Supply Chain Development Of Organic Vegetable Juice Produced From Co-products

Noen J. Jukema
Applied Plant Research (PPO)
P.O. Box 430, 8200 AK Lelystad, The Netherlands
Telephone: +31 (0)320 29 11 11
Telefax: +31 (0)320 23 04 79
E-mail: noen.jukema@wur.nl

ABSTRACT

Provalor has developed a more efficient technique for extracting vegetable juice from co-products of the processing industry. Provalor believes that the use of this technique can be expanded in the organic market because of strong international demand for organic vegetable juice from bottling companies. In order to implement this expansion, Provalor needed more information about the main drivers of the organic supply chain.

The research is carried out in close public-private cooperation. Because of positive research results a chain for organic carrot juice is built. The first bottles of organic carrot juice were sold in September 2007 by German retailers.

KEYWORDS: public-private cooperation, chain development, organic, co-products

INTRODUCTION

The Dutch company Provalor has developed and patented a unique technical concept for extracting vegetable juice for human consumption from co-products of vegetables that are left over from the vegetable processing industry. Dutch food processing firms produce large quantities of co-products, many of which are of very low value. Co-products in the vegetable processing industry arise for example when vegetables contain a spot or are too thin or crooked. The current destination of this food processing ‘waste’ is often cattle feed. The technique of Provalor creates substantial economic value to co-products, because it enables whole co-product exploitation. From residues of rejected vegetables, vegetable juice is made. The pulp that remains yields colouring agents and nutraceuticals. The almost dry pulp that eventually remains may be fermented to produce hydrogen gas (Van Ede, 2006). The activities of Provalor find broad appreciation in the agricultural sector. It has resulted in winning a number of prestigious prices, like the Food Valley Award in 2006.

The vegetable juice can be produced by current juice producers or by vegetable processing companies themselves on mobile installations that are located on site. The juice is produced according to the Provalor-concept and Provalor pays these companies for the juice they produce. Provalor supplies the juice to bottling companies.

The company operates in the conventional vegetable juice market and exports the juice primary to German bottlers. Vegetable juice is a well-liked product in Germany, due to the strong juice culture in this country. Most of the juices that are sold by Provalor are carrot juice, red beet juice, mixed vegetable juice and sauerkraut juice.

Because there are a growing number of health-conscious consumers in Germany who favor organic drinks, Provalor got an increasing demand from German bottling companies to deliver organic juices. Germany has the largest market for organic juices in Europe. Therefore

Provalor wanted to identify and evaluate the issues involved before their technology could be expanded into the organic juice market. Because Provalor is unknown in the Dutch business chain of organic vegetables and doesn't know the specific organic product characteristics, the company needed more information to determine if their current technical concept had sufficient potential to create a new chain.

RESEARCH APPROACH

Problem statement

Provalor needed information about the following aspects to support the decision of creating a new chain of organic vegetable juice produced from Dutch co-products of vegetables:

- *Economic perspectives of the chain*
  When considering new organic juices Provalor first needed to know whether the co-product flows of organic vegetables in the Netherlands were sufficient. Therefore more information was needed about the amount of supply of co-products of different organic vegetables and on which level of the chain and at which companies most supply becomes available. Also more information was needed about current prices and destinations of organic co-products. Subsequently the company assesses itself which vegetable juices have highest potential.
- *Technical perspectives of the chain*
  Because organic vegetables grow less forced and therefore contain less liquid conventional vegetables differ from organic vegetables. It is unknown to Provalor what the consequences are of the difference between conventional and organic vegetables. More information was needed about criteria for acceptance of defects in an organic lot of co-products to guarantee organic juice quality.
- *Microbiological safety and co-product traceability of the chain*
  To guarantee good and reliable certification of the organic juice Provalor needed more information about requirements of food safety, product quality and co-product traceability that apply in the organic market. The company wanted to know what the consequences of microbiological safety and co-product traceability of the chain are for specific chain partners.
- *Sustainability of the chain*
  To increase the acceptance of the new chain by industrial customers and to position the organic vegetable juice in the market, Provalor needed more information about the score of the new chain on sustainability (people, planet and profit). The company wanted to compare the sustainability of the organic chain with the sustainability of the conventional chain.
- *Chain development*
  To develop a chain Provalor needed chain partners from the organic business environment. More information was needed about suppliers and traders of co-products of organic vegetables to determine potential chain partners and the strategy of cooperation in the chain.

Objective of the research

The objective of the research was to identify and evaluate the issues involved in building a chain of organic vegetable juice produced from co-products.

Research questions

Derived from the problem statement the following research questions (RQs) were investigated in the project work plan, which comprised five interlinked work packages (WPs):

- *WP1: Economic perspectives of the chain*
    1. Which organic vegetable juices have the highest sales?
    2. On which level of the chain do co-products of organic vegetables become available in large quantities?
    3. What is the amount of supply in the Netherlands of co-products of organic vegetables with high potential for organic juices?
    4. What are the prices and destinations of co-products of organic vegetables with high potential for organic juices?
- *WP2: Technical perspectives of the chain*
    5. What kind of deviations mostly appear in co-products of organic vegetables?
    6. How high should the weighing factor be of different deviations to accept a lot of co-products of organic vegetables for the production of organic vegetable juice?
- *WP3: Microbiological safety and co-product traceability of the chain*
    7. Which certification of microbiological safety and co-product traceability apply to organic food products?
    8. What are the consequences of requirements of food safety and co-product traceability for chain partners?
- *WP4: Sustainability of the chain*
    9. Which aspects of the chain are positively evaluated on the field of sustainability and can be exploited in the positioning of the organic product?
    10. What is the score of the organic chain on sustainability compared to the conventional chain?
- *WP5: Chain development*
    11. Which companies have potential to become chain partners?
    12. How should the chain be coordinated and cooperate?

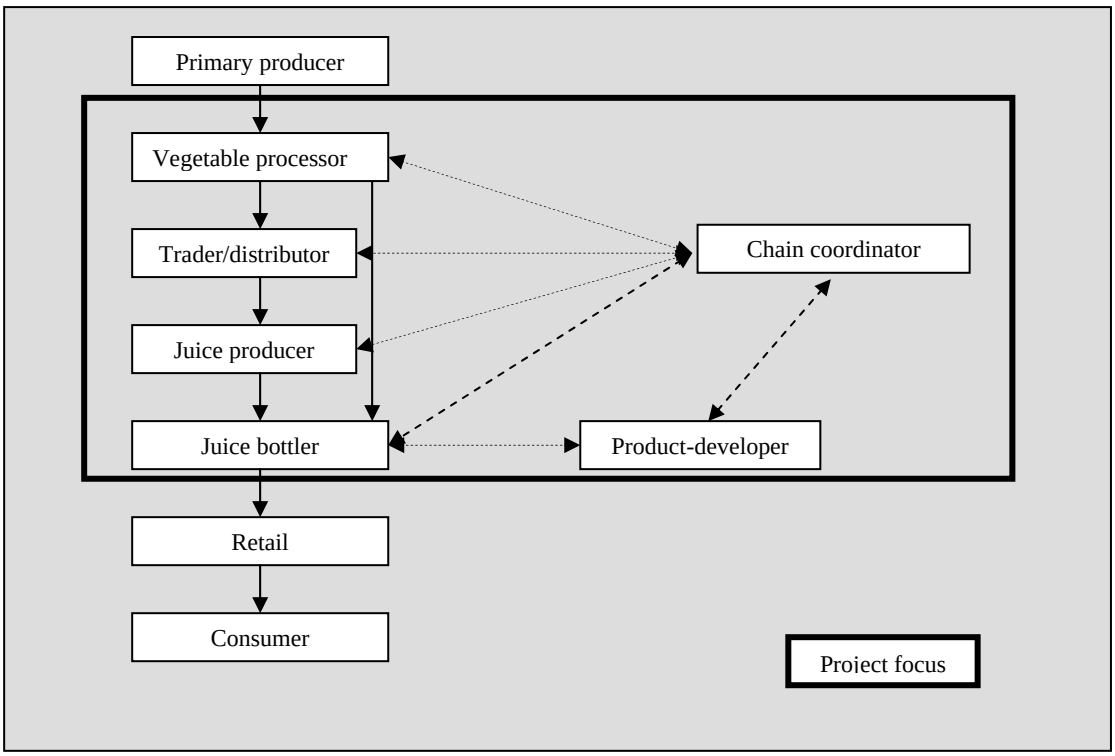
This paper describes the research results of the five work packages of the project.

Demarcation of the research

The research concentrated on a chain in which organic vegetable juice is produced. No research is done about useful products and ingredients that can be made from organic co-products of vegetable juice.

Figure I depicts the chain of organic vegetable juice produced from co-products according to the Provalor-concept. In this chain Provalor acts as a chain coordinator. The figure shows the levels of the chain on which the research has focused.

Figure I. *Chain of organic vegetable juice produced from co-products according to the Provalor-concept*



Public-private cooperation

Small companies like Provalor experience barriers in continuous innovation because of lacking knowledge, budgets and competences to systematically improve processes and products. Provalor needed support to finance the research because of lacking budgets and competences to carry out the research itself and lacking knowledge in the organic business environment. A supported cooperation was necessary between fundamentally oriented scientific institutions and practical oriented companies to explore the perspectives for their innovation in the organic market

The Dutch Ministry of Agriculture, Nature and Food Quality is aware of the important role of public-private cooperation to enhance the knowledge-base for innovation in the agri-food sector. Via the co-innovation program 'Organic Distribution Chains' the Dutch Ministry of Agriculture, Nature and Food Quality subsidised research projects about innovation in organic distribution chains. The program was aimed at filling pre-competitive knowledge gaps in organic distribution chains. In the program companies and non-government organisations worked together with scientific institutions and the government in order to seize medium-term opportunities for market growth. The Foundation for Agri-Chain Compentence represented the Dutch Ministry of Agriculture, Nature and Food Quality by monitoring the compliance of project appointments. Research themes of the program were (www.akk.nl):

- Appreciation of organic products for the consumer
- Efficiency and price-premium of organic products
- Quality and traceability of organic products
- Collaboration and coordination in the organic distribution chain
- Market broadening of organic products
- Relation between organic and conventional products
- Relation between consumer and producer in the organic distribution chain

This research about the perspectives of building an organic distribution chain of organic vegetable juice produced from co-products was one of the fourteen research projects that were funded by this program in 2006 and 2007. The research focused on the research theme 'collaboration and coordination in the organic distribution chain', but it also contains elements of other themes of the program. The research took one and a half year and started in January 2006.

Because of the experience of Applied Plant Research (PPO), part of Wageningen University and Research centre, in the research about organic arable farming and field production of vegetables, Provalor asked PPO to coordinate and carry out the research. PPO took also care of the administration and played an organising role by calling meetings between project partners, a workshop with potential chain partners and a final symposium with stakeholders. Another Dutch research institute that carried out research for the project was HAS Knowledge Transfer (HAS).

For practical business knowledge to carry out the research a processor and trader were needed from the organic business environment. These businesses were also necessary for chain development. Via a short market research before the start of the project PPO selected a couple of Dutch traders in organic vegetables that could collect large quantities of co-products from the organic vegetable processing industry. From this selection Provalor choose Green Organics as project partner and potential chain partners (trader). Green Organics is an internationally operating organisation that trades in organic potatoes, vegetables and fruit. The company is founded in 2000 and is meanwhile one of the Dutch market leaders. Because of business contacts of Green Organics, the Dutch company Green Ways participated also in the research as potential organic vegetable processor of the chain. Green Ways has been functioning for years as part of an organic farm. In 2000 Green Ways and this farm have gone their own ways. The role of Green Ways within this farm has been the development and production of new products like black salsify, sweat corn and pumpkin.

Research methods

Table I shows which method is used for the research questions per the work package. The table also shows which project partner coordinated each research question.

Table 1. *Research method and coordinator per work package (WP) and research question (RQ)*

WP	RQ	Research methodology	Coordinator
1	1	▪ Three market researches of German research offices ▪ Contacts of Provalor with potential German organic bottlers and with German agents of Provalor ▪ International publications about market statistics of consumption of fruit- and vegetable juices in Europe	Provalor
	2	Internal study that PPO carried out in 2004 about the opportunities for valorisation of organic co-products of vegetables.	PPO
	3,4	▪ Telephone interviews with 18 Dutch companies from all levels of the chain that produce organic co-products of vegetables. The interviews were carried out with a structured questionnaire. The survey questionnaire was prepared based on research questions of WP1. The companies were selected from business contacts of Green Organics and the internal study that PPO carried out in 2004 about the opportunities for valorisation of organic co-products of vegetables. ▪ Data collection about figures of organic vegetable production and yields from Dutch statistical databases and databases of PPO about quantitative financial information for organic arable farming.	PPO

WP	RQ	Research methodology	Coordinator
2	5	Literature study about: ▪ differences between conventional and organic vegetables in the Netherlands ▪ deviations that can arise in organic vegetables (toxins, diseases, etc.) ▪ process of making vegetable juice	HAS
	6	Practical experiments with organic carrots with different kind of deviations were carried out. In these experiments the process of juice making was imitated and the juice quality of lots with different kind of deviations was checked. For the appraisal of the juice quality the following quality provisions were performed: ▪ microbiological research ▪ sensory research ▪ colour measuring ▪ acid provisions ▪ remaining provisions such as brix, dry substance quality, etc.	HAS
WP	**RQ**	**Research methodology**	**Coordinator**
3	7	Literature study about certification of microbiological safety and co-product traceability that apply to organic food products in Europe.	PPO
	8	13 depth interviews with companies that process organic vegetables (and conventional vegetables). The interviews were carried out with a structured questionnaire. The survey questionnaire was prepared based on research questions of WP3. The companies were selected from the telephone interviews of WP1 and can be subdivided in three categories: growers, processors and industrial adopters.	PPO
WP	**RQ**	**Research methodology**	**Coordinator**
4	9	Depth interviews with: ▪ 2 experts from research on the field of marketing of sustainability in a chain. ▪ 3 experts from business on the field of sustainability of agrifood chains. The interviews were carried out with a structured questionnaire. The survey questionnaire was prepared based on research questions of WP4. Interviewees were selected from networks of researchers of PPO.	PPO
	10	▪ Literature study about sustainability of agrifood chains ▪ Earlier studies about sustainability of the conventional Provalor-chain ▪ Data analyses of depth interviews	PPO
WP	**RQ**	**Research methodology**	**Coordinator**
5	11	Workshop with 5 potential chain partners (primary producers and processors). Workshop participants were selected by Provalor and Green Organics from the research of WP1.	PPO
		Visit to world's major organic trade fair BioFach in Germany.	Provalor
	12	5 project meetings	PPO
		Literature study about collaboration and coordination in agrifood chains.	PPO
		Final symposium with stakeholders of the research and project partners.	PPO
		Business meeting with business partners of the research.	Provalor

RESEARCH RESULTS

WP1: Economic perspectives of the chain

Most consumers buy vegetable juices for drinking. Vegetable juice is critical to good health because it is an important source of raw food. Many German people drink vegetable juice to gain health benefits or to use it in a diet to lose weight. Other consumer applications of vegetable juice are the processing of vegetable juice in e.g. soup, shakes or as a basis for sauce.

Because of the growing number of health-conscious consumers who favor organic drinks, the market of organic vegetable juice is growing. This is especially the case in Germany, but also in countries like Italy, France and the Netherlands. Germans are the world’s largest juice drinkers and have the largest consumption rate of organic juices in Europe. The total consumption of vegetable juices in Germany is circa 1,25 kilogram per year per person, of which is 20% organic. Like conventional vegetable juices, organic vegetable juices are becoming more commonly found in supermarkets. Organic juices are also sold in health food shops and by dedicated organic food retailers.

Based on market demand of Provalor from bottling companies and raw material supply in the Netherlands organic carrot juice was selected as most promising product for chain development. Organic red beet juice was selected as second promising product. The residue flows of these organic vegetables were sufficient in the Netherlands to produce the requested quantities of juice. The raw material supplies of these organic vegetables come at highest volumes available at the processing industry, including washing and sorting stations. Because of defects in the vegetables like dry spots and rotten parts the products are sorted out. Nevertheless these co-products have enough potential to be used for the production of organic juice. The current destination of this food processing 'waste' is often cattle feed. Other applications are to use it as fertilisation for the soil or for the processing of bio fuel. Table II shows average figures of 2004 and 2005 of the annual production of organic carrots and red beets in area and yields per hectare, the amount of co-products of this product stream and the price that is paid to these co-products in the Netherlands (Jukema, 2007).

Table II. *Areas in hectares, yields, residue flows and prices of residue flows of winter carrots and red beets (average Dutch figures of 2004 and 2005)*

Vegetable type (organic)	**Area (hectares)**	**Yields (tonnes per hectare)**	**Residue flow (tonnes)**	**Prices of residue flows (Euro's per kilo)**
Winter carrots	600	55	4.500	€ 0,02
Red beets	77	48	550	€ 0,01

The following specific characteristics of the organic market of co-products cause a higher cost price of co-products of organic vegetables compared to the conventional market:

- Higher prices of organic co-products, because organic cattle feed is scarce. Organic farmers prefer organic cattle feed above conventional cattle feed and therefore want to pay more for it.
- Insufficient amount of high volumes per supplier, because of the small-scale of the sector. The collection of co-products from many Dutch suppliers raises transportation costs.
- Spread out availability of co-products, because there are a few organic vegetable processors and they are located all throughout the Netherlands. This spreads out availability and raises transportation costs.
- Lower amount of juice per kilo, because organic vegetables typically contain less liquid than convential vegetables.
- Supplementary rules for separation of conventional co-products from organic co-products, because of certification requirements.

These higher production costs are off set by higher retail prices. Because of this compensation the economic feasibility for the new organic chain was positively evaluated. However, due to lower quantities of produce correct logistics is a critical factor for success. Provalor currently delivers organic vegetable juices to two German and two France bottlers. The turnover in the first year (2007) was € 300.000. The company expects that this turnover will double in 2008. Expectations of turnovers in the organic market in 2009 are approximately 1 million Euro. In 2005 Provalor revenues in the conventional market amounted to a total of also 1 million Euro, which is equivalent to 3000 tonnes of juice (van Ede, 2006).

WP2: Technical perspectives of the chain

Because carrot juice was selected as the most promising product for chain development,

technical feasibility was studied by developing criteria for defects of organic carrots and to evaluate the effect of these defects on carrot juice quality. These deviations can be taste-, fragrance- or colour deviations and microbiological dangers. It has become clear that branched off carrots, carrots with dry spots and burst open carrots have no influence on the quality of the juice. On the other hand carrots with black spots, maggot breaches, praise, mould and rotten spots do have influence on the quality of the juice and therefore could not be processed entirely to carrot juice.

To stipulate the borders of disapproving of a lot of organic carrots, further study has been done into the border of acceptance of carrots with black spots, maggot breaches and praise and root with mould and rotten spots. With these results an evaluation scheme to be used at producer level was made, for the acceptable percentages of defects in a lot of organic carrots that is acceptable for carrot juice production. In this system the number of deviations from a sample with 100 organic carrots is filled in. Figure II shows this evaluation scheme.

Figure II. *Evaluation scheme for the acceptance of defects in a lot of carrots*

Category of defect	**Quantitative deviation**			**Weighing factor**	**Judgement**
	Visually	**Degree**	**Number**		
1. Burst open		1		0	
		2		0	
2. Branched off		1		0	
		2		0	
3. Rotten		1		5	
		2		5	
4. Spots through insects and diseases		1		5	
		2		5	
				Total score	

The evaluation scheme shows four kinds of categories of defects: carrots that are burst open, branched off carrots, rotten carrots and carrots with spots through insects and diseases. Each category of defects has two degrees: degree 1 defects are less worse than degree 2 defects. The evaluation scheme makes (in colour) visual to what degree a carrot belongs. The number of carrots that are found in each categery of defect are multiplied by the degree and the weighing factor. The total score can varry from 0 (0*0*0) to 1000 (2*100*5). The higher the score the less arranged a lot is for juice production. The evaluation scheme helps the consumer to accept a lot for juice production or not. The consumer determines itself which score is acceptable (Van Santen et al., 2006).

WP3: Microbiological safety of the chain

Organic juice should fulfill all requirements in food safety and traceability. On top of that the organic standards should be adhered to as well. In the Netherlands Skal has been assigned by the Ministry of Agriculture, Nature and Food Quality as inspection body for the organic production. The rules for organic production in the Netherlands are based on the EU-regulation (EEC) nr. 2092/91. When the production process fully meets the requirements, certification can take place. In that case Skal issues a certificate as document of support. In most cases the producer is also allowed by Skal to use the EKO Quality symbol on the products that originate from the production process certified by Skal. The consumer knows and recognises this symbol of certified organic production (www.skal.nl).

Processors should extend the procedures under the existing Hazard Analysis Critical Control Points (HACCP) or other certification scheme to the secondary stream. This implies administrative and technical measures like choice of materials to store the raw material and cleaning schedules for that part of the installation. For the organic certification the raw material must be produced and processed under an organic certification scheme and must be processed according to its specifications. Additives must have registration for use in organic products. In the pilot productions for the market, microbiological safety of the chain was verified positively (Kosters and Van der Voort, 2007).

WP4: Sustainability of the chain

The sustainability of the organic chain is positively evaluated. It is assessed according to the ‘Triple p’ criteria: people, planet and profit. It is a comprehensive approach in marketing embracing the social (people), ecological (planet) and economic aspects (profit) of the company, product or service.

The chain scores high on the aspect ‘people’, because the chain guarantees food safety, healthy feeding, optimum use of foodstuffs and clean employment. It is doubtfully if the organic chain scores higher on the aspect ’people’, because different scientific researchers who investigated health advantages of organic products compared to conventional ones do not agree with each other. However, Provalor provides with the new chain a product that meets the consumer needs, because there is growing number of consumers who favor organic vegetable juices.

The chain scores also high on the aspect planet. The 100% use of organic co-products as raw materials for healthy and good tasting organic vegetable juices makes this a unique and sustainable way to produce food. It causes less ground-tied production and more high-quality foodstuffs from the same raw material. Planet is the most important aspect of sustainability appraisal of the organic chain, because of recognized advantages on which organic cultivation of vegetables distinguishes it positively from conventional cultivation, such as no chemical pest management resources and no use of artificial fertilizer. The environment impact includes also energy efficiency and $C0_2$-eq emissions. The energy use of conventional carrots is 1.050 MJ/ton of production and for organic grown carrots it is 900 Mj/ton. The CO_2-eq

emissions of both cultivation systems for carrots are similar. It could be strengthened when the energy used for processing can be compared to the current processing systems. It is suggested that an environmental certificate (SMK) could be applied for that will also quantify the energy use. Since the energy advantage for an important part is stipulated by the difference in transport need it is recommended that at the organisation of the distribution in the chain logistics strongly must be taken into account. Because of the small-scale of the organic sector, lower volumes and more spread out availability of co-products per supplier arise compared to the conventional sector. This causes more transport movements in the organic chain. The score of the organic chain on this aspect of sustainability is therefore lower compared to the conventional chain.

The technique of Provalor creates substantial economic value to co-products, because it enables whole co-product exploitation. This is an important aspect of the 'profit' of the chain. The main reason why the organic chain scores high on the aspect 'profit' is that the new chain creates economic advantages for companies that are involved in all levels of the chain (Kosters, 2007).

WP5: Chain development

Product specifications for organic juice from co-products are comparable to that of juice from standard organic raw material. However, the specifications are different from the regular carrot juice and must be developed in close cooperation with a product developer and the market. In the project extensive contacts in the German market were necessary to understand product specifications. Research results have proven it to be feasible to produce high quality vegetable juice from organic co-products. A pilot production was successfully produced in the autumn of 2006. Because of the positive research results Provalor decided to operationalise the chain. The first bottles of organic carrot juice are sold in September 2007 by German retailers.

In the project the three business partners learned to know each others personalities, companies, capabilities and competences. Five project meetings and mutual business meetings have contributed to this 'familiarisation' process. The successful cooperation between the three businesses Provalor, Green Organics and Green Ways was the result of a high degree of strategic complementarity and cultural agreement between the companies. According to Zuurbier et al. (1996) this was important in vertical coordination. The strategic complementarity of the three companies was the successful combination of the experience of Provalor in the conventional chain with the experience and business knowledge and contacts of Green Organics and Green Ways in the trade and processing of organic co-products of vegetables. Green Organics and Green Ways also helped to understand economic, technical and microbiological safety issues in the chain. The 'fit' in personalities and way of doing business between the partners resulted in cultural agreement between the companies during the research. The strong chain leadership of Provalor was accepted by other chain partners and has been very important for chain formation and coordination.

Provalor and Green Organics continued cooperation after the project. In a workshop of the project five potential chain partners were selected that could deliver large quantities of interesting co-products of organic vegetables to Green Organics. In order to gain more potential chain partners Provalor and Green Organics visited in February 2007 world's major organic trade fair BioFach in Germany. The workshop and visit to the BioFach also helped to further understand issues involved in building a chain of organic vegetable juice produced from co-products. Green Ways does not process products that are in first instance interesting for Provalor for the production of vegetable juice. Therefore the cooperation with this company is not continued after the project.

Figure I has depicted the chain of organic vegetable juice produced from co-products

according to the Provalor-concept. The primary producer produces organic vegetables which are processed by an organic vegetable processor. At this level of the chain most co-products arise. Green Organics coordinates as a trader the contacts with organic processors of vegetables and collects the co-products for the juice producer. The juice producer produces juice from the co-products according to the Provalor-concept. Provalor pays these companies for the juice they produce and supplies the juice to juice bottling companies, so the company does not carry its own brand. The retail store buys the juice from the juice bottlers and sells it to the consumer. In the organic chain Provalor acts as a chain coordinator.

CONCLUSION

The perspectives of building a chain of organic vegetable juice produced from co-product were positively evaluated in the research. Based on market demand from German bottling companies and raw material supply of co-products of organic vegetables in the Netherlands, organic carrot juice was selected as most promising product for chain development. The chain of organic carrot juice is economic feasible, because compared to regular juice the higher production costs are off set by higher retail prices. However, due to lower quantities of produce correct logistics are a critical success factor.

Technical feasibility was also evaluated positively. Experimental juice production was done on lots with high levels of carrots with dry spots, rotten parts and other defects. An evaluation scheme to be used at producers level helps to determine the acceptable percentages of defects in a lot. For the organic certification the raw material must be produced and processed under an organic certification scheme and must be processed according its specifications. Additives must have registration for use in organic products.

The sustainability of the chain is an important issue. According to the ‘Triple p’ criteria ‘planet’ is the most important aspect of sustainability appraisal of the organic chain, because of recognized advantages on which organic cultivation of vegetables distinguishes it positively from conventional cultivation. The 100% use of raw materials for human consumption is also a very positive contribution to the sustainability of the chain. This will be beneficial in the positioning of this vegetable juice to the industrial customers. This could be strengthened when the energy used for processing can be compared to the current processing systems. It is suggested that an environmental certificate (SMK) could be applied for that will also quantify the energy use.

Because of the positive research results Provalor decided to operationalise the chain. A pilot production with organic carrots was successfully produced in the autumn of 2006. The pilot production was carried out in close cooperation with bottlers, to ensure that supply chain activities were adapted to consumer demands of product specifications. The first bottles of organic carrot juice were sold in September 2007 by German retailers. The turnover of Provalor in this first year in the organic market was € 300.000. The company expects that this turnover will grow exponential. The chain of organic carrot juice can function as a practical blueprint for Provalor to design and implement other chains of promising organic vegetable juices, like sauerkraut juice, redbeet juice and mixed vegetable juice.

The public-private cooperation has proven to be a succesful approach to fill knowledge gaps of Provalor and realise innovation in the supply chain. The public research institutes contributed by coordinating the research, testing the technology and instruments to improve the performance of the supply chain. The organising role of PPO, by calling meetings between project partners, a workshop with potential chain partners and a final symposium with stakeholders, helped to learn more about the opportunities and issues involved in supply chain development. The successful cooperation between the three private firms Provalor, Green Organics and Green Ways was the result of a high degree of strategic complementarity

and cultural agreement between the companies. The strategic complementarity of the three businesses was the successful combination of the experience of Provalor in the conventional chain with the experience and business knowledge and contacts of Green Organics and Green Ways in the trade and processing of organic co-products of vegetables. The private firms that were involved in the research helped to understand the organic business envirionment and product characteristics of organic vegetables. The strong chain leadership of Provalor was accepted by other chain partners and has been very important for chain formation and coordination.

Provalor and Green Organics continued cooperation after the project. Green Organics coordinates as a trader the contacts with organic processors of vegetables and collects the co-products for the juice producer. Green Ways does not process products that are in first instance interesting for Provalor for the production of vegetable juice. Therefore the cooperation with this company is not continued after the project.