FOOD & BIOBASED RESEARCH
WAGENINGEN UR

Sustainable conventional and organic vegetable flow to Europe: Supply Chain Optimization

BO-10-006-039.02 Bilateral Projects

Drs. Ing. J.C.M.A. Snels
Ir. E.H. Westra

Report 1104

FOOD & BIOBASED RESEARCH
WAGENINGEN UR

Sustainable conventional and organic vegetable flow to Europe: Supply Chain Optimization

BO-10-006-039.02 Bilateral Projects

Drs. Ing. J.C.M.A. Snels
Ir. E.H. Westra

Report 1104

Colophon

This project is part of the programme "BO Cluster International, Bilateral Projects". BO Cluster International is a programme financed by the Dutch Ministry of Agriculture, Nature and Food Quality. It aims to contribute to economic development and poverty reduction in developing countries, with special attention to the strengthening of sustainable agriculture and production chains, and nature management. The programme implements a demand-driven approach in which the research agenda is determined jointly with governments, research partners, NGOs and the private sector in the South.

The results presented in this report where accomplished in close cooperation with Pronature S.A. and Endivias Belgrano S.A., both established in Argentina.

Furthermore we express great thanks to the Agricultural Counselor in Argentina, Freek Vossenaar for initiating this project.

Wageningen, 17th December, 2009
Joost Snels

Title	Sustainable conventional and organic vegetable flow to Europe: Supply Chain optimization
Author(s)	Drs. Ing. J.C.M.A. Snels, Ir. E.H. Westra
Number	6233062900
ISBN-number	978-90-8585-566-8
Date of publication	January 2010
Confidentiality	No

Wageningen UR Food & Biobased Research
P.O. Box 17
NL-6700 AA Wageningen
Tel: +31 (0)317 480 084
E-mail: info.afsg@wur.nl
Internet: www.wur.nl

The quality management system of Wageningen UR Food & Biobased Research is certified by SGS International Certification Services EESV according to ISO 9001:2000.

Abstract

A group of growers (the same as in the 2007 project, "*Start up of a sustainable vegetables and fruit trade flow from Argentina to Europe" BO 10-006-109. J.C.M.A. Snels & E.H. Westra. Wageningen, December 2007)*, clustered and coached by the Argentinean service provider Pronature S.A.[1], and specialized in overseas export of fruits and vegetables wants to widen the knowledge and experience in transporting vegetables overseas by using marine transportation based on the experience gained in the foregoing project and the successful achievements. In the project carried out in 2007, as mentioned in the title, a start up has been made. Protocols have been written and knowledge has been transferred. Also some trail shipments have been conducted supervised by AFSG (using different packaging and stuffing methods). However, for translating the theory into practice more real life shipments are necessary. In relation to the project of 2007 trail shipments must be set up for more products and different postharvest treatments as well as different packaging materials.
This specific Argentinean case is an example of a global trend that bulk production of fruits, vegetables, cut flowers, pot plants, starting material etc. is more and more shifting to low labour cost countries often with a large distance to End-User markets. However, taking into account that in these chains the majority of products of interest are highly perishable, it is essential to develop a good market entrance at reasonable costs and the guarantee of a good quality.
Logistical costs often exceed production costs.

The goal of this project is to further develop successful supply chain concepts for sustainable export of qualitative high-grade export flow of, especially organic, vegetables from Argentina to Europe during the European winter season.
The ultimate deliverable of the project is a conclusive and tested set of distribution protocols for the mentioned products, tailored to organic products. These protocols of the 2007 project are the base for the test trials to Dutch wholesalers and retailers.
The overall research question in this project is how to maintain product quality on a high level in this specific chain at acceptable costs and within the constraints of the available infra-structure and facilities.

Due to the different harvesting seasons the project team decided to jump start the project by executing trail shipments of Brussels sprouts using different packaging materials. Also in the 2007 project several shipping of Brussels sprouts to The Netherlands where implemented and quality protocols written based on these trial shipments. Starting with setting up and executing trail shipments of Brussels sprouts, making use of the available protocols (the core of this project) makes it possible immediately testing and updating the protocols.
Parallel to this research the project team also decided to gather useful information regarding drying unions / shallots. One of the targets of the project is after all to see if it is possible to ship

[1] *In order to monitor local production, Pronature is working together with its sister-company Endivias Belgrano S.A., who is an experienced producer of vegetables selling locally and exporting within the Mercosur-region. Both companies are founded and managed by a group of Dutch investors.*

(organic) shallots. Because drying is in regard to the keep ability of shallots and/or unions one of the most important postharvest activities and therefore making it even possible to ship these type of products to Northern America or Europe.

Again this project had to stop early. This time the unforeseen extremely low prices in the Dutch and UK market (final destination of the Brussels sprouts) in combination with low production yields made the grower, exporter and imported decide to terminate the export programme. Prices dropped because of disappointing sales in the consumer market (in particular in the United Kingdom).

The export programme of Brussels sprouts was the backbone of the total exporting programme and the main driver for the test shipments. The Argentinean organizations decided to terminate the project because of the cancellation of this export programme. Therefore we as a research institute were (again) unable to finish this project in a promised and proper way.

We can learn from the past 3 years that reality is something everybody has to cope with. Beforehand one can try to foresee al kind of problems, challenges to face, and so on. But eventually in real life things can occur, like a global financial crisis, nobody can predict but that has major impact on organizations, markets, et cetera.

However, reflecting on the last 3 years it is clear that Argentina can supply Europe with high quality vegetables in contra season at competitive prices by using deep sea shipping. The infrastructure, organizational professionalism, knowledge of (post)harvest activities, et cetera are in place.

Most important for the coming years still will be to build long lasting robust and trustworthy chains focussing on ongoing improvement of product quality. Growers, packers and retailers in Argentina started the process of uplifting product quality most of the time focussing on the growing. Of course this must be the important first step in reaching the set targets. But Argentina is in the unique position of parallel to this process starting the optimization of postharvest handling (using know technology for example from The Netherlands), the cold chain en the handling in the distribution centres and shops of the retailers. The importance of all these aspects is recognized by most of the stakeholders, for example the certification body AOI launched the idea of certifying the 'unbroken cold chain'. Most of the needed knowledge en technology is available in The Netherlands and 'exporting' both this knowledge and/or technology gives both Argentina (agro (logistic) sector) and The Netherlands good opportunity to uplift product quality not only sold in The Netherlands / Europe but also in Argentina. In this way it also opens the market and guarantees the availability of good quality vegetables for the consumers in Argentina.

Content

1 Introduction

A group of growers (the same as in the 2007 project, "*Start up of a sustainable vegetables and fruit trade flow from Argentina to Europe" BO 10-006-109. J.C.M.A. Snels & E.H. Westra. December 2007)*, clustered and coached by the Argentinean service provider Pronature S.A.[2], and specialized in overseas export of fruits and vegetables wants to widen the knowledge and experience in transporting vegetables overseas by using marine transportation based on the experience gained in the foregoing project and the successful achievements. In the project carried out in 2007, as mentioned in the title, a start up has been made. Protocols have been written and knowledge has been transferred. Also some trail shipments have been conducted supervised by AFSG (using different packaging and stuffing methods). However, for translating the theory into practice more real life shipments are necessary. In relation to the project of 2007 trail shipments must be set up for more products and different postharvest treatments as well as different packaging materials.

Furthermore in this project there will be a focus on the export of organic perishables from Argentina to Europe. After a careful analysis, Pronature has recognized that the European market offers a good opportunity for selling organic vegetables. There is little experience in exporting organic vegetables overseas, therefore all involved parties in the distribution chain of Argentinean vegetable trade flow to Europe are in need of more practical knowledge in almost all aspects of marine transportation, such as postharvest, logistic constraints, grading, pre-cooling, packaging, container set-points, consolidation of different products in one container, market demands (tracing and tracking), quality effects of treatments and storage on remaining shelf life, quality management, costs etc. The advantage is that the starting level of knowledge for these specific questions is rather high due to the possibility of transferring available knowledge, acquired during the project of 2007, of the non organic products.

This specific Argentinean case is an example of a global trend that bulk production of fruits, vegetables, cut flowers, pot plants, starting material etc. is more and more shifting to low labour cost countries often with a large distance to End-User markets. Examples are: Ethiopia, Ghana, Vietnam, China, Latin America a.o. In many cases, Dutch entrepreneurs (breeders, growers, auctions, traders, technology suppliers) and/or the Dutch government are direct or indirectly involved in the funding and/or the development of such new trade options. However, taking into account that in these chains the majority of products of interest are highly perishable, it is essential to develop a good market entrance at reasonable costs and the guarantee of a good quality. Logistical costs often exceed production costs.

From an LNV perspective it is valuable to invest in this region via Dutch knowledge and technology as the region is recognized as an increasing factor for future European food supply

[2] In order to monitor local production, Pronature is working together with its sister-company Endivias Belgrano S.A., who is an experienced producer of vegetables selling locally and exporting within the Mercosur-region. Both companies are founded and managed by a group of Dutch investors.

(concept-regional vision). Enhanced knowledge of long distance distribution of fresh products using dedicated logistic tools in combination with validated quality decay models and knowledge bases is necessary to offer the "BV Nederland" a good platform and a strong position in international chain directing of perishable fresh products.

1.1 Target group

The possibilities of exporting fruits and vegetables from Argentina to Europe are large. The most important reason for this market demand is that the Argentinean production season is opposite to the European season. When in late winter/early spring the availability in European markets of products like leeks, Brussels sprouts, shallots, radicchio rosso, butternut squash, garlic, sweet corn, cherries and blueberries is low, Argentina is able to fill in the "fresh" market demand. As learned in the project "*Start up of a sustainable vegetables and fruit trade flow from Argentina to Europe"* the central and southern part of Argentina (Prov. St. Cruz, Chubut, Buenos Aires, Santa Fe a.o.) is very suitable for open field vegetable and fruit production: soils are fertile, clean water is abundantly present, presence of both pest insects and plant pathogens is low (especially in the Patagonia region), the climate is relatively dry, land cultivation and irrigation is supported by local governments etc.

However, the distance from the production areas to the market is very long. Although transportation by air freight is a common measure to overcome this problem, this is becoming increasingly more difficult as a result of high and still raising air freight costs in combination with a lack of air freight capacity. Only sea freight, i.e. the use of Reefer containers, as an element of a completely closed cool chain, is a relevant but also a more sustainable transportation method.

Until recently there was little experience in exporting these perishables overseas, in particular when exporting is done by means of marine transportation. Within the project of 2007 knowledge is developed and shared with the involved parties in Argentina. Also the first experience is gained concerning transportation of vegetables in reefer containers to Europe.

1.2 Objectives

The goal of this bilateral activity is to extend the framework build in the foregoing project (BO 10-006-109) in order to set up a sustainable vegetable and fruit flow from Argentina to the European market on an acceptable risk level.

Therefore the developed, and now available, distribution protocols for a group of six products will be used tested and sharpen up and tailored to organic products. This will be based on real life pilots and inventories in field missions. The expertise of involved parties in all links of the distribution chain will be explored and utilized. The available postharvest technology (knowledge) and facilities in Argentina are most likely still the most crucial success factors.

The same groups of growers, one exporter i.e. Pronature SA and several Dutch importers are involved in the project. Other direct involved partners are the research organization INTA, the agricultural school Gobernador Gregores, province governments and Dutch seed companies. If relevant, other Argentinean exporters and/or export organizations will be informed about the project. The intention is to enlarge the group of interested exporters companies and with their input to make a ranking of (other) interesting and available products.

The selected products to develop distribution protocols for are: radicchio rosso, (organic) shallots, butternut squash and Brussels sprouts. As mentioned in the proposal of the 2007 project the harvest season in Argentina for these products is at the end of 2007, real world pilot tests have to be carried out in 2008 (en where originally not included in the project of 2007. None the less we carried out some trial shipments). If possible on-land storage (transport simulation) tests carried out by local research centers and guided by AFSG specialists will be initiated.

1.2.1 Goal

The goal of this project is to further develop successful supply chain concepts for sustainable export of qualitative high-grade export flow of, especially organic, vegetables from Argentina to Europe during the European winter season.

1.2.2 Deliverable

The ultimate deliverable of the project is a conclusive and tested set of distribution protocols for the mentioned products, tailored to organic products. These protocols of the 2007 project are the base for the test trials to Dutch wholesalers and retailers.

1.2.3 Research question

The overall research question in this project is how to maintain product quality on a high level in this specific chain at acceptable costs and within the constraints of the available infra-structure and facilities.

1.3 Relation between the projects of year 2007, 2008 & 2009

As stated above the project of 2007 gave the results and showed the opportunities for shipping (organic) vegetables from Argentina to Europe / The Netherlands.
For this reason the project team applied for a next project to, for example, translate the theory into practise, setting up shipments using more types of products, different postharvest treatments and using different packaging materials. This to make the protocols more robust and validated.

Our request was granted and in 2008 we started with preparing and executing trail shipments of butternut squash (a new product in regard to deep sea shipping to Europe). However, due to

several problems (i.e. strikes, lack of reefer containers in Argentina, failing computer systems used by customs, deadly accident in the port of Buenos Aires followed by an other strike, et cetera) in combination with bad weather circumstances (heavy rainfalls leading to moult and failed harvests) lead to insufficient product quality for export and the impossibility to export at all.

This 2008 project focused on the evaluating and refining of the protocols based on real life pilots. As mentioned, for the export of butternut squash and sprouts we planned the exports and the testing (using different types of packaging / liners and following the protocols (first drafts) which were developed in 2007). In spite of all the problems we were able to export some containers of butternut squash to the Netherlands. Due to bad product quality and problems with the cardboard boxes we were not able to get a good first impression to evaluate the protocols. Unfortunately after these first shipments the export stopped.

In dialogue with all the people concerned we decided to push the activities through to the beginning of 2009. Not only the content of this project, the problem it tackles and its goals, but also the people, companies and government agencies involved (i.e. the relevant network) justifies this pushing through of the budget.

1.4 Work plan project 2009

1.4.1 Approach and activities in 2009

A. Further knowledge exchange
- Workshops with partners: Pronature S.A., growers, seed companies, technology providers (Maersk Line), local government, local test stations (INTA), agri-cultural school via prepared presentations
- Technology scans via visits to facilities and interviews with key persons.
- Inventory of other interested exporters and/or export boards

Specialised Wageningen UR/AFSG representatives prepare and perform workshops, interviews during missions to Argentina. Organisation and arrangements in Argentina will be done with the help of Pronature and the local LNV-Board.

B. Scenario analysis using, calculations, expert opinions

C. Mission:
- Coaching/advising Pronature and local test centres: packaging tests (2 types of liners)
- preparation of pilot tests and shipments
- communication with other stakeholders: growers, exporters, boards etc

D. Trail shipments, and packaging tests (2 types of liners)

E. Tested protocols on paper based on the 2007 project, further information gathered during the mission and the real life trail shipments

F. Summarizing report; 4 distribution protocols

1.4.2 Timeframe

Activity A will take place during 2009 and will be planned and carried out following the findings and results of the trail shipments
Activities B, C and D will take place in the period January – Augustus. Activities E and F will be carried out in the period September – December 2009.

2 Research

2.1 Test 'Shipping Brussels sprouts'

Due to the different harvesting seasons the project team decided to jump start the project by executing trail shipments of Brussels sprouts using different packaging materials. Also in the 2007 project several shipping of Brussels sprouts to The Netherlands where implemented and quality protocols written based on these trial shipments. Starting with setting up and executing trail shipments of Brussels sprouts, making use of the available protocols (the core of this project) makes it possible immediately testing and updating the protocols.

2.1.1 Test Export of Brussels sprouts

In order to establish robust and excellent results with the export of Brussels sprouts out of Argentina the following tests we planned to be carried out.

2.1.1.1 Ventilation

In order to prevent an anaerobic atmosphere inside the container ventilation is needed. The amount of necessary ventilation is unknown. In a desk study, AFSG will look for the optimal ventilation settings. Results will be available before the first shipment (mid-April).

Activities AFSG:

- *Desk study for ventilation settings*
- *Communicating the ventilation settings before first shipment with Pronatura*

Activities Pronatura:

- *Communicating the planning of shipments with AFSG*

2.1.1.2 Packaging

In coming shipments of Brussels sprouts to The Netherlands the aim is to test several bags. Endivias Belgrano has 3 types of experimental bags (16 of each). In one pallet in a shipment, we can test the effect of the bags. Test setup:

- 4 References crates
- 4 crates without bag
- 4 crates with Xtend Brussels sprouts bags (815-BS13/a)
- 4 crates with Xtend Leek bags (815-LK8)
- 4 crates with Xtend Corn bags (815-CR76/a)
- Total: 20 crates

With the 16 bags available, we can repeat this 4 times (e.g. 4 different shipments over the season). Additional extra test crates can be used for other tests (free to come with ideas). AFSG will check the product quality after arrival at the warehouse of the importer (in cooperation with the quality department of the importer) and will analyze the results. Feedback will be given after every arrival.

Activities AFSG:

- *Evaluation of product quality of each shipment containing a test pallet*
- *Sampling gas decomposition of atmosphere inside bag*
- *Feedback to Pronatura about results*

Activities Pronatura:

- *Communicating the planning of the test shipments*
- *Prepare test pallet according test setup above*
- *Mark test pallet clearly*
- *Attach temperature sensor to test pallet (e.g. Temptale4)*
- *Load test pallet in the second to last row from the door of the reefer container*

→ *Pronatura / E.B. will pack the crates according to the test setup above, all the crates/cartons will be packed on a clearly marked pallet. The pallet will be loaded on the second to last row from the door of the container.*

2.1.1.3 Quality monitoring

To learn of each shipment, basic information must be stored in some sort of log. Later cause – effect statistics can be performed to see which factors influence the quality on arrival. In decision making this information can be used to have the highest change for success. AFSG will prepare this so called log, i.e. will setup a table of contents / the headings we would like to be filled.

Activities AFSG:

- *Prepare a quality log*
- *Communicate with Pronatura about contents*

Activities Pronatura:

- *Evaluate quality log*
- *Feedback to AFSG about practical use*

The results of this research will be in chapter 3.

2.2 Desk Research drying Unions

Parallel to this research the project team also decided to gather useful information regarding drying unions / shallots. One of the targets of the project is after all to see if it is possible to ship (organic) shallots. Because drying is in regard to the keep ability of shallots and/or unions one of the most important postharvest activities and therefore making it even possible to ship these type of products to Northern America or Europe.

Results will be given in chapter 4.

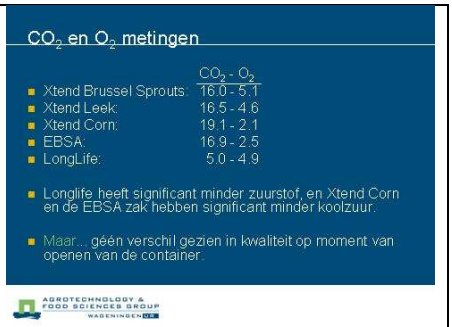
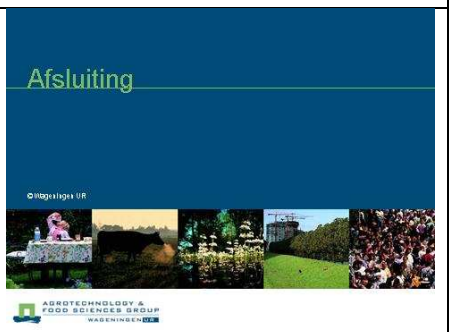
3 Results of test 'Shipping Brussels sprouts'

In total 6 shipments of 1 40 feet reefer container are planned for this season. Each shipment will be monitored and analyses as stated in the test protocol. In this chapter you will find the results of the first and second shipment. The reason for not being able to present the results of the other four shipments will be given in chapter 5.

The results of the first shipment were presented to the project members in both Argentina and The Netherlands in a PowerPoint format as can be seen in the table. The result of the second shipment is focusing more on product quality and therefore is presented making use of the photos showing the difference between the products shipped in different bags.
In both cases gas concentrations within the bags are measured.

Table 1: results first shipment of Brussels sprouts (PowerPoint)

Explanation	Sheets presentation
Results first shipment of Brussels sprouts. Date of arrival: 22nd May, 2009 Cultivar: Cirus	
General Impression: a. The Brussels sprouts looked very good regarding the influence of transportation on the product quality; b. No noticeable difference between the quality of the Brussels sprouts packed in different bags; c. Unpacked Brussels sprouts where dehydrated and tenacious.	
Initial Quality: a. The Brussels sprouts are grown thick in Argentina that made them a little elongated i. This leads toward waste because of cutting loss for using them in ready to eat packaging b. Furthermore, a different cultivar was packed and transported (but not part of the test). This cultivar had a rather loose outer leaves ii. Again, leads to cutting losses	

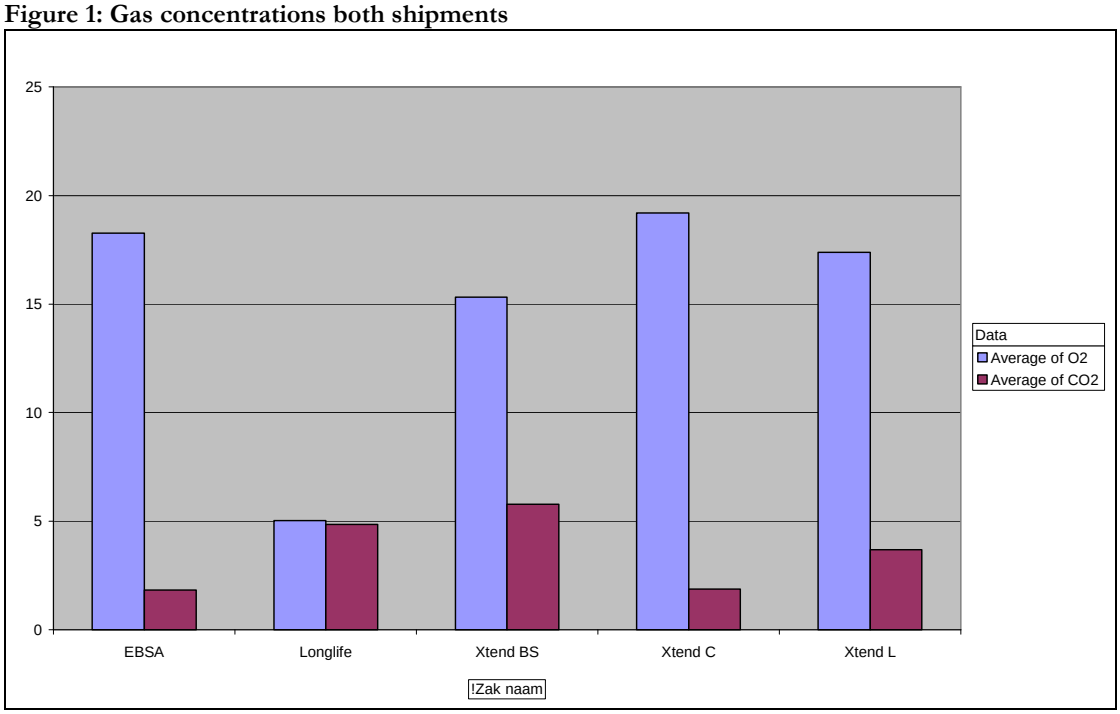
Measuring CO_2 and O_2: a. Longlife has significant less oxygen (O_2), and the Xtend Corn and E.B.S.A. bags have significant less carbon dioxide (CO_2); b. BUT … no noticeable difference between the different bags regarding product quality at the moment of opening the reefer container	
Closing the airflow: The advice given in the foregoing project was to close the airflow within the reefer container by applying cardboard trays at the end (door site) of the reefer container. However in the first shipment also the airflow underneath the pallets was closed. Advice: leaving a space of approximately 6 centimetres free to let the airflow pass underneath the pallets	
	

The result of this second shipment is focusing more on product quality and therefore is presented making use of the photos showing the difference between the products shipped in different bags.

Table 2: results of second shipment of Brussels sprouts

Results second shipment of Brussels sprouts. Date of arrival: 6th July, 2009 Cultivar: Abacus Remark: no Longlife bags available		
Bag	**Remark**	**Photo**
Xtend Brussels Sprout	Loose Minimal mechanical damage Discolouration cutting surface	
Xtend Leek	Loose Discolouration cutting surface	
Xtend Corn	Loose Minimal mechanical damage Discolouration cutting surface	
E.B.S.A	Loose Discolorations of outer leave Black edges Fungus like deposit	
No bag	Loose Discolorations of outer leave Black edges Some dehydration	

Figure 1: Gas concentrations both shipments



Remark: In the second shipment there were no Longlife bags available, so the results are based on only the first shipment.

- Of all tested bags Longlife has the lowest O_2 value. In the international literature a low O_2 concentration is seen as positive towards the product quality of Brussels sprouts when suboptimal temperatures are used. These Brussels sprouts, however are stored at an optimal temperature level what means that effect of Modified Atmosphere is nil. When the Brussels sprouts in this case should encounter higher (suboptimal) temperatures acidification could take place when using Longlife bags.

- The Xtend BS bag has a higher level of O_2 and also a heightened CO_2 level which indicates that this bag could give a better protection for the Brussels sprouts.

- E.B.S.A. bags showed in most of the cases a leakage as a result of which the bag looses its Modified Atmosphere function.

- The Xtend Corn and Leek bags are comparable when looking at their Modified Atmosphere function. They both show no low O_2 levels and a slightly raised CO_2 level.

3.1 Summarizing results Brussels sprouts shipments

Based on two shipments it is impossible to generate useful conclusions regarding the relation between the used bags and product quality after shipping them to The Netherlands using reefer containers.

What can be seen is that the E.B.S.A. bag and shipping without making use of a bag are the options that have the worst result. Difference between the different Xtend bags can not been seen. And looking at the gas concentrations you can also see that they are close to each other for the different Xtend bags. Unfortunately it is in this stadium of research impossible to connect gas concentrations to product quality.

Overall, no noticeable difference between the different bags regarding product quality at the moment of opening the reefer containers.

4 Drying Onions

4.1 Introduction

When growing onions it is necessary to dry the onions before storage. When the onion bulbs are not dried before they are stored weight loss and more severe mold will occur. Proper drying of the onions minimizes disease development and produces top-quality onions for the market. The aim of the drying process is to remove 4 to 5 percent moisture to get onions with tightly closed necks and dry outer scales which "shriek" when handled. Drying minimizes further shrinkage due to water loss during storage and marketing.

Drying removes excess moisture from the outer layers of the bulb prior to storage. The dried skin provides a surface barrier to water loss and microbial infection, thereby preserving the main edible tissue in a fresh state. Drying also reduces shrinkage during subsequent handling, reduces the occurrence of sprouting, and allows the crop to ripen before fresh consumption or long-term storage (Opara and Geyer, 1999). This process of dehydration is sometimes called 'curing', but the use of the word 'curing' for onion drying is rather inaccurate since no cell regeneration or wound healing occurs as in other root crops such as yam and cassava. Drying reduces bulb weight and since they are sold mostly on a weight basis, achieving the desired level of dehydration is critical. Weight losses of 3-5% are normal under ambient drying conditions and up to 10 % with artificial drying.

4.2 Ambient drying

In traditional small-scale operations, onion drying is carried out in the field in a process commonly called 'windrowing'. It involves harvesting the mature bulbs and laying them on their sides (in windrows) on the surface of the soil to dry for 1 or 2 weeks. In hot tropical climates, the bulbs should be windrowed in such a way to reduce the exposed surface to minimize damage due to direct exposure to the sun. In wet weather, the bulbs can take longer time to dry and may develop higher levels of rots during storage. The side of the bulb in contact with wet soil or moisture may also develop brown strains or pixels, which reduce the appearance quality and value. Obviously, successful windrowing is weather dependent and therefore cannot be relied upon for large scale commercial onion production business. Bulbs harvested for storage require in total 14-20 days of ripening or drying before being stored. Harvested onions may also be placed in trays, which are then stacked at the side of the field to dry. In some tropical regions, the bulbs are tied together in groups by plaiting the tops, which are then hung over poles in sheds to dry naturally (Opara and Geyer, 1999).

4.3 Artificial drying

Harvested bulbs can also be taken straight from the field and dried artificially either in a store, shed, barns, or in a purpose-built drier. This method is commonly used when crops are stored in

bulk but it can also be applied to bags, boxed or bins. Under this method, bulbs are laid on racks and heated air is rapidly passed across the surface of the bulbs night and day [O'Connor, 1979; Brice et al., 1997]. Drying may take 7-10 days and is considered complete when the necks of the bulbs have dried out and are tight and the skins shriek when held in the hand. The control of humidity level in the store is critical. Under very high humidity, drying is delayed and fungal infection can increase. However, if relative humidity is too low (below 60%), excessive water loss and splitting of the bulb outer skins can occur, resulting in storage losses and reduction of bulb value. Placing onions on wire mesh in well ventilated conditions and using air at about 30°C, 60-75% rh and 150 m^3.h-1.m-3 is generally recommended for mechanical drying of onions (Opara and Geyer, 1999). A few options are mentioned below.

4.3.1 Pallet Bins

A fan and pallet bin arrangement similar to that used in forced-air cooling applications and located in an open building may be used to dry onions. This method will give satisfactory results with unheated air, provided that the atmospheric humidity is low enough for good drying. The time required for complete drying ranges from 3 to 7 days or more, depending on the temperature and relative humidity. Although low in initial cost, this method may be too slow for many growers, and it increases the risk of infection from neck rot and other postharvest diseases. Such an arrangement may also be assembled with a heat source inside a closed building, as shown in Figure 1. Adding a suitable properly vented gas or oil heater will reduce drying time considerably. The building should be relatively tight and have a concrete floor. A building with a dirt floor is not suitable for drying onions. A moderate amount of building insulation would improve energy efficiency. The relative humidity inside the building can be regulated with a combination of louvered vents and exhaust fans (Boyette *et al.*)

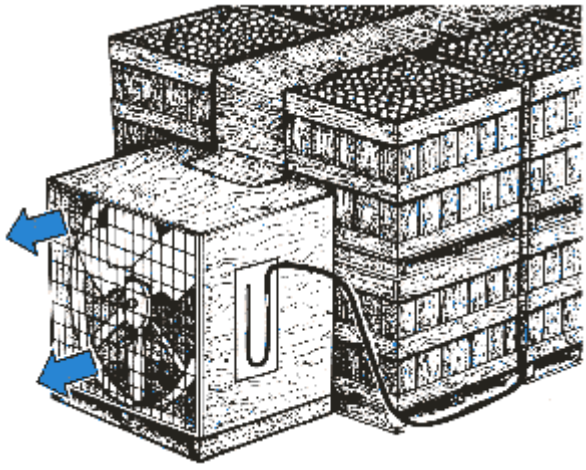


Figure 2: Fan and pallet bin arrangement used to dry onions.

A more sophisticated system that uses permanently mounted fans and a heat source will dry as many as 10,000 bushels (500 20-bushel pallet bins) at one time. Such a structure is known as a

horizontal air ventilation system. This system could, with slight modifications, be used for several crops. For example, such a building might be used to cure and store sweet potatoes. With the addition of refrigeration, the same building can be used for forced-air cooling of fruits and vegetables.

4.3.2 Peanut Drying Wagons

Some onions are grown in peanut-producing areas. In these areas, onions have been successfully harvested into peanut wagons and dried with peanut dryers. This arrangement allows growers to make efficient use of their equipment since onion harvesting and peanut harvesting occur several months apart. From the standpoint of energy efficiency, however, this alternative may not be the best. For a given volume, onions dry much slower than peanuts. Since most peanut-drying equipment does not have provisions for air recirculation, a large percentage of the heated air is not efficiently used (Boyette *et al.*).

4.3.3 Tobacco Barns

Onions have also been successfully dried in both rack- and box-type tobacco barns. Many bulk-curing barns have slotted metal (grain) floors onto which mesh bags of onions may be stacked and dried. Figure 2 illustrates onion drying in a tobacco-curing barn (Boyette *et al.*).

Figure 3 Onions drying in a box-type tobacco barn.

5 Premature ending of project and Conclusion

Again this project had to stop early. This time the unforeseen extremely low prices in the Dutch and UK market (final destination of the Brussels sprouts) in combination with low production yields made the grower, exporter and imported decide to terminate the export programme. Prices dropped because of disappointing sales in the consumer market (in particular in the United Kingdom).

The export programme of Brussels sprouts was the backbone of the total exporting programme and the main driver for the test shipments. The Argentinean organizations decided to terminate the project because of the cancellation of this export programme. Therefore we as a research institute were (again) unable to finish this project in a promised and proper way.

Pronature and Endivias Belgrano regret the fact that this has to be the case. After the problems the project encountered last year (2008) they had of course not anticipated on problems from the opposite side, i.e. the demand site (last year the problems were mostly related to the production and supply side). They believe that the main reasons for the current problems are the global financial and economic crisis.

They explicit stated that they highly appreciate the work and support AFSG gave Pronature and Endivias Belgrano the last years.

5.1 Lessons learned

If we like to learn something from the past 3 years the main conclusion or lesson can be that reality is something everybody has to cope with. Or like people like to say "truth is stranger than fiction". Beforehand one can try to foresee al kind of problems, challenges to face, and so on. But eventually in real life things can occur, like a global financial crisis, nobody can predict but that has major impact on organizations, markets, et cetera.

Related to this project, Argentina, the specific vegetables, et cetera we learned that both the supply and the demand side can influence the chain and market in such a way that export and import can come to a total stop. Ways to conquer these problems (predictable and unpredictable) is a whole other research topic far beyond postharvest technology and agro logistics.

5.1.1 Further research/challenges

Most important for the coming years still will be to build long lasting robust and trustworthy chains focussing on ongoing improvement of product quality. Growers, packers and retailers in Argentina started the process of uplifting product quality most of the time focussing on the growing. Of course this must be the important first step in reaching the set targets.

But Argentina is in the unique position of parallel to this process starting the optimization of postharvest handling (using know technology for example from The Netherlands), the cold chain en the handling in the distribution centres and shops of the retailers. The importance of all these aspects is recognized by most of the stakeholders, for example the certification body AOI launched the idea of certifying the 'unbroken cold chain'.

Most of the needed knowledge en technology is available in The Netherlands and 'exporting' both this knowledge and/or technology gives both Argentina (agro (logistic) sector) and The Netherlands good opportunity to uplift product quality not only sold in The Netherlands / Europe but also in Argentina. In this way it also opens the market and guarantees the availability of good quality vegetables for the consumers in Argentina.

In this perspective it is for The Dutch Ministry of Agriculture, Nature and Food Quality, more in particular the Agricultural Counsel, still valuable to invest in this region via Dutch knowledge and technology as the region is still recognized, in spite of the current global crisis, as an increasing factor for future European food supply (concept-regional vision). Enhanced knowledge of long distance distribution of fresh products using dedicated logistic tools in combination with validated quality decay models and knowledge bases is necessary to offer the "BV Nederland" a good platform and a strong position in international chain directing of perishable fresh products.

References

Boyette,D., Sanders, D.C., Estes, E.A., Postharvest cooling and handling of onions, AG-413-6, North Carolina Cooperative Extension Service

O'Connor, D. 1979. Onion storage. Grower guide No.2. Grower Books, London

Opara, L.U., M. Geyer. 1999. Onion storage. In: Bakker-Arkema et al. (eds). CIGR Handbook of Agricultural Engineering Volume IV Agro Processing. pp. 125-156. The American Society of Agricultural Engineers, St. Joseph, MI.

Snels, J.C.M.A., E.H. Westra. 2007. "Start up of a sustainable vegetables and fruit trade flow from Argentina to Europe" BO 10-006-109. Wageningen UR / AFSG.

Internet links regarding drying of unions

North Carolina State University:
http://www.bae.ncsu.edu/programmes/extension/publicat/postharv/ag-413-6/index.html

FAO:
http://www.fao.org/inpho/content/compend/toc_main.htm

Research Institute of Vegetable Crops:
http://www.ba.ars.usda.gov/hb66/099onion.pdf