

Success story: Recycling and upgrading of bone meal for environmentally friendly crop protection and nutrition in horticultural – vegetable industry. FOOD-CT-2005-514082



Introduction:

Phosphorus is an essential, critical and limited nutrient in crop production with no alternative substitutes. All living organisms require phosphorus to grow and it forms part of important life sustaining molecules such as DNA and RNA.

Today agriculture relies on phosphorus fertilizers mostly processed from mined phosphate rock which is a non-renewable resource that takes 10-15 million years to form and current known reserves are likely to be depleting 50-100 years. The rate of production of economically available phosphate reserves will soon reach a peak, followed by a rapid steep decline and subsequent ongoing decline of productivity. Demand for phosphorus fertilizers is expected to increase by 50-100% over the next 50 years due to increased population, increased demand for meat and dairy-based diets and increased demand for non-food crops like biofuel crops. The quality of phosphate rock is continuously declining: the concentration of P₂O₅ in mined P rock is decreasing; and the concentration of associated heavy metals like Cadmium is increasing. The

Uranium contamination is a naturally occurring element in the phosphate rock, therefore in many cases the phosphate rock is also used for production of Uranium extractions for nuclear power plant fuel. The Cadmium content of the sedimentary phosphate rock can be very high. This is either considered a harmful concentration for application in agriculture or expensive and energy intensive to remove. Cadmium can accumulate in soils and plants through repeated fertilizer use. The fertilizer application to agricultural land may result in the transfer of cadmium into the food chain. **There is an increasing social and ecological need for recovery, recycling and reuse of the phosphorus resources** like harvested biomass, food industrial and animal wastes (food grade bone meal of hog origin) which are reach in phosphorus into natural Phosphorus fertilizers. **To reduce hazards to human health and the environment from heavy metal (cadmium) loaded fertilisers and chemicals, the EU's Environmental Action Plan stipulates that food-chain organic wastes and by-products should be recycled and upgraded into bio fertilisers and biocontrol products.**

The aims and objectives:

The goal of the PROTECTOR project was the added value upgrading and valorisation of food/agro industrial organic by-products into safe and useful soil amendment products by integrated thermal and biotechnological zero emission recycling means, primarily used in the horticultural industry for safe vegetable productions.

Animal bone meal is a left over from food industry which, after thermal process up to 850 degree C (carbonization), contains high concentrations of Phosphorus (P) and Calcium (Ca). The porous structure of bone char offers the microbes a protected niche when introduced into soil. This product, called 'animal bone char' or 'ABC', can be used as a carrier for biological control agents or other beneficial microorganisms, meanwhile delivering P and Ca for plant growth. High Phosphorus food industrial hog animal bone meal and other agro/food industrial by-products recycled in 2 combined innovative process steps: (1) advanced carbonization to manufacture biotechnological specific solid mineral/carbon carrier and (2) innovative Solid State Fermentation/Formulation (SSFF), designed to adapt soil microbiological structures. The process upgrades by-products into high added value, safe, economical and efficient biological crop protection, plant growth promotion and natural fertilization products for environmentally friendly horticultural cultivations in soil and soil-less low-input and organic farming. During the FP6 PROTECTOR project SSFF technology was developed and optimized with <400 kg capacity for the primary selected *Trichoderma harzianum* strain in Hungary.

PROTECTOR application permit procedure:

Detailed Authority permit test investigation has been going on (from 2005 to 2008) by different independent and accredited departments from the Soil and Plant Protection Authority under EU legislation for safe food vegetable production. **The PROTECTOR product successfully received full scale application permit for open field and greenhouse vegetables cultivation in conventional, low input and organic system as well in March 31, 2009. Permit number: 02.5/67/7/2009.**

Highly impressive results of the efficiency trials in several countries under different climatic, soil and ecological conditions:

For validation of the PROTECTOR effects several open field and green house cultivation tests have been executed in Germany, Netherlands, Israel, Italy and Hungary. Applied doses was 400 – 1000 kg/ha.

- (1) **HEALTHY PLANT in NURSERY:** Already in the seedling period was realized >20 mm size differences benefit for the PROTECTOR products in greenhouse nursery. Stronger plant at nursery stage provides life time positive effect for plant growth.
- (2) **FIRST HARVEST GREEN HOUSE YIELD INCREASE:** >300% related to the non-treated control PROTECTOR treatments resulted earliness concerning yield results at the first harvest.
- (3) **SECOND HARVEST GREEN HOUSE YIELD INCREASE:** >50% increased plant yield and quality after PROTECTOR treatment in several greenhouse vegetables cultivation.
- (4) **OPEN FIELD YIELD INCREASE:** extra surplus yield 2.5-5 tonnes/hectare. Significantly increased plant yield and quality after the PROTECTOR treatment in open field cultivation with several vegetables test plant, such as tomato, green pepper, broccoli and Chinese cabbage.
- (5) **FRUIT QUALITY IMPROVEMENTS:** the >10% increased mineral and nutrient content resulted highly improved fruit quality, better taste and extended fruit storage performance. On the basis of extended soil analysis PROTECTOR treatment influenced favourable the soil structure and increased plant available soluble macro and micro nutrient content of soil.
- (6) **RESTORATION OF SOIL NATURAL BALANCE and IMPROVEMENT of PLANT NATURAL RESISTANCE:** PROTECTOR treatment influenced favourable the soil structure, increase P2O5 availability with >20% and increased the plant available soluble macro and micro nutrient content of soil. The treatment enhanced the plant natural biocontrol ability.

First industrial application and scale up of the PROTECTOR FP6 RTD results:

Following the success of the FP6 PROTECTOR applied RTD programme, a four members of consortium led by Mr. Edward Someus (a Swedish environmental engineer) successfully contracted for EACI CIP Eco-innovation Grant (2009-2012, Contract Number: ECO/08/238984/532247)) for first industrial application and market replication of the PROTECTOR technology and product.

The full scale design, industrialization and implementation of innovative PROTECTOR technology up to 8 m³/batch solid fermentation capacities will be expected by mid 2010 in Hungary. During the 36 months project lifetime full industrial scale POTECTOR substances will already be commercially test produced and market introduced in the EU and North America. **The completed ZERO EMISSION performance full scale engineering and comprehensive economical industrialization of the PROTECTOR provides 20,000 tons/year input capacity bone meal (4 m³/h), which continuous process produces 10,000 tons/year ready natural product and green energy. Specific targeted market application areas: organic farming in the horticultural / vegetable productions, food crop production in environmentally sensitive areas, and generally in most food crop production scenarios where goal sat to decrease or remove chemo-synthetic impacts. Specific targeted markets: Italy, Spain, France, the Netherlands and several other EU countries with goal for safe and healthy vegetable productions for competitive price, and the USA, Japan, Australia.**

Creation of strong business background for the exploitation of the results:

The expected results after the implementation of PROTECTOR Eco-Innovation Programme is a wide replication of the project in different business formats, including but not limited to licensing, technology transfer establishment of joint ventures and setting up large scale own production facilities in the EU and North America.

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Contact

Project coordinator: Mr. Edward Someus.

Address: Terra Humana Ltd. (Szechenyi str 59. H-1222 Budapest, Hungary).

E-mail: edward@terrenum.net or edward.someus@gmail.com

Tel: +36 20 201 7557,

Fax: +36 1 424 0224.

Websites: www.terrenum.net/protector and www.3ragrocarbon.com