

3R ENVIRONMENTAL TECHNOLOGY GROUP

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<http://www.3ragrocarbon.com>

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3R-AGROCARBON – BIOCHAR - BONECHAR

FAQ - Frequently Asked Questions

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Who is Edward Someus?

Edward Someus is a senior Swedish environmental engineer (graduated from the University of Lund, Sweden). He is one of the leading scientific researchers who work for technical development and industrial engineering of **biomass processing science, zero emission pyrolysis technology engineering and carbon negative product applications.**

The pyrolysis development programmes started up during the 80's, operating under the European Union FP5 (DG Directorate General Energy), FP6 (DG Agriculture), FP7 and Ecoinnovation since 2002. He works for EU programmes as coordinator and key technology designer, while uniting biochar efforts in more than 10 European countries. Edward Someus is the inventor, industrial pyrolysis technology process engineering designer, and owner of the 3R zero emission carbon refinery pyrolysis system. His main interests and competences are related to **COAL** and **CARBON** including:

- ✓ zero emission pyrolysis / torrefaction rotary kiln engineering design,
- ✓ catalytic conversion of pyrolysis by-products into transport fuel quality bio-oil,
- ✓ added value carbon bio-refinery (including solid state fermentation and biotech formulation),
- ✓ biomass bio-energetic processing and bio-oils,
- ✓ integrated thermal processing by pyrolysis and biotechnological processing, where specific biochars are used as carriers for biotechnological soil applications.

What is 3R?

The 3R **R**ecycle-**R**euse-**R**educe is a zero emission carbonization (pyrolysis) system operating at relatively low temperature. The 3R system is integrated into the novel agro biotechnological – solid state fermentation and formulation and syngas processing units.

The 3R is a knowledge for resource added value conversion.

The objective of the 3R Zero Emission Pyrolysis Process and Resource Conservation technology is the added value upgrading/valorisation of agro/food industrial organic by-products into safe and high value soil amendment and nutrition products by integrated thermal and biotechnological recycling technology.

The process is based on a horizontally arranged indirectly heated rotary kiln designed for reductive thermal decomposition of any type of biomasses up to <850 degree C in vacuum. The system works with zero emission, comprehensive recycling and reuse of all process materials and gases.

Is 3R an official programme?

Yes, this is an official and high priority programme of the European Union since 2002 and supported by the European Commission Directorate General DG Energy and Transport, DG Agriculture, DG RTD and CIP Ecoinnovation.

What is 3R biochar + agrocarbon?

The 3R biochar or AGROCARBON is **plant and/or animal biomass origin carboniferous material for carbon negative soil enhancement eco-safe applications**. The biochar effects are natural slow release fertilization, food crop plant growth promotion, improving soil retention of nutrients and water, while decreasing and/or substituting the use of chemo-synthetic substances in agriculture. Biochar can be an important tool to increase food security and cropland diversity in areas with severely depleted soils, scarce organic resources, and inadequate water and eco-friendly fertilizer supplies. The 3R biochar application doses varying from 600 kg/ha to 1000 kg/ha and safely used in any open ecological soil environment. The 3R biochar technology has been specifically developed for the **temperate climatic zone** countries production and applications. All biochar productions and applications in industrial scale require accredited Authority permit in the temperate climatic zone countries.

The **3R biochar is made by advanced zero emission production technology**. The **carbon negative** wide range ecosystem **biochar application** conditions meets the European Union and international “*end of waste*” criteria policy, including that the biochar is commonly used for specific agricultural and environmental purposes; fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to biochar in the temperate climatic zone countries; the use of the biochar will not lead to overall adverse environmental or human health impacts and market demand exists.

The **AGROCARBON providing efficient solution and response to major issues facing agriculture** in the temperate climatic zone countries. In this context the AGROCARBON is providing improvements for:

- **Technical and environmental issues:**
 - Improving soil fertility and restoring soil natural balance in different climatic conditions and at different soil types,
 - Substituting intensive farming agricultural chemicals and chemo-synthetic fertilizers,
 - Improving bio-security and food safety while removing biological threats,
 - Improving plant drought tolerance and cultivation water security,
 - Combating weeds,
 - Providing carbon negative applications to avoid global warming caused by climate change, and
- **Economical issues:**
 - Decreasing food production costs for low input and organic farmed horticultural food crops, while offering options to more Consumers for affordable priced safe food,
 - Providing more business tolerance to compete with tariff costs on exports in the importing countries, where possibly need to price compete with subsidized farm products, and
 - While making business with Agrocargon, improving more business tolerance for currency fluctuations and price volatility.

Why do we want to avoid using Bone Meal in livestock feed and fertilizers?

Despite bone meal is a sterile product at the point of production, there is a very **high risk for cross and recontamination** during applications. As because bone meal is mammal protein based, the following human and animal pathogens are prime risk potential: anthrax, salmonella, TBC and mouth and foot disease. There are clear WHO reports on such disease trans-contamination routes related to Bone Meal in livestock feed and fertilizers, used in open ecological environment.

The Producer Responsibility Principle: Producers having full responsibility for animal by-product disease cross and recontamination cases (“manufacturers of products bear responsibility for the environmental impacts of their products throughout the products life-cycles, including upstream impacts inherent in the selection of materials for the products, impacts from manufacturers, production process itself, and downstream impacts form the use and disposal of the products. Producers accept their responsibility when they design their products to minimize the lifecycle environmental impacts and when they accept legal, physical or economic responsibility for the environmental impacts that cannot be eliminated by design” [Davis, Gary 1994].

The cross and re-contamination routes of the crude animal bone meal, MBM/PAP:

- While rendered products leave the cooker negative of the bacteria, **recontamination can occur anywhere** along the way to the feed mill or in the feed mill. Renderers take many precautions to prevent recontamination while the meal is in their possession but have little control over their product once it leaves a facility.
- Bone meal untreated finished feed constitute a significant reservoir of Salmonella contamination. In Europe, during the late 1980s and early 1990s, animal proteins were the most important source of contamination. Human and animal salmonellosis is still causing high economic losses. In humans, the main infection vector is related to poultry product consumption. The US Agriculture Department has reported that animal feeds are the main source of infection in poultry production, and *Salmonella Enteritidis* is the most frequently isolated serotype. **Salmonella may be present in animal feeds at such low levels that it is difficult to detect, but nevertheless it proves to have a high survival and colonization ability in bone meal, after introduced in new in-vivo environment.** The control methods for Salmonella in animal feeds depend on the effectiveness of feed decontamination and the prevention of recontamination. Since bone meal materials are an important reservoir of Salmonella, it is of utmost importance to ensure a total decontamination of feeds.

Therefore, usual treatment 133°C, 20 minutes, 3 bar thermal treatment, may not be enough to fully safely treat the bone meal. Added value carbonization processing over 500°C **providing fully safe and for producer/user juridical fully protected solution** for this issue, and also offering far better business opportunity for product valorisation, - which is versus the risky market use of the crude bone meal for any in vivo applications.

Which types of feed materials are processed by the 3R?

- ✓ Category 3 and 2 bone meal (all types),
- ✓ Category 3 and 2 MBM meat and bone meal / PAP processed animal protein (all types),
- ✓ Category 1 animal rendered products (all types),
- ✓ Dry manure (all types),
- ✓ Plant based and non contaminated refused and organic waste materials,
- ✓ Any low moisture organics, where added value processing can be achieved. Different feed materials may require different permit and installation scenarios.

What is MBM?

Meat and Bone Meal is a product of the animal waste rendering industry. It is typically about 50% protein, 35% ash, 8-12% fat, and 4-7% moisture. MBM is no longer allowed in feed for ruminant animals.

What is PAP?

Processed animal protein is defined in Regulation (EU) No 142/2011 as animal protein derived entirely from Category 3 material, which has been treated in accordance with Section 1 of Chapter II of Annex X (including blood meal and fishmeal). PAP not intended for human consumption, including mixtures and products other than pet food containing such protein:

- Must come from an approved country,
- Must come from an approved/registered plant,
- Must be accompanied by an animal health certificate.

What are the animal by-product categories?

- **Category 3 FOOD GRADE:** parts of animals that have been passed fit for human consumption in a slaughterhouse but which are not intended for consumption. Category 3 material also includes former foodstuffs (waste from food factories and retail premises such as butchers and supermarkets). Catering waste, including domestic kitchen waste is category 3 material.
- **Category 2 INDUSTRIAL GRADE:** rendering waste, includes fallen stock, animal manure and digestive content, also default status of any animal by-product not defined as either category 1 or category 3 material.
- **Category 1 specified risk material**, including pet, zoo, circus and experimental animals. Wild animals may be classified as category 1 material when they are suspected of carrying a disease communicable to humans or animals.

How the 3R output products are improving the food safety?

The 3R bone char (apatite mineral based) - made from category 1 food grade bones - is a **pure natural and fully safe product**, aiming restoration of soil natural balance. The 3R bone char does not containing Cadmium or Uranium contamination, such as P rock fertilizers does, and does not containing any chemosynthetic substances or potentially toxic chemicals as well. (P rock fertilizers are also apatite mineral based, but in many cases originating from the by-products of the Uranium enrichment operations). 80% of the human Cadmium and related heavy metal intake is from the agri use of rock phosphate. There is a rapid P crisis under development worldwide.

What is the market insight as to what the demand is, who buys it?

There is a wide and rapidly expanding green market for the 3R products in large international dimension, for which the main uses including, but not limited:

- (1) Horticultural farming soil cultivation productions in **low input and organic farming sectors**, with clear objective to remove toxic chemicals from the food chain production base. **Supplier of natural NPK.**
- (2) Horticultural and forest nursery.
- (3) Compost makers for production of enriched compost.
- (4) Adsorption industry and water treatment.

- (5) Agricultural and environmental biotech industry, solid state fermentation and formulation.
- (6) Green energy production, transport biofuel and green electric power.

Are the customers available, how much will we have to hold on hand in inventory and such as we would have to pay capitalized interest on the value of those goods that we have to store in either the raw material form or the finished good form?

As different product lines made in the same installation for different and wide range of “green business” market applications, the production schedule and delivery is always continuous, therefore no large inventory stored.

If there is no fertilizer use market during the winter, would it require huge inventory amounts tying up a lot of capital? Is the 3R bone char seasonal product?

No, the 3R bone char is a continuous year around application scenario for different alternative use. There are three major applications of the 3R processing products:

- **Bone char-to-agricultural and horticultural farming** to achieve triple soil effect, such as plant growth promotion, biocontrol by-effect and natural fertilization. (based on category 3 food grade bone meal input).
- **Bone char-to-adsorbent**, water treatment and environmental decontamination. Although bone char having <100 m²/g specific surface area only, it is far higher efficient adsorbent of large molecular organics, than any high grade coal or plant based activated carbon. There are many different adsorption scenarios with **wide market application possibilities, such as drinking water treatment, effluent treatment, treatment of raw waters in rural locations, removal of colloidal / suspended contaminates, arsenic removal, sugar refinery (since 1870), ion exchange, chemisorption, incorporation of heavy metals and radionuclides, removal of pesticides and THM precursors.**
- **MBM/PAP-to-energy**, for production of transport quality bio-fuel and recycled liquid Nitrogen fertilizer. The installation is same as for bone char, same unit is processing MBM material cat 3-2. (based on category 3 and cat. 2 meat and bone meal / processed animal protein inputs). (Category 1 processing is also possible, but need separated production scenario, due to legal requirements).

The 3R animal waste processing output product markets are extensive, wide range and continuously developing, therefore, there is no seasonality of the bone char production, but rather it is a continuous supply to diverse application channels. The 3R high grade bone char is possessing special characteristics, including total macro porosity, eco-safe performance, >90% calciumphosphate and <10% carbon only.

Who owns the 3R IPR?

The sole owner of the 3R IPR is the inventor, developer and the 3R technology industrial engineering designer Edward Someus.

What is 3R slow pyrolysis?

The 3R pyrolysis is a **zero emission thermochemical decomposition, or reductive thermal processing**, of plant and/or animal origin biomass waste and by-products in the absence of oxygen, under vacuum and between material core temperature ranges from 450 °C (842 °F) up to 850 °C (1562 °F). The word pyrolysis is coined from the Greek-derived elements pyr "fire" and lysis "separating". The 3R slow pyrolysis technology is a horizontally arranged, - electric or gas fired –

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indirectly heated rotary kiln and auxiliary chemical processing original solution, invented and designed by Edward Someus. Pyrolysis of biomass substances produces solid residue rich in carbon content “biochar” and separated volatile crude pyrolysis gas which may be condensed into liquid crude oil and non condensable gases. After catalytic conversion of crude pyrolysis liquid and/or gas products, synthetic fuel and transport quality bio-oil produced. The 3R pyrolysis is safer, better, faster, more economical and environmental friendly than any other solutions.

What is the 3R Zero Emission Carbon Refinery processing?

The 3R Zero Emission Carbon Refinery processing is a mimic of the Nature, that emits no any waste products that pollutes the environment or disrupts the climate, in which process all and any materials and energy are recycled and reused into useful products.

The Nature can not afford to waste materials and/or energy, while it always finds the most efficient material and energy recycling and reuse conversion pattern during the ever ongoing bio-geo-chemical cycles. In order to mimic the Nature, the 3R bio-geo-chemical process - where it is possible, necessary and/or advantageous - coherently integrates three carbon and nitrogen related cycles, such as:

- ✓ **Carbon Recycling and Refining**, thermal processing by carbonization for recycling of carbon for wide range of natural and carbon negative product applications.
- ✓ **Carbon Bio-formulation**, biotech formulation of carbon for efficient bio and plant availability of nutrient uptake process support.
- ✓ **Carbon Bio-energy**, chemical processing of carbon for synthetic transport liquid fuel bio-energy production.

The feed materials of the 3R are always low grade wastes or non food by-products generated by human activities, and not from primer or secondary agricultural land use that are related to food production. Characteristics of the output product are reflected in the characteristics of the input material. The high feed flexibility provides high added value and wide range of different types of output products together with wide range of market demanded application possibilities targeted in the rapidly developing natural soil fertilization agro market, green energy and environmental adsorbent business.

Does the 3R technology providing environmentally safe solution?

Yes, fully safe and sustainable solution is provided from which 3R process total safe output natural products made for any open ecological soil or environmental applications. The full life cycle of 3R technology and product starting from feed material supply via processing to formulation into a product for open ecological application is certified for environmental sustainability and meets all major international, industrial and environmental norms/standards, especially of the targeted markets in the EU, USA, Canada, Australia and Japan.

What are the possible animal feed materials (Nitrogen heteroatom based biomass) for the 3R pyrolysis process?

Animal rendering processing materials:

- (a) **NATURAL FERTILIZER + GREEN ENERGY:** Food grade bone meal (category 3 of all bone types) for natural Phosphate mineral and Nitrogen fertilizer production with liquid fuel by-production. Fish bone (internal bony skeleton and backbone), shellfish external skeleton or shell and low moisture content manure from herbivorous animals,

such as poultry, sheep, goat, horse, are also optimally processed for natural mineral fertilizers.

- (b) **ANIMAL WASTE - to - GREEN ENERGY**: Meat and bone meal MBM/PAP (categories 3 and 2) for transport quality liquid fuel production, and liquid Nitrogen fertilizers.
- (c) **ANIMAL WASTE - to - GREEN ENERGY**: Meat and bone meal MBM/PAP (category 1) for destruction and energy production.
- (d) **DRY ANIMAL MANURE - to - GREEN ENERGY** for transport quality liquid fuel production,
- ✓ **Combinations of feed materials** are also possible during continuous operation and blends also can be prepared advantageously (depending on the availability and logistics of the feed materials).
- ✓ **Combinations of biochar**: Bone char and plant based biochar can be combined for advanced and controlled composting blends.

What industrial process capacities are available for the 3R pyrolysis technology?

The **nominal capacity** of the 3R system (or the average capacity) for single rotary kiln installation is from 4 m³/h or 30,000 m³/year throughput at 7500 h/year operation (312 days), which means ~80% utilization of the system. (Note that different feed materials have different specific weights and carbonization characteristics.)

The **rated capacity** of the 3R system (or the maximum capacity for which the 3R system is designed, delivered at specified conditions of pressure and temperature) for a single rotary kiln installation is 5 m³/h or 40,000 m³/year throughput at <8000 h/year operation (333 day), which means 100% utilization of the system.

The specific weight of bone meal is approx. 670 kg/m³, which means 20,000 t/year or 30,000 m³/y capacity for bone meal feed. Carboniferous materials have highly variable specific weights, such as from 100 kg/m³ for rice husk and 1000 kg/m³ for coal.

Capacity can be increased by multi reactor installations:

- **2x** capacity installation: nominal capacity is 8 m³/h or 60,000 m³/year throughput.
- **4x** capacity installation: nominal capacity is 16 m³/h or 120,000 m³/year throughput.
- **8x** capacity installation: nominal capacity is 32 m³/h or 2400,000 m³/year throughput.
- **12x** capacity installation: nominal capacity is 48 m³/h or 360,000 m³/year throughput.

If capacity extension is planned, than further reactor(s) should be added for multi reactor installations, up to 360,000 m³/year throughput capacity per site. Logistics and auxiliary units must be adjusted and carefully planned according to the capacity increase.

What kind of energy supply is needed for the 3R system?

The 3R is an energy self sustaining pyrolysis system with comprehensive energy recycling during standard performance. During **thermal heat up process two versions are available** (selection depends on the project conditions)

- **Electrical heating**: 2 units of onsite “isle mode” 1 MWe rated capacity (refurbished recommended) biooil driven gensets installed, total 2 MWe, with nominal output 1,4 MWe at 70% utilization. The gensets operated for 16 hr start and heat up, than for

production of 725 kWh electric consumption and 675 kWh to grid connection for sale (5,000 MWe). The energy consumption also depends on the material moisture content.

- **Oil/gas fired system:** bio-oil or gas fired heating up procedure.

Can all kind of animal livestock bones (eg. pigs, poultry, sheep, goat, horse etc.) be converted into bone meal that is needed for the 3R technology?

All types of animal bones can be converted into bone meal that is needed for the 3R pyrolysis technology input. Mainly standard **food grade category 3 pig and poultry bones is used**. Mainly mammal and avian bones, however fish bones also can be utilized for producing high quality bone char for natural phosphate and mineral recycling. Different bone characteristics will be reflected in the bone char performance; for instance, sheep, horse and goat bones are denser, whereas the avian bones are more porous and lighter.

What is the importance of phosphorous mineral fertilisation?

Phosphorous (P) plays several roles in plant metabolism and is one of the essential nutrients required for plant growth and development. It has functions in forming the structure of macromolecules such as nucleic acids and also in energy transfer in metabolic pathways of biosynthesis and degradation. Beside nitrogen, phosphorous is the most abundant nutrient contained in the microbial tissue, accounting for as much as 2% of the dry weight.

Phosphorous is one of the key nutrients because of its relative scarcity and its essential role in all life forms. P is a major constraint on food and fibre production in many parts of the world. Therefore, an **economical supply of P is necessary for a secure production in agriculture and forestry**. Nutrients such as nitrogen and phosphorous are removed from soils during plant growth and need to be replaced.

What is fertilizer?

Fertilisers are plant nutrients, which can be natural or synthetic products and made of organic or inorganic materials. Fertilizers are added to plant systems in order to supply one or more nutrients required for healthy plant growth. Any material, organic or inorganic, natural or synthetic that supplies plants with the necessary nutrients for plant growth is called fertilizer.

Why do we need fertilizer?

The soil often does not contain enough nutrients in desirable quantities needed for economical and high yield food crop plant growth.

What is the conventional/synthetic/inorganic fertilizer?

Synthetic fertilisers are either mined and refined, or manufactured products, containing one or more essential plant nutrients in available or potentially available forms and in commercially valuable amounts without carrying any harmful contaminant above permissible limits. There are concerns about the limits of the harmful contaminants, especially heavy metals, such as Cadmium and Uranium in P rock. Unfortunately, most of the P rock fertilizer deposits containing over high level of heavy metals, therefore the human Cadmium intake 80% are traced to P rock fertilizer use. Although organic fertilizers are also prepared and used, they are not yet covered by the term fertilizers, largely due to traditional nomenclature (FAO). Inorganic fertilisers are derived from non-living sources and include most of our man-made, commercial fertilisers.

Phosphate rock is mined from sedimentary deposits, with phosphorites being the predominantly mined deposit type. Most phosphate rocks display elevated uranium, thorium, heavy metal, metalloid and rare earth element levels. Although phosphorus is a nutrient, P-fertilizer also contains variable amounts of cadmium (Cd), an intrinsically toxic substance and one of the “heavy metals”. These undesired contaminants are absorbed by the growing crops, will appear in the food, which subsequently leads to intake by the consumers. P-fertilizer is the only mineral fertilizer that suffers from this problem. Synthetic fertilizers are made from chemically treated phosphate rocks. **If safe food production targeted, high Cd/heavy metal content P rock fertilizers are not recommended for use as they are highly concentrated and reactive.** When applied on the field they react with calcium, iron, magnesium and aluminium, and thereby quickly form such compounds that make phosphorous unavailable for the plants. They may also react with trace elements, bind them causing deficiencies of micronutrients.

What is the problem with the quick release fertilisers?

Inorganic fertilizers are typically quick release materials, may contain contaminations, such as from **Phosphate rock Cadmium and Uranium**, a have leach potential compared to organic fertilizers. Because of the lack of carbon, inorganic fertilizers “feed the plant but not the soil.”

What is the problem and concern with the intensive agriculture?

Intensive farming is concerned above all with productivity and uses a **high level of inputs** to achieve it. The inputs are usually in the form of chemicals, fertilisers, pesticides and growth-regulators produced by energy intensive industrial processes and additional energy is consumed due to the high levels of mechanisation. Food production systems are partially responsible for elevated levels of green-house gases in the atmosphere due to the heavy reliance on fossil fuels.

Traditional chemosynthetic P fertilizer production is based on chemical processing of high-grade insoluble mineral phosphate ore, which includes an **energy intensive** treatment with sulphuric acid at high temperature. Since natural gas is such a critical resource in fertilizer production, natural gas price fluctuations have a dramatic effect on fertilizer costs. As energy costs continue to rise, and the demand for fertilizers increases, this effect is becoming more pronounced.

What is the organic fertiliser?

Organic fertilisers are derived from living or once-living material, including animal wastes, crop residues, compost and numerous other by-products of living organisms. The term organic fertilizer is used to describe **nutrient sources of organic origin either natural or processed**, containing at least 5% of one or a combination of the three primary nutrients (N, P, K). In these sense organic materials of animal origin such as guano, bone meal, fish meal, leather meal, are true organic fertilizers beside the commonly used organic sources of nutrients such as manure, slurry and compost. If the nutrient content is below 5% they are considered as organic amendments.

What are the advantages of the slow release natural fertilisers?

A slower nutrient release **results in more sustained availability of the nutrients**, and a lower “burn and leach” potential as compared to their inorganic counterparts. In addition, organic fertilizers may act as energy source for microorganisms in the soil, which can improve soil structure and plant growth.

What is the problem with the synthetic phosphorus fertilizers?

Today’s agriculture relies on phosphorus fertilizers mostly processed from mined phosphate rock which is a practically non-renewable resource since it takes 10-15 million years to form and currently known reserves are likely to be exhausted in 50-100 years. **Phosphate rock (PR) is a finite, non-renewable natural resource. Geological deposits of different origin are found throughout the world. Currently, few PR deposits are mined.** 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 the increasing population, increasing demand for meat and dairy-based diets and increasing demand for non-food crops like biofuel crops.

The quality of phosphate rock continuously and rapidly declines: the concentration of P_2O_5 in mined phosphate rock decreases and the concentration of associated heavy metals like cadmium increases. The Uranium contamination is a naturally occurring element in the phosphate rock, therefore in many cases the phosphate rock is primarily used for production of Uranium extractions for nuclear power plant fuel, while the phosphate is a by-product for this nuclear industrial operation. The cadmium content of the sedimentary phosphate rock can be very high. This is either considered as 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 application of fertilizer on agricultural lands 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) rich in phosphorus into natural Phosphorus fertilizers.

How can we replace the finite non-renewable phosphate rock and inorganic phosphorus fertilisers? What are the alternatives of the chemical P-fertilisers?

Manure and compost typically have very low NPK content but rich in organic carbon and contain active micro-flora. From manure or compost **very high quantity (20-30 t/ha) is needed for providing sufficient amount of nutrients**. Cu and Zn are used as growth promoters at pharmacological levels, or because wide safety margins are applied, Cu and Zn are often oversupplied in pig diets. Consequently, these elements are highly concentrated in pig manure and accumulate in soil, where they may impose a medium or long-term toxicity risk to plants and micro-organisms.

Soft rock phosphate and natural phosphate is mined from sedimentary deposits, with phosphorites being the predominantly mined deposit type. Some phosphate rocks display elevated **uranium, thorium, heavy metal, metalloid and rare earth element levels** and **also contain variable amounts of cadmium (Cd)**, an intrinsically toxic substance and one of the “heavy metals”, which is also absorbed by growing crops. Therefore these contaminants appear in the food, which subsequently leads to intake by the consumers.

Guano is a bird or bat droppings with approx. 8-12 % P content. Guano has accumulated over centuries on small islands on the Pacific Ocean or the coast of Chile and Peru, where it was mined in such large quantities that its deposits are **now severely depleted**. In contrary to phosphate rocks it is a renewable resource, however only over a long period of time; therefore guano in practice is an finite resource. Bats are highly vulnerable to regular disturbance to their roosts, therefore most bat guano exploitations are already stopped or underway to be stopped by natural conservation regulations.

Sea-bird guano also contains high level of mineral (As) contamination and its renewal also takes for a very long time.

The organic mineral fertilizers typically consist of organic materials (peat, meat, meal and composted and humidified cow or chicken manure) mixed with mineral fertilizers (DAP) or natural P source (mostly GAFSA rock phosphate). The problem is the uranium and cadmium impurities.

There are no any other materials with high P content (15-18%) known than apatite minerals from phosphate rocks or bone char. The P content of other materials can be as low as 0.1-1.5 % only, if any, vs high P content 15-18% bone char.

Does the steam processed bone meal provide a safe alternative solution for substitution of the phosphate rock based fertilisers?

NO. Steamed bone meal has a high (15%) P content, but there is concern as to whether the standard steam or thermal treatment (133 °C/3 bar/20 min) is sufficient for safe microbiological inactivation of MBMs. Furthermore, the raw **bone meal protein content is an optimal culture medium for human and animal pathogen re-infections of public health concern (such as anthrax, salmonella and mouth and food diseases). The protein content resulting high risk for cross and post contamination** after thermal inactivation, unless the protein content is not removed by high temperature pyrolysis treatment. In this context, all protein based organic waste streams are potential risk materials for human and animal pathogen infections.

The **animal bone char** - produced from food grade animal bone meal by thermal process up to 850 degree Celsius (carbonization) - is protein free and a full – total environmental and human **safe P rich material**.

What is the animal bone char carrier?

Animal bone char carrier is a formulated carboniferous material produced from animal bone meal by thermal process. Food grade hog animal bone meal is a left over from food industry which, after thermal process up to 850 degree C (carbonization), contains natural phosphorus (P) and calcium (Ca) in high concentrations. 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 formulated biological control agents or other beneficial microorganisms, meanwhile delivering P and Ca for plant growth.

What nutrients are in the 3R-AGROCARBON – BIOCHAR product?

The specific animal bone char carrier based 3R-AGROCARBON contains high amount of P₂O₅ (13%) and Ca (27%) available for plants, which allows efficient, environmentally safe and natural renewable phosphorus supply. Beside the highly available phosphorus content the animal bone charcoal also contains important trace elements, and other nutrients such as N and K.

The heavy metal content of the 3R-AGROCARBON product approaches the range of non detectable level.

The 3R-AGROCARBON product is a microbiologically formulated substance which means that beneficial natural soil microorganisms are entrapped on the internal and external surface of the carrier. These microorganisms are able to solubilise the nutrients of the 3R-AGROCARBON carrier and make them available for the plant.

These microorganisms can also utilize the chemically bound soil nutrients which are not available for plants. The positive effects of the application of the 3R ABC products are the plant growth promotion activity, natural fertilization and biopesticide effects.

Different types of specific 3R biochar and mineral carrier composites are available depending on the input material and carbonisation process.

Does the 3R-AGROCARBON product provide a safe alternative for natural phosphorus supply?

YES. The 3R-AGROCARBON product is not only a slow release natural P bio-fertiliser but also has a plant growth promotion and bio-pesticide effects, increases the natural resistance of the plant and helps in the natural restoration of the degraded soil without any negative environmental impact.

There is no any other material with high P content (15-18%) known than formulated bone char that can provide an environmentally safe and renewable natural phosphorus source available for the plant.

What are the physical properties of the 3R-AGROCARBON made from bone char?

Physical state and appearance:	granulated solid substance
Granule size distribution <ul style="list-style-type: none">• < 4.76 – 2.83 mm (4/7 mesh)• < 2.83 – 1.0 mm (7/18 mesh)• < 1.0 - 0.149 mm (18/100 mesh)• < 0.149 mm (<100 mesh)	<ul style="list-style-type: none">• 15%• 76%• 6,5• 2,5
Colour:	Black

Odour:	Odourless
pH	7.5 - 8.0
Specific gravity (kg/dm ³)	0,53 – 0.65
Moisture content (wt %)	5
Dry matter content (wt %)	95
Solubility:	Slow release solubility, promoted by formulated micro-organism fungus
Packing	Small bag: 25 kg; big bag: 1000 kg (90x90x160 cm)

The physical characteristic and chemical composition of the 3R-AGROCARBON end product may also depend on the input material characteristics.

What is the composition of the 3R AGROCARBON bone char?

- Hydroxyapatite phosphate mineral 70-76%
- CaCO₃ 7-9%
- Carbon 9-11%
- Moisture content < 5%
- Total surface area <100m²/g
- Carbon surface area <50 m²/g
- Pore size distribution 7.5-60000nm
- Pore volume 0.225cm³/g

What type of microorganisms does the 3R-AGROCARBON product contain?

The 3R-AGROCARBON product contains only **Non-GMO natural soil fungal strains**, of which application is safe for environment and human health. Human health and environmental safety evaluation tests have been executed and **the safety of the microbiological substance has been proved.**

Is the 3R-AGROCARBON-PROTECTOR authority permitted?

Yes, both the 3R-AGROCARBON production and application are fully permitted by EU Authorities.

PRODUCTION PERMIT:

The 3R-AGROCARBON is produced in the **ZERO EMISSION** 3R carbonization technology, which process is approved by the following EU Authorities:

1. Environmental Protection Agency
2. Industrial Safety Inspection
3. Fire Protection Inspection
4. Human Health Protection Inspection
5. Workers Safety Inspection
6. Local Building Construction Office
7. Soil and Plant Protection Inspection
8. Road Inspection
9. Chimney Authority
10. Water Works
11. Electrical Works

12. Gas Works

First EU case permitting is done in Hungary under EU legislation.

APPLICATION PERMIT

The detailed Authority permit tests were carried out in 2005-2008 by different independent and accredited departments from the HU national Soil and Plant Protection Authority under EU legislation.

The following **authority certification** and test reports are available for the Agrocarbon-Protector:

- Biological efficiency tests of PROTECTOR AGROCARBON:
 - In different treatment (green house, open field) and soil conditions (calcic chernozem soil, sandy)
 - Different independent Authority test areas.
 - Test plants: tomato, sweet pepper, broccoli, corn, bean, cauliflower, chinese cabbages.
 - Complete soil and plant chemical analysis (input-output)
 - plant/fruit yield and quality analysis
 - Economical aspects
- Impact analysis on other (monocotyledonous and dicotyledonous) plants.
- Ecotoxicological analysis, soil microbiological test, dehydrogenase enzyme activity test .
- Detailed physical and chemical analysis.
 - Organic and inorganic (including heavy metal analysis)
 - Macro and micro nutrient analysis
- Weed and germination test, phytotoxic effect assessment.
- Safety assessment of the microbiological substance: human health and environmental safety.
- Material Safety Data Sheet (MSDS).

Summary of the 3R-AGROCARBON-PROTECTOR permit:

Manufacturer and Permit Holder:	3R-Environmental Technologies Ltd./Edward Someus
Permit Registration Number	02.5/67/7/2009.
Date of registration:	31, March, 2009.
Permit validity:	31, March 2019.
Substance:	Formulated granulated agrocarbon biochar microbiological substance (animal and plant base origin).
Product Application Area:	Open soil and green/glass house organic, low input and conventional vegetable cultivations.
Mode of action:	Plant growth promotion, natural mineral fertilization.
Recommended dose:	400-1000 kg/ha
Microbiological strain safe deposit number in Hungary:	114/2008. At National Collection of Agricultural and Industrial Microorganisms

Has the 3R-AGROCARBON been field demonstrated?

YES, highly impressive results were obtained during the efficiency trials carried out 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.

- 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.
- FIRST HARVEST GREEN HOUSE YIELD INCREASE: >300% related to the non-treated control PROTECTOR treatments resulted earliness concerning yield results at the first harvest.
- SECOND HARVEST GREEN HOUSE YIELD INCREASE: >50% increased plant yield and quality after PROTECTOR treatment in several greenhouse vegetables cultivation.
- 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.
- 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 favourably influenced the soil structure and increased plant available soluble macro and micro nutrient content of soil.
- RESTORATION OF NATURAL BALANCE OF SOIL and IMPROVEMENT of PLANT NATURAL RESISTANCE: PROTECTOR treatment favourably influenced the soil structure, increased P₂O₅ availability by >20% and increased the plant available soluble macro and micro nutrient content of soil. The treatment enhanced the plant natural bio-control ability.

The results of the Authority field tests are clearly demonstrated that the 3R-AGROCARBON is effective natural plant nutrient source, plant growth promoter and plant health improver with biological control effects against soil borne plant diseases. The biological efficiency of the 3R-AGROCARBON is evident. After the 3R-AGROCARBON treatment of the soil plant available phosphorus content is significantly increased which results in significantly higher plant yields as compared to the untreated control.

Are there any 3R industrial like pilot plant?

Yes, the 3R Technology field demo is located at the Agricultural Biotechnological Innovative Research, Demonstration, Validation and Training Centre in Polgardi, 80 km West from Budapest, Hungary. Operational field: from applied science to economical scale up industrialization.

- Location: West Hungary, 80 km West from Budapest along highway M7 (2 kilometres from the site) and Balaton Lake East, 170 km East from Vienna.
- Area: 8000 m² land area, 642 m² build in area (recently rebuilt for RTD use, including 100 m² conference room)
- Infrastructure (utilities): fully equipped, including natural gas supply, industrial electricity, municipal water supply, own water well with large capacity, sewage water treatment facility, fire protection water pipe lines, fire protection water tank (100 m³)
- Industrial permits: the site is fully permitted by ten Authorities for coal & carbon, renewable energy and agro biotechnological industrial production and interrelated RTD-Demonstration programmes.

What kind of equipments is available for 3R agro-biotechnological development and production of soil fertilisation and microbial products?

- Liquid phase fermentor with 4 m³/week capacity
- Solid phase fermentor with 8 m³/batch capacity
- Liquid phase fermentor with 400 litre capacity, complete installation & operating unit
- Solid phase fermentor with 400 litre capacity
- Inoculum storage and transfer with 100 litre capacity
- Sterile air supply with temperature control between 15°C to 40°C
- Pneumatic solid material transport
- Carbonization - pyrolysis rotary kiln, for sterile production of solid carriers: complete installation, continuously operated (up to 6000 h/year), indirectly heated, capacity: 100 kg-250 kg/h up to 1000 t/year input (depending on the feed material qty), treatment temperature up to 850°C, incl. process control automatization and complete field instrumentations.
- Air selector for solid carrier materials (0-5 mm), capacity up to 250 kg/h
- Liquid phase fermentor with 600 litre capacity (planned installation, hardware is delivered to the site but not yet installed)
- Liquid phase fermentor with 6000 litre capacity (planned installation, hardware is delivered to the site but not yet installed).

What types of laboratory resources are available in 3R-Agro-Biotechnology on site biotechnological laboratory?

- Microbiological Optimization Research Liquid Phase Fermentor with 3 x 5 litre capacity (Chemoferm)
- Microbiological Optimization Research Liquid Phase Fermentor with 12 litre capacity (Chemoferm)
- Microbiological Optimization Research Liquid Phase Fermentor with 3 x 10 litre capacity (INEL-RICHTER)
- UV spectrophotometer (spectral range 190 nm – 1100 nm) for liquid and solid materials
- Atomic absorption spectrophotometer for heavy metal analyses
- Research microscope (1000x magnification) with digital camera
- Research microscope (1000x magnification)
- Autoclave, 100 litre capacity
- Sterile box (several units)
- Centrifuge
- Ball mill unit, 7 kg capacity
- Thermostat
- Vacuum drier
- Complete laboratory installations (all stainless steel)
- Laboratory thermal treatment test oven (4 litre), up to 1150 °C
- Sieves for fractioning the solid carrier materials (50 micron to 5600 micron)
- When accredited and/or additional laboratory analytics are needed, than samples submitted to modern and well equipped accredited environmental laboratory, located 10 km from the

site at a multinational chemical industrial factory. Mobile measurements are also possible. Other labs and university research lab facilities are also connected to our works.

Is the first industrial demonstration of the 3R Technology available?

Following the success of the FP6 PROTECTOR applied RTD programme, four members of the 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 3R-AGROCARBON technology and product. The full scale design, industrialization and implementation of innovative 3R-AGROCARBON technology has been completed and is available since mid 2010 in Hungary. During the 36 months period of the project full industrial scale PROTECTOR substances produced and introduced on the markets of the EU.

For which climatic conditions and soils has the 3R application been developed?

The 3R AGROCARBON has been specifically developed and tested for **TEMPERATE CLIMATIC ZONE** applications (in each hemisphere, the temperate zone is found between 60 and 30 degrees latitude). The technology can be flexibly used for different soil conditions, especially for degraded soil conditions.

What are the 3R application scenarios and market targets?

- Horticultural low input farming, horticultural organic farming, medicinal and aromatic plant farming, environmentally sensitive area farming and farming in natural conservation areas.
- Enhanced biomass production and energy forest plantation programmes for improved biomass energy production cultivations.
- Regeneration of degraded agricultural and natural soil conservation areas.
- Conventional farming, targeting decreased inputs or substitution of synthetic products towards healthier food crop production.
- Environmental applications, such as absorbent for gas/liquid.

Who are the possible consumers and targeted end user groups of the 3R product?

- Horticultural and other high value low input and organic food crop farming producers (vegetables, flowers, medicinal plants, aso).
- Food chain biomass by-product producers: slaughterhouse (bone), sugar industry (sugar beet pulp, molasses), corn wet milling industry (corn steep liquor), fruit juice producers (by-products, such as fruit pulp), milk (whey) industry (residuals).
- Food chain organic waste processors: animal waste, sugar waste, vegetable oil and milk residual processors. Interest: safer, better, faster and less costly processing and waste management.
- Biomass energy production units.
- Energy forest younglet plantations.
- Capital investors. Interest: turning “trash into cash” with the AGROCARBON product system, applicable to a wide international market with strong demand.

What is 3R Nitrogen Oxide Emission Mitigation and Recycled Nitrogen Fertilizer?

Nitrous oxide is a powerful greenhouse gas, important in climate change, and as well, is a stratospheric ozone depleting substance. The human population has grown at an unprecedented rate past decades and this has resulted in many localized significant environmental impacts. Food production is considered as a major source of global nitrous oxide emissions. The nitrogen in wastewater and solid wastes may be a significant fate of much anthropogenic nitrogen. Up until now less attention has been given to human impacts on the global nitrogen cycle, impacts which are quantitatively greater than the impacts on the carbon cycle. It is likely that much of the Earth's population now relies on anthropogenic nitrogen in its food supplies, resulting anthropogenic nitrogen contained wastes. Carbon dioxide and nitrogen cycles are strongly coupled. Human nitrogen additions are the principle cause for the increase in terrestrial nitrous oxide emission since 1960, and contribute to about one fifth of the current global net carbon uptake. The climatic effects of the anthropogenic nitrogen perturbation from the the greenhouse gases CO₂ and N₂O gases are very substantial.. The anthropogenic Nitrogen is the input of man on nature, that is induced or altered by the presence and activity of man (such as fossil fuel combustion and agricultural fertilizer use activities) which makes anthropogenic interference of the global nitrogen cycle, as global fertilizer. Humans have approximately doubled the global rate of N fixation since pre-industrial time up to now. The global-warming potential (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. The GWP of anthropogenic reactive Nitrogen oxide is 289 over 20 years. It is also considered that 1.6 kg of CO₂ needed per kg of NH₃ production.

The 3R recycled Nitrogen process is extracting Nitrogen from the food chain and re-use it again. The recycling of reactive N back to agriculture is reducing the requirement for new reactive N and would also prevent the carbon-based greenhouse gas emissions associated with the manufacture of high energy intensive nitrogenous fertilizers from fossil fuels.

What is the status of the 3R Technology?

Industrial scale proven, demonstrated, wide range tested, permitted, economical large scale application detailed engineering designed and ready for commercialization. It has been developed under EU FP6 and follow up Programme between 2005-2011, now it is a permitted product and industrialized system, with 30,000 m³/year bone meal throughput. 100% of the IPR belongs to Edward Someus, so the IPR is all the ways clean and clear.

- The comprehensive and complete AGROCARBON process developed = COMPLETED
- Successful field tests executed with dose 500 kg-1000 kg/ha = COMPLETED
- Successful product permit tests at EU Authority made 2005-2009 = COMPLETED
- Comprehensive risk assessment = COMPLETED
- Comprehensive scale up engineering design (30,000 m³/y bone meal throughput) = COMPLETED
- Market evaluation, SWOT analysis, CBA analysis = COMPLETED

The status of the 3R technology is post development, industrially proven and field demonstrated with clearly achieved full scale industrial phase; with comprehensive fully scaled up engineering design. The 3R-AGROCARBON technology is a patented original solution, also protected by comprehensive and very specific know-how, which is well documented and prepared for technology transfer during replication phase.

The 3R-AGROCARBON technological solution has already been successfully true industrial value real life tested in Hungary while its products successfully real life field tested in Israel,

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Italy, Germany, The Netherlands and Hungary. The prototype system has been “industrial product like”, including all components and elements of scale up, therefore no potential technical reasons are expected that it will not work in larger scales. Thus, the technological risk is limited to almost zero, e.g. to same as for any commercial solutions. However, still need a push from proven prototype to industrialization level.

What is the basic economy in full scale 3R zero emission pyrolysis processing production?

The AGROCARBON is produced by zero emission environmental performance conversion of waste materials into high added value products; it is an advanced economical valorization process.

The AGROCARBON is SAFER, BETTER, FASTER and LESS COSTLY than any know competitive technologies. Basic production unit has a capacity of 30,000 m³/year. For natural P recycling bone meal input the capacity is 20,000 t/year input and 10,000 t/year output. The technology shows high feed flexibility for alternative feed materials for different application strategies. The system is energy self sustaining. The output product value starts from US\$/1.5/kg EXW whole sale, while the investment is on a reasonable level. Short return on investment is expected (2-4 years). The 3R output products are:

- ✓ 10,000 t/y bone char phosphate mineral.
- ✓ 3,500 t/y recycled Nitrogen fertilizer.
- ✓ 6,500 t/y transport fuel.
- ✓ 5,000 MWe /y excess electric power.

What are the economical advantages of using 3R-AGROCARBON in agriculture and forestry industries?

Higher crop yield, significantly better fruit quality, safe food, substitution of expensive agro chemicals, sustainable crop protection, possibility to restore degraded soils, and generally higher product value in the application fields of low input and organic farming. AGROCARBON has high flexibility for different alternative application strategies as of need in different temperate climatic and soil environment.

What are the 3R Business objectives?

- 3R-Agrocarbon technology licensing, technology transfer and/or equity investment.
- Enter EU/North American/Australian markets.
- Develop a world wide marketing centres in North America (USA, Canada), Europe (SE, IT, DE, NL, FR, UK, ES) and Pacific Area (Australia, Japan). Territorial licenses considered for Western Europe, North America and Asia.
- “Value for Money” by the combination of reasonable License and Royalty Fees.

Basic contact for further technical and business information

Mr. Edward Someus
3R AGROCARBON – BIOCHAR - BONECHAR

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