Title: METHOD FOR PRODUCING PROTEIN AND ETHANOL FROM ENSILAGED PODCROP

Abstract: A method to use ensilaged pod-crop to produce protein for animal-feed and for human consumption together with production of energy as solid, gas and liquid. The purpose is to store the crop and to shorten the time in the field to secure the harvest yield and to be able to plant the next crop in rotating farming already in the fall as for instance winter-wheat. This method also make it possible to take benefit from the nitrogen fixated by the pod-crop and the carbon left in the soil as humus that decreases the level of CO2 in the atmosphere. An apparatus that separate, clean and ennoble the crop locally to take care of the all the useful substances.
Method for producing protein and ethanol from ensilaged podcrop

Background: Field beans and peas are rich in protein, sugar, starch, cellulose, hemicellulose and lignin. It is also an excellent pre fruit-crop to for example winter crops such as winter wheat.

Parts of the above substances are present in the stalks and pods as shown in the description, and much of these substances will be lost if threshing the crop, while harvesting time will be so much later that the next crop can't be sown the same season. To benefit from these substances need the crops are harvested fresh and to store as silage is an excellent method.

The stalks consist of 11% protein and pods consisting of 14% protein which is lost while threshing. This means that the total amount of protein that can be extracted per unit area increases by 50%. Compared with soy, 3 times as much protein can be extracted per unit area. There is also 13% fermentable material in the stems.

When the bean is harvested early autumn, for example, winter wheat can be sown immediately afterwards, this means that the nitrogen bound can be taken up by the new crop.

If the crop is threshed you'll have to wait until the next spring to sow the new crop, which means that it is a risk of leaching of nitrogen.

If the bean is harvested early autumn when the plant is still fully green, there will be no weed, because the bean is a good ground cover, and no light reaches the ground so that weeds can germinate. This means that the next crop can be undersown without plowing in between, it's enough with light harrowing.

The carbon that is sequestered in the roots, which make up 40% of the plant decays when the humus instead of plowing the drought and resign as carbon dioxide.

The result of this method is to yield 50% more protein that can be recovered, minimal leakage of fixed nitrogen and 13% more sugar can be recovered in the same area. In addition, large amounts of fibres from stalks that are of good quality, they are lost in the threshing.

It is always risky to thresh late autumn when the soil can be wet and also covered with snow. This is a contributing factor to the bean has not grown more than it does, despite the need for protein is very large.

Previously Laid harvest can also sowing of field bean postponed. This is currently very early, sometimes even frost in the ground, in order to have time to get the crop ready as early as possible. The risk with this early planting is that it can be very dry in the ground which prevents the field bean germinates. When the bean has been germinated, it is a very safe and durable plant crop.

Ensilage also has the effect that the cell walls of the stems exploded so that the liquid easily flows out, which facilitates drying. The shells of the pea and bean release easier by ensiling process so that they can separate which is an advantage when the shells contain tannins which can give the product a pungent taste. This prevents feeding can be done in full, for example, to pigs and poultry. Likewise if one wants to produce vegetarian meat substitutes, it is an advantage if the pea and bean is scaled to achieve the meat flavor. When feeding cattle, however the amount of tannins to be higher to slow digestion so that the animal can better assimilate food.

Description:
The method is a rational continuous technology that aims to take advantage of the emergence both starch, glucose, maltodextrins, cellulose, hemicellulose, sugars, lignin and protein.

The raw material is preferably silage.

The plant, the raw material is preferably a legume alone or in combination. The pod-crop advantages is its ability to fix nitrogen from the air into the soil as it grows, and it also creates a favorable structure of the earth. This is called the preceding crop method also sequestering carbon to the ground.

Nitrogen fixation is very useful when leguminous not need nitrogen fertilization and also leave from 30 to 50 kg N/ Ha of land to the next crop in cultivation. Leguminous also creates a very positive structure to the soil resulting in yield increases for the next crop.

Leguminous contains large amounts of the protein composed of the amino acids mentioned above is edifying for both humans and animals. The carbohydrate is available in the form of sugar, maltodextrin, starch, cellulose, hemicellulose and lignin. Which means that this is a valuable part of the process. The Peas on Earth concept enrich the soil with nitrogen fertilizer, and carbon in the form of humus from the air so that the concentration of CO2 in the atmosphere decreases.

Production takes place in a ekoreaktor where energy, raw materials and semi-finished products (transfer products) are used as catalysts in the process that begins with plant fibers are separated out and purified.

This is preferably from a fresh, ready-grown silage crop. In this way the shortened growing season so that the next crop can be undersown early autumn. By means of rolling, in such a way that the fibers are not broken, cleaned in this way, the fibers of the stems from fermentable carbohydrates such as the aforementioned starches, sugars and dextrines.

Rolling is designed to first on a winder in the form of a conveyor Figure 1.a scratch and threshing the crop so that the seeds are exposed and separated, this is done by means of a rotating scratch Figure 1.b both scratch out the seeds and throw fibers to another conveyor moving at a higher speed so that the material of the roll becomes thinner.

The seeds fall into the collector 1.c. Furthermore, the crop is brought in between two threaded rollers Figure 1.d spreading fibers evenly to the surface so that a rough separation between the fibers occurs from each other and shell parts fall off. Next, a combination of a stiff perforated roll over a rubber covered Figure 1.e which squeezes the liquid. The last rolls are placed on a hard surface with holes. These rollers 1.f. have an angle difference, so that the crop rolls laterally back and forth on a hard excess heat from the process is heated flat surface. This has the consequence that the fibers are cleaned of less carbohydrates and proteins through the holes has the desired granule size. The exposed fibers are dry and are collected in a desirable manner.

The remaining material consists together with the seeds and pods of protein, starch, maltodextrin, cellulose, lignin and sugars, preferably glucose, which is collected using vat 1.c. and carried on in ekoreaktor process by means of a screw into the bottom of 1.c. There, it is mixed with the granulated material transfer solution consisting of water and / or filtered stillage along with glucose causing a specific weight of preferably 1.15 kg / litre. This
glucose formed by hydrolysis and protein defoaming, but before adding the yeast later in the process and separated by the heavier starch with a specific weight of 1.25kg/litre sink to the bottom and the lighter protein 1.05 kg / liter float to the surface. This occurs in a vertical high and from the top narrow designed tank 6.a. The starch / protein fraction are mixed Fig 6, b with the hydrolyzed glucose solution so that it separates while it slowly flows through the vessel at room temperature.

When the starch is sunk to the bottom it is screwed out of the vessel by a screw 6.c. The protein floated skimmed from the surface of the drying of the first screwed with a trapezoidal screw above the scrim Fig 6.d. and then to a filter press where the wirecloth and screw takes the form of a cone which is described in Figure 6.e. The dried protein was removed from the process for storage via 6.f. Transfer solution continues to fermentation by yeast addition Fig.3.b.

The extracted starch can also contain sugar and malt-dextrin are mixed with water and / or filtered stillage. These are heated by a heat exchanger having the form of a trapezoidal screw which surrounds Figure 2.a (enclosing) tube with good conductivity, preferably of copper or aluminum in Figure 2.b.

The screw is enclosed in a larger tube with poor conductivity, preferably stainless steel or plastic insulated Figure 2.c The heat starts to rupture the cell walls of the feed starch is gelatinized, this creates a viscous liquid that is transported by the one described above screw.

The liquid is heated by the hot fluid that needs to be cooled Fig 2.d. The screw is of trapezoidal shape, which is driven by an angle gear. The liquid is heated by the hot fluid that needs to be cooled Fig 2.d. The screw is of trapezoidal shape, which is driven by a bevel gear. Figures 2.e screw has a design so that it simultaneously by mechanical impact (scraping) keeps the inner and outer pipe free from accumulations of protein and other solids.. Figures 2.e screw has a design so that it simultaneously by mechanical impact (scraping) keeps the inner and outer pipe free from accumulations of protein and other solid particles.

The third function of the screw is to transfer liquid from inside the hot inner tube to the cold outer and vice versa for achieving maximum heat transfer. This occurs by the screw has a configuration with guide rails on the top of the trapezoidal screw is angled so the liquid exiting from the inner tube in the middle and at the bottom are angled so that liquid supplied to the inner tube. Alternatively, the guide rails designed so that liquid is introduced into to the hot tube on the top and on the underside.

Heat is also added the same way from the hot stillage to be cooled and the excess heat from the heat pump. This is described later in the application.

The outer and inner tube together with the screw is flexible and can therefore be fitted in a ekoreaktor so that it takes minimal space.

After heating the hydrolysis can be initiated by an enzyme sprayed over the viscous liquid which is now using a "letterbox technique" widespread across a moving heated surface, preferably in the form of a drum or two against each other rolling drums as Fig.3.1.a so that a large area is created Figure 3.1.a. By the heated surface moves and passes through a "mailbox" distributed evenly distributed raw material which is preferable as the amount of enzyme Fig.3.1.b. alternatively sprayed onto the other drum then can be optimized.

This hydrolysis lasts approx. 2 hours while the liquid by spraying, or rolled onto Fig.3.1.c. slowly ahead under stirring by means of a screw similar to that of Figure 2 in the vessel 3.1.d.

This screw heat exchanger can supply heat and keep liquid at a constant temperature. Supplements heat coming from the heat pump Fig.5, from forehead Fig.2.f, from the stillage and breaks up starch to malt-dextrin, while the gelatinization is broken and the liquid once again becomes fluid.
After the hydrolysis, the liquid is moved further and the temperature is raised further by energy from the heat pump Figure 5. and / or the heating boiler Fig. 2.f. now in the next "letter-box" spread on a moving heated surface, preferably in the form of a drum. The remaining protein is released when the granulate contains and forms a foam that floats up from the liquid in which the mechanically foamed out. Foaming takes place by means by an inclined steel with holes where Fig. 2.g is positioned between the liquid and the buoyant protein foam and thus separates them from each other. This protein is discharged from the process by means of a conveyor belt with carriers Fig. 2.h and a screw through a tube Fig. 2.i. the protein from the process for densification and refinement.

Then the temperature is lowered to preferably between 50 and 70 °C by pre-heating of the distiller Fig. 2.j and after cooling a further hydrolysis takes place of the commodity, now cleansed from protein and in the form of malt-dextrin and sugars is spread through the "letter-box" technology of Fig 3.1 a. on a moving surface preferably in the form of a drum or two mutually rolling drums to provide a large surface area. This surface is sprayed Fig. 2.k. with a further enzyme or applied by means of a drum Figure 3.1.c. and under stirring via twisted plastic rails Fig 2.i. which liquid passes and convert the liquid to the glucose aqueous solution. Glucose-water mixture is cooled by heat exchange to fermentable temperature by means of the screw 2.a., which heats up the original o-hydrolycerade commodity.

The fermentable transfer fluid is then used as the catalyst for the separation of starch and protein which are described previously. Yeast is then at Fig. 3.b with one or two drums according to Fig. 3.1. for fermentation. The fermentable liquid is introduced into a ferment-tower where it is pumped into the bottom and spends a time of preferably 48 hours in a spiral which prevents spontaneous walks into the liquid and simultaneously sucked up by the vacuum from the distiller.

Alternative, the liquid is driven by a trapezoidal screw Fig. 3.c and mixed continuously while the same method as in Fig. 2. The inner tube Fig. 3.d in this case is filled with water and equipped with valves for the escape of carbon dioxide through airlock Fig. 3.e.

The liquid begins by the fermentation to produce alcohol which is lighter than water and therefore seeks to add to the top. Jastornet described in Figure 3.

When the liquid reaches the top of the tower it has an alcohol content of 11-13%, preferably at Fig. 3.f and is now distilled to achieve fuel power Figure 4.

This is achieved by heating the liquid to a temperature just below the boiling point of ethanol 78 °C. Preheating takes place through a heat exchanger by the cooling required in the hydrolysis Fig. 4.a. and from stillage Fig. 4.b.

Then the liquid is spread out again over the inclined element of a staircase Fig. 4.c filled with 77 °C hot fluid and subjected to a vacuum so that the boiling point is lowered.

This also results in decreas of the vapor pressure over the surface, which reduces the energy consumption of the liquid to be transited into a gaseous state by the negative pressure generated in a pump Fig. 4.e and which sucks in the gas now formed and which consists of pure alcohol, the negative pressure also makes the liquid in ferment-tower sucked up Fig. 4.d and Fig. 3.e.

The pump is of the piston form and configured so that a valve Fig. 4.f is open at the inlet when the piston moves so that the volume of the cylinder increases and the alcohol portion of the liquid turns into gas. The valve is then closed when the piston reverses and the cylinder volume decreases and gas is compressed when the Fig. 4.g another valve that opens and outside of which is a nozzle Fig. 4.h whereby the gas is compressed. The heat is removed from the pump so that the cooling of the cylinder can take place via a heat exchanger, a Fig. 4.j. and the carried away heat is emitted into the process. After the nozzle the temperature falls and the gas is condensed back into liquid. At the same time another piston is working in the opposite direction so that the vacuum and pressure are kept constant.
This liquid is pressed through the nozzle consists of pure alcohol and are collected for this purpose in the appropriate container. Figure 7.

The additional energy that the process needs adds to the process by pyrolysis of the collected and pelleted, brick discounted fibres, but primarily from the abducted excess heat from distillation-pump.

The pyrolysis gas is supplied to a conventional internal combustion engine that through a generator produces electricity that the process needs. The cooling water from the engine supplies the ekoreaktor process thus becomes self-sufficient.

Excess heat from distillation heat-pump be used together with the stillage to be cooled. The ekoreaktor is preferably driven by two electric engines fueled by the the above mentioned generator.
Claims

1. A method for the cultivation and harvesting of legumes harvested fresh, whole with stems, for the storage of silage in bales, in silos, as loaf on the ground or similar for processing and ensiling of protein for animal feed and meat substitute for human consumption, glucose and ethanol, and long fibers into fuel pellets and briquettes, or to the industry as the content in board. This is done by rolling, folding, lay or otherwise placing the material on a conveyor Fig. 1 to separate stems from the seeds and pods, stems spread by means of threaded rollers, and then by means of a mangle press out the proteinaceous liquid the material. The various materials then are refined in various ways. The protein is filtered and purified, the starch is hydrolyzed into sugars and fermented and distilled further, if necessary, to ethanol. The fibers are dried to become raw material for boardskivør fuel pellets or briquettes.

2. An apparatus for the process of the ensiled material, which rolls out a bale of ensiled legumes or leguminous crops ensiled by another storage form and by means of a conveyor belt that is described in Figure 1 with a number of rollers clean fibers from other materials by scratching the seeds and pods which fall into a trough, the rep in the form of a rotating pipe with strong pegs standing in rows out of the tube and the tube rotates at a speed higher than the conveyor so that the crop spread lengthwise. The stems lands on the next conveyor belt which has a higher speed than the first conveyor belt and where one fibre are separated from another through pairs of radially corrugated rolls wherein the grooves are in the form of a thread that rotate in opposite directions so that the unrolled fibers distributed uniformly over the substrate.

Furthermore, with a preferably soft and a hard roll perforated mechanically separate the liquid present in the crop. With two against each other angled rollers get fiber to roll back and forth on a hard surface heated and thus purged completely from the fiber-free materials such as proteins and starch. This material is collected in a trough and is screwed on to a grinder. The fibers are not cut but preferably collected in length coiled on a spool, or rolled or folded as a mat.

From trough screwed material between two soft rolls peeling bean which has come off by ensiling and on to a mill to grind the seeds into powder. After milling the powder is mixed with a sugar solution with a specific gravity of between protein 1.05 kg/liter and the starch 1.35 kg/liter which is used to distinguish them in a tank such that the protein floats up and starch will sink to the bottom. The tank is equipped with a screw in the bottom for the transport of the starch and a sieve gauze with a screw top for transport and dewatering of protein. The screw presses since protein by a cone of the filter cloth for optimum dewatering. Part of this can be seen in Figure 6.

The sedimented starch is mixed with part of the sugar solution and diluted with water and purified dregs to the appropriate concentration and fed into a trapezoidal screw as shown in Figure 2, whose function is to heat exchanger two liquids. Within the screw in a tube with a preferably good conductor has a hot liquid to be cooled and the screw, as described feeding a cold liquid to be heated which also holds both the inner and the outer tube clear of protein and starch accumulation and can transport liquids of different density and fluidity. The screw is formed with inclined guide rails which causes the liquid to move between the inner and outer tubes for optimum heat transfer.

The screw is driven by a simple angle gear. This heat exchanger can be bent and optimal printiness of this material is further directed to a device by means of heating and expansion of a liquid by means of an inclined steel can skim proteins from a material. This protein is then removed by means of a conveyor belt with carriers and then with a screw from the process.

The remaining liquid is pumped into a ferment-tower Figure 4 including a helical path that keeps track of the fluid being pumped in from the bottom of the screw heat exchanger and
is sucked up from the top of the distillation. This jastorn is also equipped with an inner water-filled tube with valves against which the web is inclined upwards so that the carbonic acid formed may be evacuated from the process by the overpressure produced by fermentation. The web is also if necessary a trapezoidal screw which drives the liquid forward and mixing the active, when the liquid reaches the top of the alcohol formed being sucked into a distiller, where the fermented liquid after preheating from the previous step in the process is poured over a stepped medium of Figure 5 of hot liquid filled element with good conductivity and subjected to pressure by a piston in a cylinder in parallel with a similar piston cylinder application and as may the cylinder volume to increase with pressure drop as a result causing the liquid boiling point to fall and vaporates. As the piston turns the valve through which the alcohol gas is sucked into the pump and another valve opens outside which a nozzle is disposed and the is pressed against the nozzle alcohol gas wherein the heat emitted and collected by a heat exchanger and is removed from the cylinder. This means that the gas is cooled and condensed at the rear of the nozzle. Simultaneously opposite sequence in the second cylinder. The heat produced by the compression of the gas used as additional energy in the reactor process. In order to drive the process that is self-sufficient in energy, a generator driven by an internal combustion engine. The fuel for the internal combustion engine is so called gas produced by pyrolysis of the fiber materials produced in ekoreactorn. As a supplement to the heat the ekoreactor need used engine cooling water.
Fig 3

3.1.

Fig 4.
Fig 3
3. 1.

Fig 4.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IP: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A01 B, A01 D, A01 F, C10L, C12M, C12P, D01 B, D01 G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>WO 201 0129724 A2 (SCHWARTZ ANNE), 11 November 2001 0 (2001-01 1-11)</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  
  **A** document defining the general state of the art which is not considered to be of particular relevance
  
  **E** earlier application or patent but published on or after the international filing date
  
  **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  
  **O** document referring to an oral disclosure, use, exhibition or other means
  
  **P** document published prior to the international filing date but later than the priority date claimed
  
  **Q** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  
  **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  
  **Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  
  **&** document member of the same patent family

Date of the actual completion of the international search
08-01-2013

Date of mailing of the international search report
09-01-2013

Name and mailing address of the ISA/SE
Patent och registreringsverket
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**INTERNATIONAL SEARCH REPORT**

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos. 1,2
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

   According to PCT Article 6, claims shall define the matter for which protection is

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)
sought and they shall be clear and concise.

However, in the present application, present claims 1-2 are not clear and concise because the way they are formulated makes it impossible to know the contribution to the art as they include many different aspects and processes related to harvesting and producing ethanol and many of these aspects are already known in the art, per se or in different combinations.

The claims must not, in respect of the technical features of the invention, rely on references to the description or to drawings. However, in claims 1-2, some aspects or details are described by a reference to the drawings, e.g. "conveyor Fig. 1" in claim 1 and "that is described in Figure 1", "trapezoidal screw as shown in Figure 2" in claim 2. Also in claim 2, the screw presses are described by a reference partly to Figure 6 and the "ferment-tower Figure 4".

Regarding how to make references to figures in claims, please see PCT Guidelines, Chapter 5, Claim, 5.10 and 5.11.

In addition, present claims 1-2 include vague and unclear expressions such as in claim 1 "or similar", "or otherwise", "conveyor Fig. 1", "various materials", "various ways".

Therefore, a lack of clarity and conciseness within the meaning of Article 6 PCT arises to such an extent as to render a meaningful search of the claims impossible and therefore the claims have been searched only partly; namely those parts of the application which appear to be clear and concise; harvesting fresh, whole legumes, silaging and producing bioethanol from ensilaged legumes. The conveyor in Figure 6 with subsequent "scratching" and seed separation (Fig. 1 in the claims) has also been included in the search.
### DOCUMENTS CONSIDERED TO BE RELEVANT

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International Patent Classification (IPC)

C12P 7/10 (2006.01)
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C10L 7/02 (2006.01)
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