BIOLOGICAL AND ECONOMIC REALITIES SUPPORT RECYCLING TRACTOR EMISSIONS

By Braddon Modra, Director,
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THE BIO-AGTIVE METHOD OF USING TRACTOR EMISSIONS TO STIMULATE PLANT GROWTH IS A GROWING PRACTICE IN 'CARBON FARMING' AROUND THE WORLD.

President and founder of N/C Quest Inc Gary Lewis says food security and climate change are some of the biggest issues facing governments and society. The Bio-Agtive technique presents primary producers many opportunities to meet that challenge.

He says using the Bio-Agtive method, food production can go beyond carbon neutral to a point where healthy soils can be used to sequester carbon.

Field results from the past 10 years combined with latest university research shows recycling tractor emissions and incorporating them into the soil provides a number of benefits. With more and more positive data surrounding the Bio-Agtive method, farmers and contractors with high horsepower tractors have many good reasons to take advantage of what is now a wasted resource.

THIS BIO-AGTIVE UNIT TAKES THE EXHAUST FROM THE TRACTOR AND AND INJECTS IT INTO THE SOIL NEXT TO THE TYNES OF THIS AGRISEM CULTIVATOR.

THE BIO-AGTIVE EXHAUST KIT INCLUDES A HEAT EXCHANGER THAT COOLS THE EXHAUST TO THE POINT THAT IT CAN BE INJECTED INTO THE SEED CART AND THE SOIL.

The Bio-Agtive method involves cooling the tractor exhaust emissions then injecting the condensed gas into the air cart or directly into soil while sowing or cultivating. N/C Quest tractor exhaust kits are available to suit tractors from 100hp through to 500hp+.

Tractor exhaust kits for larger tractors retail for around $44,000. They include a computer system that connects wirelessly to a iPhone or iPod. This provides information back to the operator regarding operating temperatures and logs all emissions incorporated back into the soil.

When seeding with Bio-Agtive emissions technology (BAET), the cooled exhaust emissions are directed firstly to the air cart. It exposes the seed to humidity and oxidized elements from the emissions.

Gary Lewis began experimenting with BAET in 2001. He put together a 200hp natural gas irrigation pump and motor. The exhaust was used to make a nutrient solution that would be more like rain water that naturally had absorbed nitrogen and carbon from the emissions.

In 2005 he began trials injecting cooled emissions into the furrows with the seed. He says this filled the soil air spaces with the oxidised organic matter from the emissions.

Gary Lewis has travelled all over the world and finds the soil similar in its mineral make up. The big difference is how much carbon the plants have been able or allowed to store and how much carbon has been lost due to farming practices.

He recommends to farmers in Canada, the USA and Australia that they need to capture more sunlight energy on their farms. Bio-Agtive adds this captured carbon energy into the soil where it helps grow roots, and allows mycorrihzal fungi to access more phosphorous and minerals and feed bacteria to make more nitrogen available.

BAET increases soil biological activity, promoting greater root development, reduces soil compaction and surface crusting, and increases water holding capacity. All of these are very important when farming in a hot, dry climate.

Concerns that minerals such as phosphorous will be eliminated if the BAET system is used without fertiliser are typically at the forefront of farmers' minds when they consider the system. Gary Lewis says that P is important and needs to be added if deficient. Rapid declines in soil organic matter are generally more significant, however, and this is something BAET seeks to reverse.

Gary Lewis encourages regular soil testing in conjunction with BAET to identify deficiencies not dissimilar to conventional fertiliser programmes.

Research on exhaust emissions at the Montana State University Bio-Energy Centre has monitored exhaust emissions as affected by types of fuel, engine loads and temperature. The effectiveness of injecting emissions in ▶

the soil is largely determined by the fuel type, operating settings, conditions effecting combustion, cooling and condensation.

Even new efficient and environmentally friendly engine technologies are not free of emissions. Soot, un-burnt fuel and NOX are lower, however the oxidized organic matter that makes up the fuel hydrocarbons are still present making the waste product valuable for recycling back into the soil.

The Montana research compared diesel fuel, Camelina bio-fuel, Canola bio-fuel, and safflower vegetable oil under different load settings and correlated their emission composition to plant growth. The plant nutrition value of each fuel is quite different.

Extensive soil and tissue tests combined with microbial phospholipid fatty acids (PLFA) and fatty acid methyl ester (FAME) analysis on seed and soil were conducted all with positive results in favour of emission treatment. The extensive study will be published late this year.

Research by Dr Jill Clapperton of Earth Spirit Consulting shows that putting exhaust emissions onto the seed and into the soil affects soil microbiology. PLFA results indicate that continued use of exhaust treatment has an accumulative effect on the soil.

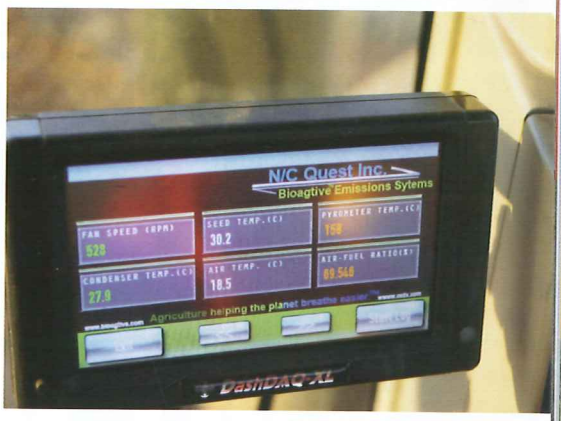
The results show that the exhaust treatment had the highest biomass of bacteria compared with both the fertiliser and control. Jill Clapperton says ongoing research has to demonstrate that these increases in bacteria biomass are significant enough to effect changes in soil chemistry or mineralization.

Her recent studies regarding the effects of exhaust on seed germination and the seed microbial community showed that there was a statistically significant interaction between the seed species, and the exhaust treatment ($p < 0.05$), and that the germination of seed exposed to the exhaust was greater than seed without exhaust (control) ($p < 0.004$).

The research suggests that seed from different crops is more or less affected by the exhaust. For example, the mung bean seed had the greatest benefit from being treated by the exhaust in terms of improved germination.

It was consistently observed that there were fungi growing on the control germinated seed, and this was rarely observed when the seed was treated with exhaust. This suggested that the exhaust and or the temperature of the exhaust emissions affected the microbiology of the seed coat, and perhaps seed-borne fungi.

Farmers are typically increasing fertiliser inputs as soils become less fertile, lower in carbon and out of balance. Given the recent droughts farmers are struggling to pay for fertiliser inputs and hence the strong interest in alternatives such as BAET.



N/C QUEST PROVIDES A MONITOR THAT MEASURES THE WORKING TEMPERATURE OF THE KEY ELEMENTS OF THE BIO-AGTIVE SYSTEM AS WELL AS THE AIR-FUEL RATIO.

N/C Quest is committed to funding ongoing research and education programs that provide facts to farmers to help make decisions and take control of their business and their future.

Results submitted in 2008 by the Mallee Sustainable Farming in conjunction with Lower Murray Darling Catchment Authority revealed positive effects with regard to microbiota and carbon levels measured in the soil as a result of using BAET. This did not translate to increases in yield. While there were no apparent yield advantages, the report suggested potential cost savings may be significant in farming systems in the Mallee.

Ongoing university research and field results continue to demonstrate that the BAET has more advantages than disadvantages.

It may soon be a matter of 'why not?' for more farmers to put emissions back into the soil given its capacity to influence the triple bottom line. While carbon taxes may exempt agriculture in the short term, in the future farmers will no doubt be more accountable for their carbon footprint.

The rising cost of fossil fuel and the world's appetite for cheap food will put more cost squeezes on farm economics. Bio-Agtive could well be the way to achieve food security and environmental sustainability.

For more information please visit www.bioagtive.com or email sales@bioagtive.com.au. **AC**

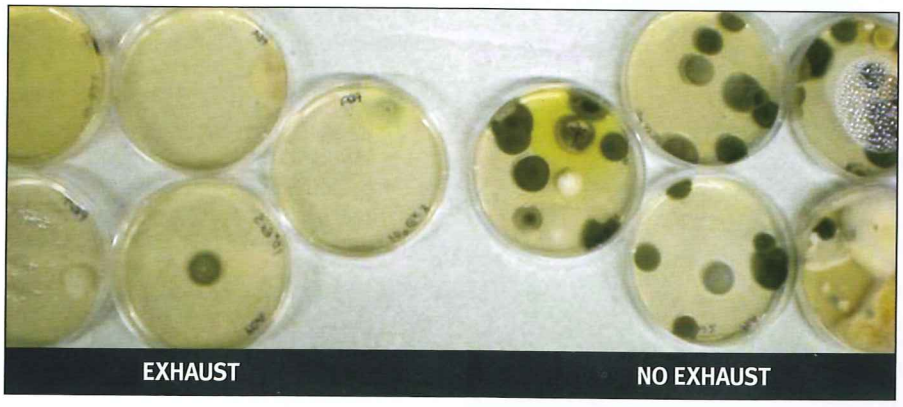


FIGURE 1: THE BLUE BARS REPRESENT THE AMOUNT OF MICROBIAL LIFE IN THE SOIL AT HARVEST AS CONFIRMED BY PLFA ANALYSIS (JON NESTER, MSUN 2012).

THIS PHOTO SHOWS POTATO DEXTROSE AGAR PLATES GROWING FUNGI WASHED FROM SEEDS THAT WERE TREATED WITH AND WITHOUT EXHAUST EMISSION TREATMENT (CLAPPERTON 2012).

NSW FARMER SAYS EXHAUST INJECTION SYSTEM GETS RID OF FERT BILLS, BOOSTS GRAIN QUALITY

THESE DAYS WHEN EVAN MICKAN SEES A TANKER OF DIESEL ARRIVE AT THE GATE, HE THINKS TO HIMSELF: 'THAT'S ANOTHER LOAD OF FERTILISER I DON'T NEED TO BUY'.

Three years ago Evan started injecting the exhaust from his tractor into his wheat and barley crops on his farm at Lake Cowal, near Forbes in central NSW. He says the results have been impressive. He has achieved higher grain quality, suffered no loss in yields, and enjoyed non-existent fertiliser bills.

"My sister lives in Canada, and I heard about the Bio-Agtive exhaust injection system that Gary Lewis developed there. It sounded like a brilliant idea to me so I started to experiment with it.

"That was in 2006 and by 2009 I had put together a heat exchanger that allowed me to cool the exhaust down to a temperature that I could put into the air seeder.

"The first season we used it was a drought year and we didn't see a yield benefit in it but, of course, we were getting the same results without a fert bill. 2010 was a bumper year and we had good quality grain. I was also very happy with the results we got in 2011."

He puts the results down to the increased biological activity in his soils stimulated by the nitrogen, carbon and other elements from the exhaust.

The soils he farms range from red loam to heavy, self-mulching ground in the lakebed that he farms when the lake level drops.

"I have noticed that my soils are much softer since I have been using the system. Elements from the exhaust nourish and stimulate microbes and fungi in the soil. There are also more worms around than I ever noticed before. One agronomist told me I am poisoning my soils but I find it strange that worms like poisoned soil."

This has led to the payoff of better quality grain, Evan says.

"In the last two years, the quality of wheat in central NSW was not high. My neighbours were selling their grain as AH9 or feed wheat, but mine was up in the AH2 and APW grades."

Evan uses a 370hp John Deere to pull a 12.5m Simplicity bar and air seeder. He directs the cooled exhaust into the fan of the air seeder. It gives the seeds a coating of soot that, he says, breaks down their surface and allows them to germinate one or two days quicker than normal.

He is so impressed with the results that he now wants to add a Bio-Agtive unit to a set of offset discs so that as often as possible, when the tractor performs an operation on the farm, its exhaust is recycled into the soil.

"Tractor exhaust is a resource. It was once a fossil fuel, and I am just returning it to the soil. And if farming ever faces a carbon tax, then hopefully I can also get carbon credits by sequestering the exhaust carbon back in the soil," Evan says.

Last season Evan carried out his own side-by-side trials to see whether combining the recycled exhaust and fertiliser would provide higher yields. He says it did but the gain did not offset the cost of the fertiliser.

"Our trails showed that 80kg of DAP produced about 4.2 tonne of wheat per hectare, 50kg of DAP produced 4.1 tonne per ha, and the exhaust produced 4.0 tonne per ha. This year the exhaust yielded better than fert trials.

"We plant from 1100 to 1600 hectares of wheat and barley. We also run sheep and undersow new pasture after crops. Our annual fertiliser bill was from $60,000 to $100,000 depending on the acreage we planted.

"Not only do I drop that cost, I no longer have to handle fertiliser. I never realised how much time I spent clowning around loading and unloading fertiliser. Now the operation is much more efficient. I fill the cart and the truck with seed and I am away for the day."

THE WHEAT EVAN MICKAN GROWS USING BIO-AGTIVE EXHAUST TECHNOLOGY HAS EXCELLENT VIGOUR AND COLOUR THOUGH IT HAS NOT HAD CONVENTIONAL FERTILISER FOR THREE YEARS.

Though he developed his own heat exchanger, Evan paid a license fee to Gary Lewis and N/C Quest to use their intellectual property.

He says paying the license links him into the network of other farmers who use Bio-Agtive technology. They share their views and experiences through a newsletter.

"Paying the license fee also gives you a monitor that measures the temperature of the exhaust at the exhaust pipe, at the heat exchanger, at the fan in the air seeder, and at the seeding boot.

"The system deals with a lot of heat. The heat exchanger has to take the exhaust down from 400° down to 30° or 40°, and the tractor produces 30,000 to 40,000 litres of exhaust per hectare. Having the monitor means you can be sure you are operating at safe temperatures."

Evan says the heat exchanger he built works well but N/C Quest has continued to develop the technology and has come up with smaller and more efficient units. When he goes to add a heat exchanger to his disc harrows, he will use one of their kitsets. **AC**

EVAN MICKAN RUNS THE EXHAUST FROM HIS JOHN DEERE 8850 TRACTOR INTO HIS SIMPLICTY AIR CART.