk, partly because the cultivation and cleaning process are new in the Netherlands. No major differences are to expect in cultivation costs compared to spring wheat.

Possible yield increase by improved cultivation, harvesting- and cleaning techniques on the one hand, and breeding of better quinoa varieties on the longer term, could make quinoa at least economically competitive compared to winter cereals. Through financial contribution of investors or grants this process can speed up.

In view of the global developments in demand and supply of quinoa a strong price drop over the next 5 – 10 years is not expected. On the other hand, the price rise will flatten with a view on the price elasticity of quinoa products and price difference with established cereal products.

As for the cleaning and processing of harvested quinoa to a ready-to-use whole quinoa seed, the product has to undergo the following operations:

Cleaning and drying

A thorough cleaning of the harvested product in combination with reduced grain losses is not easy. After the harvest, and an initial rough cleaning (removal of the chaff, pebbles, coarse weeds) the product has to be dried to a moisture content of max. 12%. This is important in order to prevent loss of quality. The product is then stored in containers or bigbags.

Before the product can be delivered from stock, a second cleaning is applied with the aim to remove weed seeds and other remaining (an) organic contamination.

Removing saponines

Naturally, quinoa contains saponins that are particularly concentrated in the seed skin. If would be chosen for saponin-containing varieties, these should be removed through brushing, etchings and/or washing the grain. After this, the grain has to be dried. This process is carried out after the second cleaning has taken place, so the least possible quality loss occurs.

The cleaning-and drying costs of (gluten-free) quinoa are relatively high, because of the small scale gluten-free chain and risk costs to rejected parties in case of a gluten contamination. Nevertheless, these costs do not seem to lead to a too low producer price, assuming the producer price is the result of the world market price minus the processing costs.



Photo 6: Manual cleaning of quinoa in Bolivia

7. Is there enough market for Dutch quinoa?

Quinoa in the Netherlands is gaining in popularity, given the increasing properties in super markets and increasing media attention. Since the beginning of 2013, quinoa is included in the assortment of all major Dutch supermarket chains. The number of circulating quinoa-recipes is also greatly increased in 2012 and 2013 (internet, advertising brochures).

The import of South American quinoa in 2008 amounted to approx. 5.000 tons with an annual estimated growth of 10-20%¹². Nevertheless, the consumption in the Netherlands is hard to estimate because imported quinoa is also partially deposited off the Netherlands. Suppose that the potential market of Dutch quinoa is 20% of the import volume (in 2008), that would correspond to 1,000 tons or about 350 hectares. An annual growth rate of 10% would increase a mean potential area of 30 hectares per year.

Dutch suppliers of imported quinoa indicate that the availability of quinoa is an increasing problem. On the one hand because of the rising consumption in Europe, on the other hand, because of the greatly increased consumption and better marketing possibilities of South American quinoa in USA and Canada. Volume growth is therefore desired and Dutch production of quinoa can contribute for local consumption.

In addition, a part of the Dutch consumers prefer locally produced products. This is strengthened by the association of local production with a positive effect on CO2 emissions and energy consumption.

Assuming a competitive quality and continuous availability, it can be concluded that there potentially good opportunities exist for the marketing of Dutch quinoa in the Netherlands and surrounding countries.

8. The structure of a Dutch quinoa chain

The figure below shows the entire chain as discussed below schematic.

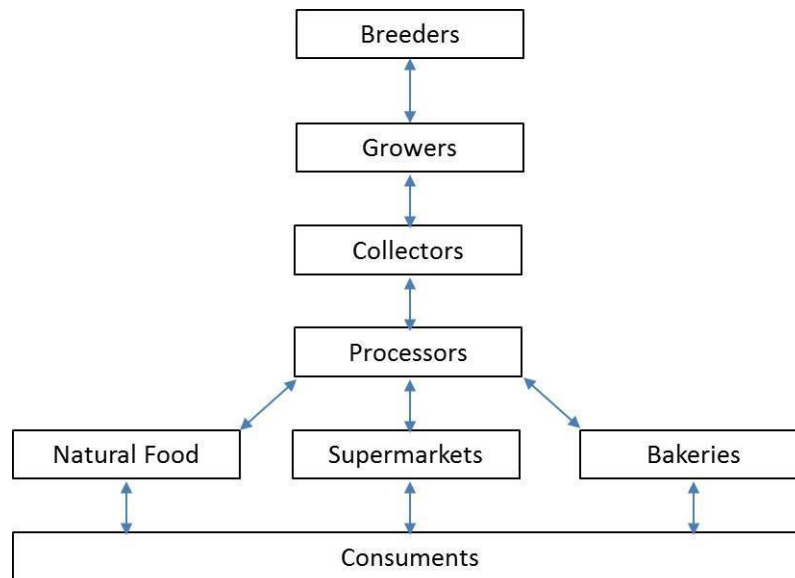


Figure 3: Structure of the quinoa chain

Consuments

Dutch quinoa must meet the need of, in particular, the Dutch consumer, assuming this quinoa has no substantial properties compared to South American quinoa. If this is the case, the challenge is to see whether these properties can be used to deliver a positive distinctive product. Besides the fact that Dutch quinoa though offers a distinctive positioning because of the difference in origin.

Retail

A few years ago quinoa was a product what was only available via organic food shops, but now can be determined that all larger supermarket chains introduced quinoa in the assortment. Because of its beneficial properties quinoa can be postioned for a wide audience in addition to specific target groups. On the other hand, Dutch quinoa production and processing is new and still has to develop. This can give preference to an initially limited assortment purchased via selection of retailers, where the commercial value of this regional product is maximally utilized. To offer a security of supply is of interest, consistent with a realistic production and sales volume in the first approx. five years. Further technical crop-, food-technologic (product development) and market research (consumer) to Dutch quinoa shall prove what the best options will be and which products and market players in the retail will give the best connection.

Processors

Depending on the form in which Dutch quinoa will be offered to the consumer (all grain, flour or ready-to-eat products like bread) the quinoa-grain will need an extra processing step in the chain. It is important that no contamination with gluten occurs and that processors don't work with gluten-containing products. In Netherlands some manufacturing companies (such as bakeries) are present where only allergen-free products are used. They have already shown interest for Dutch quinoa.

Collectors

After the harvest at the growers quinoa should be collected to a central collector. In this select a first processing to a ready-to-use raw material is done besides the task of collecting.

A gluten-free cereal-cleaningline is available in the Netherlands on a limited scale. The company Tisco is specialized in providing special raw materials for human consumption to processors of baby food, medicinal nutrition or diet foods such as gluten-free. In 2007 the company opened a new gluten-free processing plant to grind. This plant contains modern equipment for cleaning of seeds and gluten-free grains (such as rice, buckwheat, sorghum, corn, quinoa, amaranth, teff). After cleaning of raw materials a variety of gluten free flour and other grain products are produced¹².

The Koopmans flour mills also have a private location for the processing of gluten-free products, accommodated in Teff BV. Among other products, Dutch teff is grounded here. Grain chrusser De Halm chrushes gluten-free grains including South American quinoa. The flakes are not guaranteed glutenfree¹².

Incoming parties quinoa serve to be thoroughly checked on presence of gluten, preferably in a 'quarantine' room. This is to prevent cross contamination and that large quantities should be rejected.

Growers

The relatively new cultivation of quinoa asks initially progressive growers who accept proper growing risks. Cooperation with chain partners, experts (local as well as from abroad) will lead to the best results. This group of pioneering growers can make an important contribution in optimizing cultivation and harvesting methods in the Netherlands. During this research multiple Dutch crop farmers have already shown interest actively.

Because growers in all likelihood will gain experience with a limited area in the first years a regional start-up of growers is preferred. This allows limited costs related to cultivation (guidance), harvest and transport.

In addition, cultivation is preferred in regions where no intensive cultivation of gluten-containing crops such as wheat or barley is applied. Because a low contamination already can cause problems to people with celiac disease, such a harvest party will soon be rejected and should be deposited in an alternative channel at a lower price.

Previously mentioned calculations show that quinoa should be able to compete with summer grain. The relatively low yield is compensated with a high producer price. No major differences in cultivation costs are expected.

Breeders

In the field of processing of quinoa probably huge progress can be made, for example, to reduce risks in cultivation and harvest and to increase revenues. According to consumer concerns and product developers also selection on product properties can be made. The unique positive features in terms of nutritional value must to be respected. So far, in particular Plant Research International (PRI) have been active in the distribution of European quinoa breeds.

In general it can be stated that cooperation between chain partners and between chain partners of Dutch and imported quinoa can greatly help to increase awareness to quinoa (Dutch) consumers. This could lead to a faster achievement of the potential market with more effective spending of marketing budgets.

9. SWOT-analyse of (Dutch) quinoa

The following SWOT analysis provides insight into the strengths, weaknesses, opportunities and threats of Dutch quinoa. For this the analysis of historic grains from the report 'Exploration feasibility of gluten-free chains' by LEI Wageningen UR is used¹², where adjustments are made regarding the focus on quinoa as well as the knowledge that this research has given.

Opportunities

- When the other celiacs can be reached, this is a potential market growth of 90%. The group of celiacs grows due to increased knowledge (exchange) and improved detection.
- There is a growing group of consumers (non-celiac disease patients) who cares about healthy diet (organic food) which increases the demand for these 'cereals'.
- Healthy food is 'hot'. People with overweight are likely to benefit from the use of quinoa. A.o. the beneficial glycemic index creates a less hungry feeling.
- Increasing attention (marketing retail / processors and FAO: 2013 the year of quinoa) for quinoa (dishes) provide a relatively rapid increase in awareness of the product and its applications.
- Authenticity as important trend where old ancient grains fit in. This development contributes to the increased interest in quinoa.
- High-quality food: exploit the use of content materials for example, for medicinal uses, nutrition for athletes and through biotechnology. Ingredients are also useful in foods for hospital patients who have to recuperate and repair before and after surgery.
- Distance: preference for Dutch/European production takes account of transport costs and foodmiles.
- Political (in) stability can disturb production in South American countries and export from there.
- Also in other countries and continents interest and attention to the cultivation and consumption of quinoa exist. Especially in countries where health is 'hot': the US and Canada. Increasing demand leads to higher prices of quinoa.

Threats

- The production of quinoa in South America is increasing (price pressure); er is een flink produktiepotentieel met lage produktie- en verwerkingskosten. On the other hand, at present the demand seems to grow faster than the volume, given the price increase in the world price.
- A major threat to the cultivation of quinoa in the Netherlands (Western Europe) is the low production cost, for example, in South America. By contrast, the logistical costs to deliver quinoa from the grower to the Dutch consumer are higher.
- The current high cereals prices hamper Dutch growers to choose for the cultivation of quinoa (disadvantage cultivation).
- Many providers of gluten-free products: the gluten free-consumer can choose from a increasing assortment of (bread) products.
- Product quality: is it possible to approach a similar product quality compared to Andean quinoa in Western Europe?
- Ethics: production in Europe can be at the expense of poor producers in South America and Africa who have few alternatives. By contrast, poor consumers in the same regions stand to benefit from

lower prices. In addition, high prices lead in these regions lead to non-sustainable cultivation methods, such as limited set-aside and/or crop rotation.

- As a result of the current relatively high obscurity of the use and preparation of quinoa in meals, there is a possibility that 'new' (trendy) consumers will not have a positive experience, in particular concerns palatability. This allows a one-time purchase.
- Oats as a cheaper alternative for celiac disease patients. Celiac disease patients generally turn out to tolerate well the protein in oats even though this grain not known as gluten free at the NVC website. Only elderly patients were found to be sensitive to these proteins. Oats contains essential amino acids and are a good source of slowly digesting carbohydrates, contains unsaturated fatty acids and beta-glucans, which have positive effect against heart disease.
- Other continents such as the US and Canada could expand the cultivation as result of the increasing consumer demand of quinoa.



Photo 8: Dutch consumers are still little known with quinoa dishes (photo: Fautapo)

Strengths

- The cultivation of quinoa in the Netherlands is not without risks but technically possible; also for organic cultivation. As far as known, quinoa is little susceptible.
- All chain parties (collectors, processors and growers, retail) are present in the Netherlands.
- Quinoa is also suitable for non-gluten-free applications.
- New/alternative crops (exotic is disadvantage) add to the scenic value.
- Quinoa is healthy and rich in nutrients. It has a high level of specific ingredients.
- There are quinoa varieties available that are not bitter (without saponins) and able to grow in the Netherlands.

Weaknesses

- Low yield (kg per hectare) and success risk compared to competing crops.
- Quinoa has the disadvantage that harvesting and clean up is difficult, due to the small grain.
- It is unclear whether Dutch quinoa has a similar (bakery) quality as in imported quinoa.
- High production costs (labor, land) of quinoa in the Netherlands/Europe. Low yields and high costs result in a high cost: the cultivation and products are relatively expensive than.
- The high cost and potential outlets are the most important risks.
- Strong variation in yield level is possible: risky compared to wheat cultivation.
- Current price development on international grain markets (wheat, rice) is detrimental to the competitiveness of quinoa in the construction/growing plan. Growers prefer the cultivation of common crops with the highest return and low risk.
- Limited market size; especially for combination gluten-free and organic; in terms of competition.

- Ignorance: usage and consumption possibilities of quinoa are unknown to a wider audience.
- There is still little scientific research on the effect and added value of ingredients of quinoa. For example the inclusion of biopharmaceuticals from quinoa by the human body.
- Expensive raw material compared to other gluten-free flour products (maize, rice).
- Breeding: developing of the basic material is time consuming and costly.
- Gluten-free chain is precious by small scale and because of the assurance of gluten free.

10. Conclusions and recommendations

10.1 Conclusions

In this study, the feasibility of a Dutch (gluten-free) quinoa chain is investigated. The main findings of the research are listed below.

Cultivation

- the cultivation of quinoa in the Netherlands and surrounding countries is possible. In addition to growing risks the high cost, low yield and the small grain size should be taken into account.
- the cultivation of quinoa will have more perspective when yield increase by further breeding and cultivation measures are achieved as has already occurred with regular cereals.

Market

- the market for quinoa is a small market (niche market). Considering the fact that 1% of the population is celiac patient, it goes to more than 160,000 people in the Netherlands. Currently, about 25,000 people are diagnosed¹⁸. This group is growing annually.
- for the preparation of gluten-free products a large range of raw materials are available. Preferably is flour where various substitute raw materials are used (among others buckwheat, rice, corn), which is often cheaper than flour of quinoa. They are manufactured based on the optimal mix for the final product.
- Celiac disease patients experience gluten-free products as expensive. The combination of diet (gluten-free) and organic is even more expensive and limited, which concerns a small market outlets.
- the market potential of quinoa should be mainly found outside the gluten-free market segment. The odds are widened by looking for connections at themes such as health, authenticity, and high quality diet and (gluten-free) medications, medicinal uses based on biotechnology and exploitation of components in such grain. It should be pointed out on features where quinoa stands out as certain health aspects and components.

Chain

- the chain of quinoa is specialist, partly because of the assurance of gluten free. The cultivation of quinoa for human consumption in the Netherlands does not yet exist; quinoa is now imported from South America.
- Given the slump marketing of Dutch Teff, also an ancient wheat, it can be determined that the market potential of 'similar' (pseudo) grains such as quinoa should be not overrated, that there is growth potential plus that developing a market takes time.
- the gluten-free chain is becoming more accessible to the consumer by a growing number of sales channels (supermarkets and web stores) and increasing professionalism of health food stores.

¹⁸ www.gezondheidsnet.nl

10.2 Recommendations

To get more insight into a number of important aspects, the following recommendations for follow-up activities can be done:

research

Carrying out scientific research on the ingredients of quinoa, including the levels. Is the quality of Dutch quinoa similar to Andean quinoa? What makes the difference and what does that mean for consumers?

Building on this, it is also important to understand the actual intake of these compounds by the human body and health effects.

breeding

Harvest and cleaning during the maturing to much loss arises by the small size of the grain. Through breeding there may be a possibility to make this grain larger and/or losses can be limited by improved cleaning methods.

information and communication

Quinoa is still fairly unknown to a wider audience. By cooperation, chain parties could bring quinoa and its use jointly to the attention in a larger group of (potential) consumers.

Afterword

What started as a one-time experiment aimed at 'cow-feed' in 2001, for me led to a shift of focus to the potential of quinoa as a valuable food source for people 10 years later. Reinforced by the trajectory as Nuffield (Associate) Scholar and with the support of the LIB I can conclude for myself that quinoa offers interesting perspectives in the Netherlands. Also the conviction arised that quinoa is 'too good' for a nicheprodukt and actually should be available (and affordable) for consumers worldwide. The development of a successful Dutch quinoa-chain takes time, energy and financial input from chain parties, but I think has good chance of success. This can go hand in hand with the statements above.



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