1. **Monopoly Period.** The Danish starch industry was static during the monopoly 1933-73.

2. **EEC Membership.** The industry began to flourish with the EEC-membership.

3. **Expansion Period.** Over a five year period beginning late eighties production tripled. The INTERNATIONAL STARCH engineering team constructed four new plants increasing total processing capacity to three hundred tons of potatoes per hour.

   Per capita, the Danes became the largest starch-producing nation in the world with 85% exported to more than 40 countries.

4. **EU Quota System.** Mid 1990's, the European Union set an effective halt to further enlargement by introducing a quota system for potato starch. The quota system came to an end 2012.
The next significant period of growth began late 1980’s. Over a five year period production tripled. During that time span, the *International Starch* engineering team constructed four new plants with a total capacity of thirty tons of potato starch per hour. The engineering team also introduced advanced process control systems, effectively improving quality at no extra cost in labour or resources.

The production skyrocketed and per capita the Danes became the largest starch producing nation in the world. Mid 1990’s, the European Union set a halt to further enlargement by introducing a quota system for potato starch.

The campaign 2012/13 is the first after the abolition of the EU quota system and the potato starch market is now operating in an open market without production limits.

**Production Co-Operatives.**

The starch is produced on four independent plants; all of which are co-operatives owned by approximately 3,000 farmers. Each farmer has an equity stake in his respective cooperative. Each share represents the right and obligation to deliver 100 kg of potatoes per annum. The factory calls upon the farmers, when they are next in turn for delivery, and they are immediately paid a minimum price upon receipt. When the...
The International Starch Group also developed a new automated roofed potato store with capacity for over weekend operation. This type of raw material intermediate storage system is now implemented on all factories.

When a farmer wants to sell his shares, he is permitted to do so. The price is close to the value of the quantity of potatoes the shares represent. Regardless of the number of shares each farmer has just one vote at the general assembly.

The farmers elect a board of directors among themselves. The board then engages a manager responsible for the day-to-day operation. An engineer is responsible for the technical operation of the plant and maintenance. Staff and other employees make up a total of approximately twenty persons. The factory runs around the clock seven days a week, with only two operators at each watch. This level of efficiency is owed to an advanced process technique. A few extra hands are needed during the day shift for logistics and other odd jobs.

SALES CO-OPERATIVE.

The factories are independent, but none of them sell the starch themselves. Since the times of the monopoly, they have continued to sell their products through a cartel, which is a co-operative itself owned by the member factories.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Function</th>
<th>No.</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
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<td>Clerk</td>
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<td>White collars</td>
<td>Mechanic</td>
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<td>Workshop</td>
<td>Technical manager</td>
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<td>Operators</td>
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<td>Dispatch</td>
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</tr>
<tr>
<td>Blue collars</td>
<td>Irrigation</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Total employees | 19 |

Organization for a Danish Starch Factory 1999 producing 20.000 t per annum - 6 t/h round the clock in five shifts during the campaign.

1) White collars exclusive of sales- and lab staff.

2) Blue collars: Two operators on each shift make ten plus additionally seven at the day shift.

The production capacity of the largest Danish factory is four times the one referred to above but requires just a few hands extra.

Including the sales staff less than 200 people are employed in the starch industry. The annual production of starch per head exceeds 2.000 t.

THE FARMERS.

The large work force is the farmers themselves. The potato crop is labour intensive and makes it easy for a small family enterprise to earn their living.
Danish starch factory with starch modification facilities.
THE POTATO CROP.

Potatoes are grown in crop rotation, and potatoes are only grown once out of four years on the same plot. This is the most effective measure of disease control.

The harvest begins late August and ends before the harshness of winter sets in. The factories run until the entire yearly crop is processed. Under normal circumstances the production campaign ends December / January. The short campaign requires large storage capacity for the starch. A majority of the starch is stored in silos for the interim period before it is sold.

The starch industry requires potato varieties high in starch content. The breeding stations are fundamental elements of the industry and the government finances their operation. New varieties of potatoes with improved resistance against disease and higher starch yield are continuously developed and brought to the market. Potatoes with 19,5 % starch are typical. Also improved cultivation methods are applied. Maximum yield on the experimental stations is close to 90 tons of potatoes per hectare - a provocative target.

Figure. Danish potato protein factory. The potato juice is heat coagulated, dried and sold as a feed additive for young animals and in the fermentation industry.

FROM NATIVE STARCH TO HIGH END DOWN-STREAM PRODUCTS.

Phosphate groups make potato starch of all industrial starches a naturally ester. It is a food starch par excellence. It's clear and viscous gel makes it attractive as a thickener in foods, but for industrial applications these properties have to be stabilized by modification.

In 1967 we designed and erected the first Danish plant for the manufacture of modified starch.

This work has been extended and now covers production methods and equipment for the manufacture of most down-stream products derived from starch.

It includes complete programs for the production of starch based sweeteners such as glucose syrup, crystalline dextrose, maltose, fructose and sorbitol.

It includes process and equipment for products produced by fermentation of starch, such as bio-ethanol, L-lysine and monosodium glutamate (MSG).

The Danish farmers are no longer rooted in the old country, but have established starch factories as far away as China and Vietnam.

... and we at International Starch have long outgrown our home market. Now we provide turnkey plants for starch and its derivatives all over the world.

Festive opening of starch factory in North Korea.

The starch factory is supplied and erected by International Starch.
BY-PRODUCTS AND ENVIRONMENT.

Traditional by-products are pulp and fruit juice. The pulp is sold wet to nearby farmers as cattle fodder. The juice used to be distributed to nearby farmers as a fertilizer in road tankers or through pipelines. Now the protein in the juice is being heat coagulated and precipitated, dried and sold as a profitable feed additive.

The juice depleted most of its nitrogen is instead turned into biogas or concentrated as a potassium rich fertilizer called Protamylasse. The particular Danish process handles and concentrates all effluents.

The environment has been a great concern to the Danes over the years, and the starch industry has learned to live up to the strict rules set by the authorities. The industry is therefore urged to meet the challenges of the future - and starch has a future indeed. It is a most pure and versatile natural polymer with innumerable progressive uses in our everyday life.
... a member of the International Starch Group

International Starch Institute A/S,
Agro Food Park 13, DK-8200 Aarhus N, Denmark.
Phone: +45 8843 8800. Telefax: +45 8843 8813.
international@starch.dk  www.starch.dk