

## PROTECTOR

Contract number  
FOOD-CT-2005-514082



### Recycling and upgrading of bone meal for environmentally friendly crop protection and nutrition

THE "3R" CARBO ANIMALIS PURIFICATUS

Recycle-Reduce-Reuse for Prevention-Protection-Preservation

Recycling of Phosphorus from mineralized bone charcoal for natural P supply enhanced biocontrol and food crop protection

September 17, 2008

## Economical organic farming and natural food crop production 3R Integrated Thermal and Agro Biotechnology Processing

### PROTECTOR BENEFITS *From Farm to Fork*



### OVERALL BENEFITS

- ✓ **Mitigation of mineral and nutrient deficiency stress** of the food crops, natural balance and functionality restoration of degraded continental agro soils in temperate climatic regions, with controlled microbiological activity and precision farming nutrient supply for sustainable, improved, economical and ecological food crop production.
- ✓ It is **consistent with principles of organic production**.
- ✓ **Prevention of nutrient loss**, biochar may help to reduce nutrient run-off from soils and the associated problems of eutrophication.
- ✓ **Supporting beneficial soil life** forms towards **balanced living soil**. **Improving soil fertility** and stimulating the roles of plants and microbes in natural soil processes. Essential for obtaining, maintaining and increasing the fertility and biological activity of the soil or to fulfil specific nutrition requirements of crops.
- ✓ It has **positive impact on soil organisms and/or the physical characteristics of the soil**.
- ✓ **Encourages soil organisms and mycorrhiza fungi**, which can produce many compounds that help plants, including substances such as citrate and lactate that combine with soil minerals and make them more available to plant roots.

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- ✓ **Soil conditioning:**
  - The increase in available moisture observed in sandy soils make biochar a useful tool in the reversal of desertification.
  - Restoration of degraded lands by increasing soil carbon.
  - Increasing soil carbon storage
  - Improved soil moisture capture and retention

### **3R AGROCARBON ENVIRONMENTAL BENEFITS**

- ✓ Efficient use of nutrient inputs for **efficient GHG mitigation**
- ✓ **Balanced nitrogen inputs** and outputs and nitrogen efficiency
- ✓ Providing more **conservation-oriented management** practices
- ✓ **Carbon sequestration of degraded and eroded sites and areas.**
- ✓ Has a **positive effect on biodiversity.**
- ✓ **Supporting environmentally-orientated farming**, development of environmentally compatible agriculture practices with maintaining the nutrient balance of the soil.
- ✓ **Prevention of groundwater pollution**
- ✓ **Less N<sub>2</sub>O** (very powerful GHG) **emission** , even for same rate of fertilizer application -
- ✓ **Reducing direct and indirect energy** use to **avoid carbon emissions.**
- ✓ **Increasing renewable energy production** to avoid carbon emissions. Biomass energy can be used to avoid greenhouse gas emission by providing equivalent energy for heat and electricity generation, and for transportation fuel. If biomass is harvested and burned, and the same area replanted or regenerated, there are no net carbon emissions over the harvest cycle.

### **ECONOMICAL BENEFITS**

- ✓ **Improved farm income** per farmer from increased tons/hectare, which is leading to rural social improvements and gender equality.
- ✓ **Reduced per hectare expenditures on fertilizers**, therefore less pressure on increasingly limited oil and natural gas supplies - leading to lowered fuel costs.
- ✓ **Improved rural employment** opportunities
- ✓ **Combined Heat and Power harvested** from bioenergy as a byproduct with charcoal production from biomass
- ✓ **More available farm and forest residue to support more biofuel utilization**, helping on both CO<sub>2</sub> emission reduction and peak oil/peak gas supply constraints
- ✓ **Lowered disaster insurance costs** (and similar for areas with reduced or increased rainfall, etc)

### APPLICATION BENEFITS

- ✓ Improved protection of subsurface water resources from **less fertilizer run off. Nutrient balance and slow release fertilizers:** Using nitrogen more efficiently means better matching its availability to plant needs. Remaining nitrogen is released by the charcoal slowly into the soil for the plants to absorb.
- ✓ **Promotion of increased plant growth**
- ✓ Less malnutrition and better health conditions from supplying more food crops per hectare.
- ✓ **Increased use of all the non-dispatchable renewables** (wind, PV, biomass, etc), as biochar facilities provide much of the required backup (heaviest char and electrical output during peak electrical demand periods - in West it is July - August for air-conditioning).
- ✓ **Build-up of soil organic matter** that accompanies carbon sequestration provides many environmental, social, and economic co-benefits
- ✓ **Porous substance with high water and air holding capacity;** Suitable habitat for some microbes and plant growth, good material for soil amendment, absorption of chemicals and humidity control
- ✓ High alkalinity; **Neutralization of acidic soil** and improvement of chemical components of soil and selection of microorganisms
- ✓ Charcoal as **media for immobilizing useful microorganisms (spores of bacteria, root nodule bacteria, mycorrhizal fungi, Frankia and nitrogen fixing bacteria .**
- ✓ Charcoal seems to assist microbial activity by having a porosity that **provides a favourable microhabitat**, weak alkalinity and by being a substrate unfavourable for saprophytes. **AM fungi easily extend their extraradical hyphae into charcoal buried in the soil and sporulate in the particles encouraging effects of charcoal on AM colonisation.** The role of mycorrhizal fungi is particularly important in carbon cycling, because they pump the carbon compounds out of the root into a massive network of fine fungal filaments in the soil, where it becomes available to other microbes and also to larger soil organisms like worms, mites and insects. In return, **the fungus gathers phosphorus from the soil and delivers it to the plant, helping the plant to grow better.** Arbuscular mycorrhizal fungi, found living on plant roots around the world, appear to be the only producers of glomalin. The fungi use carbon from the plant to grow and make glomalin. In return, the fungi's hairlike filaments, called hyphae, extend the reach of plant roots. Hyphae function as pipes to funnel more water and nutrients--particularly phosphorus--to the plants. Higher levels of glomalin give greater water infiltration, more permeability to air, better root development, higher microbial activity, resistance to surface sealing (crusts) and erosion (wind/water). Benefit of glomalin: increased aggregate stability which leads to better soil structure which, in turn, leads to better plant production. As a glycoprotein, glomalin stores carbon in both its protein and carbohydrate (glucose or sugar) subunits. Glomalin is causing a complete re-examination of what makes up soil organic matter.
- ✓ Important by-product generated in the process is fine charcoal that, in some cases represents up to 15% of the produced charcoal. **Addition of fine charcoal in compost preparation improves the process by improving: aeration; water retention and probably by providing micro-organisms refuge and adsorption of metabolites.**

**The technology is available for international licensing and technology transfer.**