BIO CLUSTER PROJECT

Bio economy defines the future

The target of the project

The idea is to establish a business of manufacturing products with high added value based on deep processing of corn.

Location – village Naratus, Gegharkunik region, Republic of Armenia

Type of business and Industry – Private Property, Agro industrial sector

1. Agricultural company for maize cultivation
2. A plant for deep processing of corn with final capacity of 1000 tons per day; the final products are modified starch and its related products (gluten, feed, bran)
3. Starch processing enterprise; the final products include glucose, lysine, lemon acid, biofuels, bioplastics, etc. Remark: for each type of product separate legal entities can be established
4. Cattle breeding complex
5. Meat processing company

Three Stages of Business Development:

Stage 1:
  A) Agricultural enterprise of raw material cultivation
  B) Corn processing plant – capacity 300 ton per day

Stage 2:
  A) Expansion of the corn processing plant capacity up to 500 ton per day
  B) Cattle breeding complex

Stage 3:
  A) Expansion of the capacity of corn grain processing plant up to 1000 ton per day
  B) Starch processing plant
  C) Meat processing company

Required investment and deadlines for cluster development:

Phase 1 – timing - 3 years, start in 2015, finish in 2017
required investment: 25 million USD
Phase 2 – timing - 2 years, from 2018 to 2019
required investment: 25 million USD
Phase 3 – timing - 5 years, from 2018 to 2022
required investment: 70 millions USD

TOTAL 120 millions USD
The possibility of regulating the output volume at any phase of the production is one of the main advantages of our cluster business companies. It is highly important because you are able to adjust the production process to the needs of the market and therefore increase the business efficiency.

**Starch in Nature**

STARCH is a complex carbon, formed and accumulated by plants as a reserve nutrient. It is well digested and absorbed by the human body. It is the product of deep processing of grain. The technology of deep processing involves the separation of the valuable components of maize and products with high added value, which is highly demanded in various sectors of the economy.
Starch is a very versatile product, both in its raw materials and in its uses. It is a white, granular, organic chemical produced naturally by all green plants. Native starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol, or other solvents. The basic chemical formula of the starch molecule is (C₆H₁₀O₅)n.

**Starch Industry**

Starch industry is one of the most dynamically developing sectors of economy. Annual growth of the volume of production of the starch products has been more than 30% during the last years worldwide. However, the marketplace is demanding those products in increasingly larger quantities. Constantly renewable products, manufactured by deep processing of starch, appear in the market; these products include different kinds of enzymatic glucose syrup, glucose-fructose syrups, and modified starches etc. that are widely used in different industries:

- Paper production industry
- Food industry
- Confectionery industry
- Chemical industry
- Oil industry
- Pharmaceutical industry
- Perfume industry
- Textile industry

The total production volume of starch during 2014 worldwide was 67 million tons.

The main producer of starch and starch products is the United States. Companies such as FDM, Cargill, American Maize, Nat starch are located in the US. Those companies process corn grain to get starch and alcohol.

The main raw material for the production of starch products in the EU is maize. The leading starch manufacturers in the European Union are Amylum, Avers, Roquette and others. The rapid development of starch production is observed in Asia, India, China, Thailand, and other countries.

For a long time, the international community has acknowledged the threat of environmental pollution, including the pollution from plastic product waste in oceans. Plastic makes up to 70% of pollution on the planet. Conventional plastic packaging is biodegradable during 100 years and shrinking plastic particles get into our body along with the fish and seafood. However, if the packaging is made of starch-based biopolymers, the compost is transformed into bio- fertilizer in only a month.
There is no production of starch, starch products and deep processing of the corn in the Republic of Armenia, as well as in the neighboring countries. Thus, the establishment of this bio cluster in Armenia is very timely and potentially lucrative. Our project is the first in the region.

Technology

There are several phases in corn starch production:

- Cleaning raw corn grain
- Soaking raw materials
- Raw material grinding
- Separating corn germ
- Separation of starch and gluten
- Cleaning starch
- Dewatering and drying
- Packaging

The main stages of processing starch-containing raw materials:

- Pre-treatment of the raw materials from impurities
- In order to reduce energy consumption during grinding of corn grains, raw materials are preliminary crashed through chemical and biological methods
- Directed mechanical disruption of the structure of raw materials into individual components
- Fractioning of the crushed mass using cellular, accompanying, and extraction fluids of raw materials as a separation medium
- Starch extraction and concentration of by-products in multi-loop circulation systems
- Regeneration of accompanying and extraction liquids for subsequent recycling process
- Reduction of pure water consumption by means of recycling in the process of production

The cluster

Our company is presenting a business plan to design and put in operation a corn deep processing biotechnological complex in the Republic of Armenia. The production volume is 300 ton per day with potential expansion up to 1000 ton per day during the next several years.
Several products will be produced in the beginning of the process of starch deep processing. Those products have high demand in the market.

*Dry starch*
*Oxidized starch*
*Cationic starch*
*Oxidized modified starch*
*Caramel treacle*
*Maltose treacle*

Additionally, several byproducts will appear for sale during the starch deep processing, such as:

*Dry feed, dry germ and gluten*
In June 2015 our company has started bio cluster implementation project. 100 ha of agricultural land were acquired for corn cultivation. It is planned to expand the area of the land up to 1000 ha.
Required investment for implementation of the first phase of the project without the cost of the acquainted agricultural land:

1. Preparation of the site for plant construction, purchasing land, engineering infrastructure, excavation work  
   2100 thousand USD

2. Designing, engineering works  
   500 thousand USD

3. Construction of the warehouses for raw materials  
   2700 thousand USD

4. Construction of the main production building in the plant  
   6500 thousand USD

5. Construction of mechanical and transporting workshops  
   1000 thousand USD

6. Purchasing technological machinery  
   9500 thousand USD

7. Purchasing supporting materials and equipment  
   1500 thousand USD

8. Installation of the technological and supporting equipment  
   550 thousand USD

9. Commissioning of the machinery start of the operation  
   350 thousand USD

10. Unexpected expenses  
    300 thousand USD

**TOTAL**  
For the first phase  
25000 thousand USD

We are expecting to have about 20% saving from the value of the total investment, since we are planning to make construction by our own team. Also, we are planning to produce some nonstandard equipment and machinery by our own means, we have all required expertise and experience for it.

The required amount of operation cash for startup is estimated to be about 15% of the value of total investment. That amount will include marketing and promotional budget too. The estimated amount is 3,750 thousand USD.
Calculation of the cost of the produced products

Since we are going to produce several products, including byproducts that are received from the waste (but they will be sold as finished products) like, dry feed, dry germ and gluten, we are suggesting to choose the following methodology of cost calculation: we will calculate all expenses required for production of 1 ton of raw starch and will recalculate for absolutely dry starch, that is produced in condition of starch slurry.
The slurry is raw material for production of other products.

Table No1

<table>
<thead>
<tr>
<th>Type of the expense</th>
<th>Measurem ent unit</th>
<th>Required consumption for 1 ton of raw starch recalculated to absolutely dry starch</th>
<th>Unit cost, USD</th>
<th>Cost for 1 ton of absolutely dry starch, USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material – corn grain</td>
<td>Ton</td>
<td>1.6</td>
<td>210</td>
<td>236</td>
</tr>
<tr>
<td>Gas</td>
<td>m³</td>
<td>146</td>
<td>0.25</td>
<td>36.5</td>
</tr>
<tr>
<td>Electricity</td>
<td>kWt/hour</td>
<td>196</td>
<td>0.07</td>
<td>13.72</td>
</tr>
<tr>
<td>Water</td>
<td>m³</td>
<td>5</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Sewerage, draining</td>
<td>m³</td>
<td>3</td>
<td>0.15</td>
<td>0.45</td>
</tr>
<tr>
<td>Sodium metabisulphite</td>
<td>Kg</td>
<td>4.4</td>
<td>1</td>
<td>4.4</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>Kg</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Salaries and wages including taxes</td>
<td>USD</td>
<td>30</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Overhead and admin expenses</td>
<td>USD</td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Depreciation</td>
<td>USD</td>
<td>5.5</td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>440.07</td>
</tr>
</tbody>
</table>

Table No2

<table>
<thead>
<tr>
<th>Type of the product</th>
<th>Quantity produced per day, ton</th>
<th>Quantity of output per produced 1 ton of absolutely dry starch, ton</th>
<th>Cost of one ton of the product excluding VAT, USD</th>
<th>Cost of product related to one ton of absolutely dry starch, USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry feed</td>
<td>60</td>
<td>0.344</td>
<td>90</td>
<td>30.96</td>
</tr>
<tr>
<td>Dry germ</td>
<td>16</td>
<td>0.094</td>
<td>200</td>
<td>18.8</td>
</tr>
<tr>
<td>Dry gluten</td>
<td>14</td>
<td>0.084</td>
<td>500</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>91.76</td>
</tr>
</tbody>
</table>
The production cost of the dry starch is 440.07 USD. The income from sales of the byproducts is 91.76 USD. Therefore the production cost of one ton of dry starch is:

\[440.07 - 91.76 = 348.31 \text{ USD}\]

Cost calculation of maltose treacle:

<table>
<thead>
<tr>
<th>Type of expense</th>
<th>Measurement unit</th>
<th>Consumption for 1 ton of treacle</th>
<th>Unit cost, USD</th>
<th>Expenses for 1 ton of treacle, USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material – absolutely dry starch</td>
<td>Ton</td>
<td>0.8</td>
<td>348.31</td>
<td>278.65</td>
</tr>
<tr>
<td>Gas</td>
<td>m³</td>
<td>90</td>
<td>0.25</td>
<td>22.5</td>
</tr>
<tr>
<td>Electricity</td>
<td>kWt/hour</td>
<td>63</td>
<td>0.07</td>
<td>4.41</td>
</tr>
<tr>
<td>Water</td>
<td>m³</td>
<td>4.5</td>
<td>0.3</td>
<td>1.35</td>
</tr>
<tr>
<td>Sewerage, draining</td>
<td>m³</td>
<td>4</td>
<td>0.15</td>
<td>0.6</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>Liter</td>
<td>5.4</td>
<td>0.25</td>
<td>1.35</td>
</tr>
<tr>
<td>Soda</td>
<td>Kg</td>
<td>2.9</td>
<td>0.6</td>
<td>1.74</td>
</tr>
<tr>
<td>Enzyme tablets</td>
<td>Liter</td>
<td>1</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Powder filter</td>
<td>Liter</td>
<td>35</td>
<td>0.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Active carbon</td>
<td>Kg</td>
<td>3</td>
<td>2.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Salaries and wages, including taxes</td>
<td>USD</td>
<td>30</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Overhead and admin expenses</td>
<td>USD</td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Depreciation</td>
<td>USD</td>
<td>5.5</td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>392.1</td>
</tr>
</tbody>
</table>

The efficiency of the investment into the first phase of bio technological cluster, production facilities

We have to calculate the net profit of the company to estimate how effective the operation is and the payback of the investment. Since the company is producing wide range products, we have selected the mythology of calculation of the cost of the production for certain period of
time. We have chosen a year operation as a period of time. We have calculated all expenses connected to the operation of the company and revenue from the sales of the annual production.

<table>
<thead>
<tr>
<th>Name of the production</th>
<th>Annual production Ton</th>
<th>Cost of the production USD/1 ton</th>
<th>Total cost of the production, thousand USD</th>
<th>Unit price, USD/1 ton</th>
<th>Total sale of the production, thousand USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caramel treacle</td>
<td>18750</td>
<td>365.5</td>
<td>6853.1</td>
<td>550</td>
<td>10312.5</td>
</tr>
<tr>
<td>Maltose treacle</td>
<td>18750</td>
<td>392.1</td>
<td>7351.88</td>
<td>585</td>
<td>10968.75</td>
</tr>
<tr>
<td>Dry starch</td>
<td>9000</td>
<td>348.31</td>
<td>3134.8</td>
<td>540</td>
<td>4860</td>
</tr>
<tr>
<td>Oxidize starch</td>
<td>4500</td>
<td>417.7</td>
<td>1879.65</td>
<td>650</td>
<td>2925</td>
</tr>
<tr>
<td>Cationic starch</td>
<td>6000</td>
<td>550</td>
<td>3300</td>
<td>1200</td>
<td>7200</td>
</tr>
<tr>
<td>Acid modified starch</td>
<td>4500</td>
<td>417.7</td>
<td>1879.65</td>
<td>650</td>
<td>2925</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>24399.08</strong></td>
<td><strong>39191.25</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Company’s income before taxation is:

$$39191.25 - 24399.08 = 14792.17 \text{ thousand USD}$$

The income after deduction of VAT ($39191.25 \times 16.67\% = 6533.19$) is 32658.06.
The profit tax (20%) is $(39191.25 - 24399.08 - 6533.19) \times 0.2 = 1651.8$
The therefore the net annual income is:

$$39191.25 - 24399.08 - 6533.19 - 1651.8 = 6607.18 \text{ thousand USD}.$$ 

The payback of the investment is $25000/6607.18 = 3.78 \text{ years}.$

We can manage to reduce the amount of investment by 15%, if we make the construction works and production of some nonstandard equipment ourselves.

In this case the payback period of the project will be:

$$25000 \times (100 - 15)\% / 6607.18 = 3.22 \text{ years}.$$ 

**Possible risks**

1. Import of the corn from the abroad because of bad harvest here will result in price increase.
2. Increase of the cost of the logistical services.
3. Reduction of the world prices for sugar and sugar products.
Conclusions

1. During the implementation of the first stage of cluster, 500 primary and 1000 secondary job positions will be created.
2. More than 300 ton of corn per day will be processed at the plant. The plant will produce more than 180 tons of starch products, 60 tons of dry high protein feed, 14 tons of dry gluten and 15 tons of dry germs.
3. The technological processes will include imported and locally made highly effective machinery and equipment. It will make the production very efficient and productive.
4. The production is ecologically safe.
5. Payback of the investment for the first stage of the bio technological production is 4 years.