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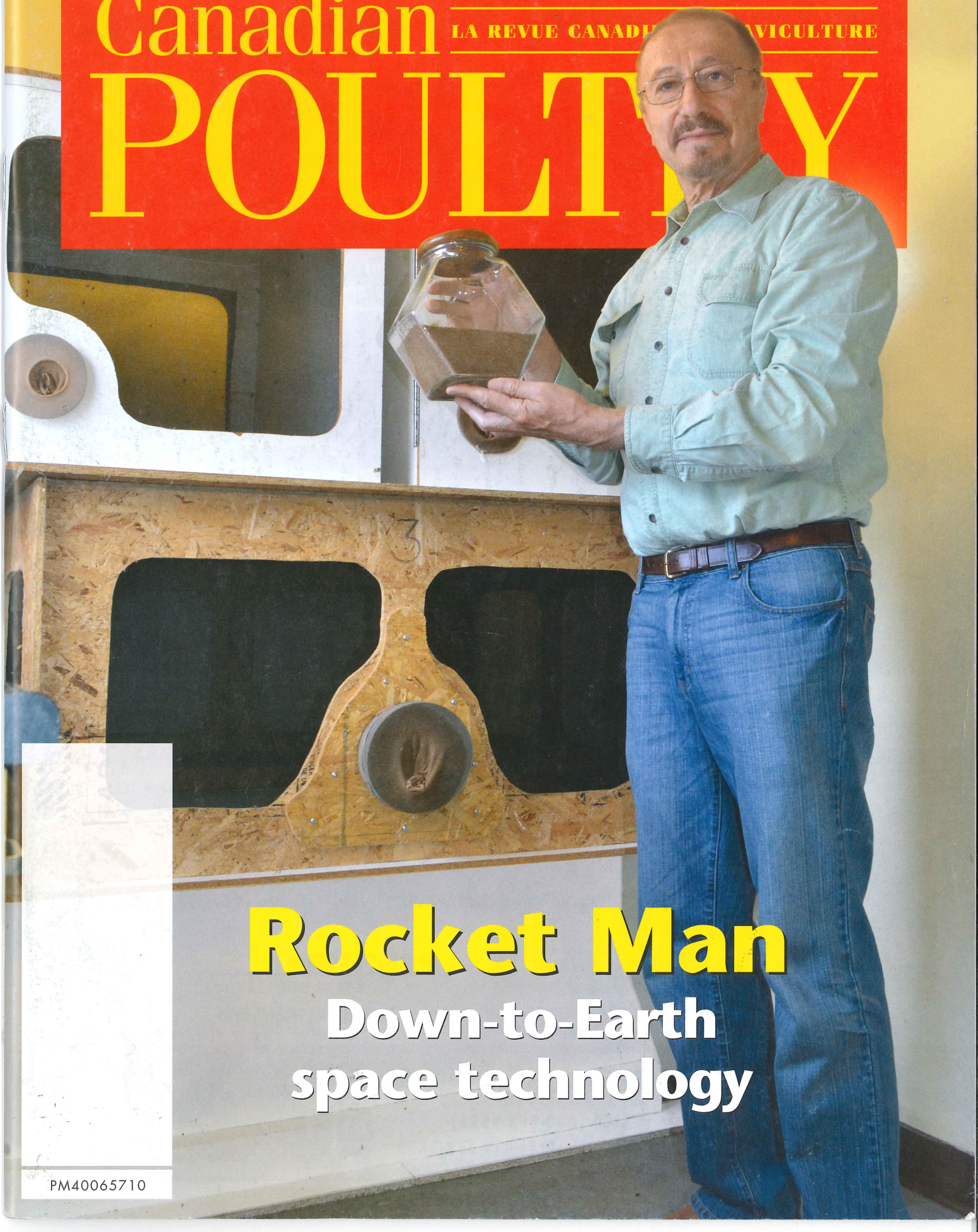

Rocket Man

Down-to-Earth space technology

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Down-to-Earth space technology

BY LIANNE APPLEBY

For centuries, the bane of agriculture's existence has been its byproduct, manure. Once a tolerated fact of life, the embarrassing subject of poop – and what to do with it – began to haunt farmers as more and more people became removed from farming. The *not-in-my-backyard* cliché is at its best when the necessary task of spreading it comes around: *Sure, you can do that, if you have to – just not across the road from* my *house.*

But homeowners who envision lower property values are the obvious opposition. What they care about first and foremost is the smell. What governments and environmentalists care about is the fact that today's technologies have not yet presented us with an efficient way to "recycle" manure, making it necessary to regulate how, where, when it's spread – and who actually does the spreading.

Ivan Milin has been thinking about those two concerns a lot. The Serbian-born, Canadian-based engineer-turned-inventor is credited with multiple inventions, but his latest one (and its multiple clauses) is on a course to revolutionize the way we think about and handle livestock manure. The technology he's patented via his Guelph- and Toronto-based company, EcoSpace Engineering Ltd., and the equipment he's designed have already turned heads locally – and now they're gaining international attention.

INDUSTRIALIZING THE PROCESSING OF MANURE

Ivan Milin poses with his prototype Milinator, which is currently being tested at the Arkell Research Station.

NOT SO OUT-OF-THIS-WORLD

Milin often refers to what he considers the "industrialized" production of animals, as the First World moved away from small farms to bigger, more efficient systems of production. The problem, in his mind, is that we have never developed ecologically friendly ways of processing manure to match that high level of production. "We have to industrialize the recycling of [animal] wastes," he says. "Only then, will we close the natural cycle, restore the balance in our environment and have a sustainable meat and egg production industry."

Inspiration came in the form of a project called *Trip to Mars*, undertaken during the communist era in Soviet Russia but later discontinued. When it was shelved, certain scientific communities learned of the idea behind the project. Milin met some of the people that were part of the work and learned for himself what it entailed.

In short, the research detailed how to sustain an environment in a spaceship during a three-year journey to Mars and back. Without the privilege of being able to truck waste away and spread it, scientists were looking at a way to recycle it on the spacecraft. In a closed, long-term environment, astronauts need live birds, such as Japanese quail, to produce eggs and food, and both the birds and the humans themselves would generate feces. The technology used in space was a simple, manual closed-system approach to dealing with that problem.

"This environmentally-friendly recycling process used the life cycle of the fly to transform feces and other organic waste into rich organic fertilizer for the spaceship plants, which would then produce oxygen," notes Milin. "The [resultant] fly larvae would be used to feed the Japanese quails, on the spaceship."

When you consider what would occur in a world devoid of human

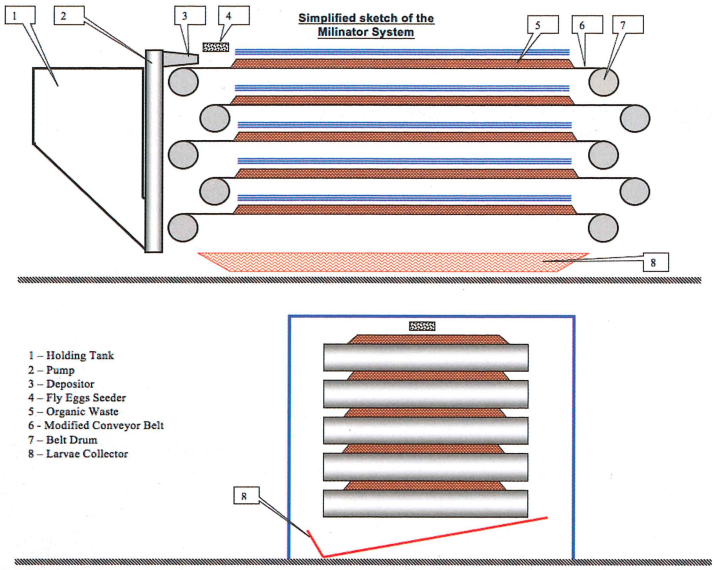


Image courtesy of Ivan Milin

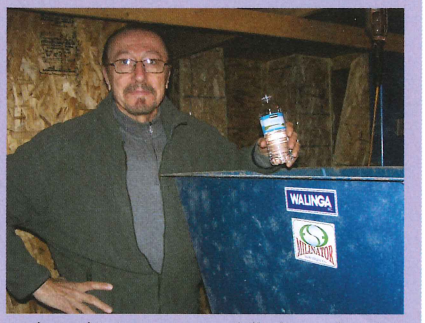
In these simplified cut-away diagrams, shown from the side and end, the Milinator's basic skeleton can be seen.

Local Involvement

The prototype Milinator was custom-built for Milin by Guelph-based Walinga Inc., a company best known for its feed delivery equipment and pneumatic conveying systems. Walinga started operations in the 1950s as Commercial Body & Coach with a staff of just two people. Today, more than 200 people are employed in Ontario, Manitoba and Michigan.

Walinga has three divisions: engineered transportation equipment, pneumatic conveying systems and machining. The latter includes clients and partnerships in many industries and markets, including material handling, plastics, food processing, mining, heavy equipment, and pulp and paper.

"Although we built the Milinator, this was 100 per cent Ivan's plan, Ivan's design," says C.H (Butch) Medemblik, the managing director of manufacturing and engineering at Walinga. "We were connected a few years before the prototype came to fruition and it's a different type of project than we normally take on. Having said that, customers ask for unique solutions to unique problems, and we try our best to work with them. Our engineers



and machinists are very skilled people who can take a dialogue with a customer and turn it into something like the Milinator."

Walinga is especially well known for its Agri-Vac, a grain mover that first came on to the agricultural scene in 1977, but Medemblik acknowledges that the Milinator was a project unlike any of the company's previous collaborations. But Walinga's slogan is *Building Any Body for Anybody* and that's just what they did here.

"We were very pleased to be approached, and we're proud to be part of this research," notes Medemblik. "The Milinator has massive implications for the way we handle manure. There were a number of Walinga's people involved with this, and it's been a great partnership so far."

intervention, the process isn't so space-aged. Wild animals produce manure and die – and in either case, the cycle is closed. In nature, flies would lay eggs in the manure, or in the decaying body. In due course, those eggs would become fly larvae, which feed off what they are living in. Birds or other animals would eat those larvae or the resultant pupae and flies, leaving a relatively cleaned-up scene and further nurtured life.

Now privy to the small-scale recycling work, Milin started to ponder if – and how – the concept could be adapted for large-scale processing of manure and other organic waste produced in modern agriculture. "Everything is so simple on a small scale but very complicated on the large, industrial scale. To me, the most interesting part of this spaceship micro ecosystem was the recycling of animal and human feces by using fly larvae. Their recycling process lasted only six days and recycling was total. All of the products were useful and no byproducts were generated to pollute the spaceship's ecosystem."

Milin says he was fascinated by the ways that this system could have when adapted and applied to agriculture. He therefore took it upon himself to find a way to adapt it to large-scale processing.

LACK OF FUNDING

The problem was, with just an idea that the technology could work, and small-scale Russian technology as inspiration, Milin needed to find money to fund the research. In a "which came first" scenario, the funding wouldn't come until he had something concrete, but he couldn't have concrete evidence without funding.

That's when Milin sat down with his wife, Bicky, and had a heart-to-heart chat. Also from an engineering background, Bicky knew that her husband was on to something.

"We talked about it and that's when she suggested we use our retirement savings to fund my research. I asked her if she was serious and she said, 'Absolutely, I love the premise of this technology and I know you could do it.' So, that's what we've done."

COOL CONNECTIONS

Along the way, Milin began collaborating with Bioenterprise Corporation, a business accelerator and commercialization agent established to help promote the creation and expansion of businesses engaged in agri-technologies. Through this relationship, he was connected to Mike Dixon at the University of Guelph.

Dixon is a professor and director of the Controlled Environment Systems Research Facility (CESRF). CESRF and its Space and Advanced Life Support Agriculture program are part of Canada's contributions to plant research and development for space and closed-environment related activities.

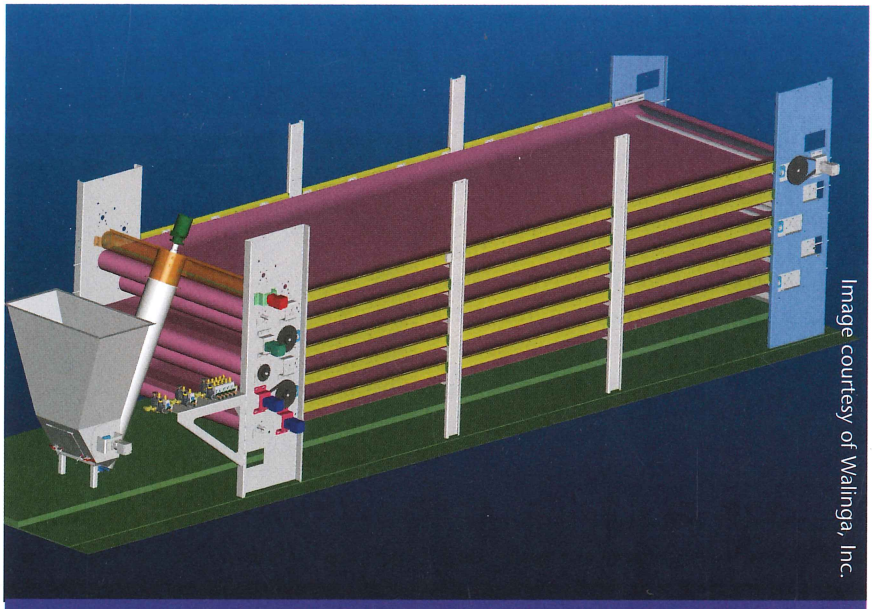
"You can't throw anything away when you leave Earth," says Dixon. His goal is to be able to sustain life indefinitely in space. "It's not like here. You're in a tin can – a tightly constrained ecosystem – and you have to recycle everything and you can't disinfect. You have to recycle nitrogen, carbon dioxide and water. Plants are absolutely necessary in space; you can't leave Earth without them. Ivan's work is one piece of our project – how to recycle the nitrogen. This is an accelerated composting."

THE CONCEPT

Right now, Milin is working on his technology in conjunction with laying hen manure only, as, for now, it's the best fit for the research purpose. His prototype is housed at the University of Guelph's Arkell Research station, but Milin's vision is that every poultry and livestock barn will eventually be fitted with the unit, which would be custom-made to handle the size of the operation.

The prototype was dubbed *The Milinator* by Milin's friend after its development, and the name has stuck. But what is it?

According to Milin, it is "an industrialized, yet natural processing of raw manure." The equipment and process he's developed essentially result in an odourless, dry organic material – a high-quality organic fertilizer. The "natural" comes in because Milin relies on the natural biological processes of the common housefly (*Musca domestica*) to do the processing, which results in his second product, a protein-rich potential animal feed in the form of fly larvae. The biologics of the process mean there is no air, water or soil pollution during the decomposition of the raw manure, and the entire cycle is completed in only four days, before decomposition would ordinarily begin to take place.



A 3-D schematic of the Milinator.

Milin says the housefly seems to be the best species to use because of its shorter life cycle, its prolificacy and the ability of its larvae to kill pathogens so the processed fertilizer is safe for use in both indoor and organic farming. Trials have been done that used the Black Soldier Fly (*Hermetia illucens*), but that species is harder to work with. Other insect larvae (such as mealworms and darkling beetles) were also considered, but abandoned because they are known to be major disease carriers.

HOW THE MILINATOR WORKS

With Dixon's help, and with support from the Ontario Ministry of Agriculture, Milin was able to secure space for his prototype, built by Walinga (See "Local Involvement" sidebar on page 12) at the Arkell Research Station. Bioenterprise Corporation secured office space for Milin in its Guelph facility for when he needs to be close to his project.

The Milinator is a series of conveyor belts (see diagrams on page 12 and above) working on top of each other. Poultry manure is deposited onto the top belt where it is mixed with fly eggs via a "fly egg seeder."

After the top belt is loaded with manure and inoculated with fly eggs, the job for that day is finished. From the eggs, larvae soon hatch and start rapidly processing manure. The next day, the belts are started again (running for only 10 to 20 minutes) and manure from the top belt together with feeding larvae is transferred to the second belt below. At the same time, the now-empty top belt is loaded with fresh manure and inoculated with fresh fly eggs. When the first batch reaches the last (bottom) belt, the processing is finished and the manure is now a very rich organic fertilizer, which is discharged from the final belt. The process is continuous and the daily capacity can be customized without limitations, says Milin.

There is no need to separate larvae from the finished fertilizer, because when larvae finish the process, they instinctively migrate out of the fertilizer and fall over the edge of the belt into the larvae collector. That leaves two products: a

rich dry, organic fertilizer, and fly larvae (which, if left untreated for two to four days, become pupae).

But what's the big problem that the Milinator system solved, which others who tried to industrialize the larval processing of manure failed to do?

Says Milin, "The scientists from the *Trip to Mars* program gave a very simple explanation for that. They said 'It is not possible to make the process profitable and nobody would use money-losing technology.' I maintain that the best way to clean the environment is to make the process profitable."

Milin says that to do this, the processed manure has to be tightly packed within the processor and that requires very precise and very uniform air circulation throughout the entire processing chamber. The Milinator patent has 24 claims on which the air circulation system is the main feature.

Manure in the Milinator system is packed so tightly that every 20 centimetres (8 inches) of vertical space contains one layer of manure together with conveyor belts, scrapers, belt holders and the air space for precise and uniform ventilation.

"The Milinator system does not change anything from what would occur naturally," notes Milin. "We simply make sure that with the technology, the conditions in every part of the processor are perfect for the larvae to live and work. Mother Nature and the larvae of *Musca domestica* do the rest."

BUILDING A FAN BASE

Finding allies who support his technology isn't really a problem for Milin, especially among the knowledgeable people within the related industry. The patented process is so revolutionary that he has already got a huge fan base for the Milinator. Tim Nelson, the former executive director of the Poultry Industry Council, has been in contact with Milin from the start.

"This innovative and natural approach to dealing with the dual issue of increasing input costs and the profitable use

Feeding a Hungry World

Image courtesy of Ivan Milin

The Milinator is a novel technology in itself, but the good news does not end there. Milin has found that the organic fertilizer produced by the process is proving to be a story in itself.

He's named the resultant fertilizer "Cyclorganic," because it's produced by recycling organic farm waste. The Milinator process captures and ties up nutrients such as nitrogen, which are later released for plant growth when applied to the soil as a fertilizer. This, Milin says, practically eliminates the risk of nitrogen escaping into the environment, where it can affect air and water quality.

But, the difference between Cyclorganic and other plant fertilizers is what the fly larvae *add* to it, during the process, he says. "Many insects and their larvae are disease carriers affecting both plants and humans, but fly larvae are known to kill pathogens and disinfect everything they touch."

At home, Milin first tried the fertilizer on his own green beans and tomato plants. Compared to his neighbour's same-variety plants, fertilized by commercially available product, Milin says the results were astounding. Vegetables and fruit flourished in Milin's garden. Although the neighbour's plants produced, the quantity of fruit and beans, leaf quality, colour, and size of growth were incomparable. That's when Milin knew he needed to get a more official verdict on the quality of Cyclorganic.

In April of 2012, the Virtual Fertilizer Research Center (VFRC), a special development unit of the International Fertilizer Development Center (IFDC) based in Alabama, contacted Milin, and it has been working closely with him since September of that year. IFDC's mission is to ensure global food security by providing smallholder farmers the best soil fertility solutions and farming practices suited to their conditions. The collaboration began as an attempt to assess the performance characteristics of the organic fertilizer created by the patented Milinator process.

VFRC is reviewing Cyclorganic as part of its goal to identify a new generation of more cost-effective and environmentally friendly fertilizers for commercial smallholder farming that can deliver higher nutrient uptake, improved micronutrient supply and convenient local sourcing.

Specifically, VFRC's work with Milinator includes the exhaustive assessment of the yield performance of Cylorganic with several crops (such as sorghum) compared to commonly available commercial fertilizers, an examination of the beneficial microbial activity in soil due to Cyclorganic, and an understanding of the key requirements for successful commercial scale-up in developing regions.

Milin believes the results of this work could be extremely positive. "Depending on the results, Cyclorganic could have implications for crop yield and in countries where there are small, independent farms. We could even be talking about solutions to hunger."

of animal byproducts has the potential to increase agricultural efficiency," says Nelson. "And, if successful, as a Canadian discovery it may well also generate important export income either as a proven technology, or perhaps of the final product itself."

Egg Farmers of Ontario (EFO) has also voiced support, stating in a letter from general manager Harry Pelissero that "the possibility of producing improved environmental benefits and a valuable output product at an acceptable cost ... appears promising." The letter goes on to offer support for securing research facilities and an interest in being kept abreast of how the work is progressing.

"The potential for commercializing this innovative process for use...on manure is very promising," says Ron Lackey, feed ingredients and byproducts feeding specialist with the Ontario Ministry of Agriculture and Food (OMAF). "I look forward to providing continued support and guidance to Ivan when and where possible, on his journey to success and satisfaction with his Milinator technology."

Accolades are pouring in from outside of agriculture as well. Gord Miller, Ontario's environmental commissioner, has visited with Milin and showed great support for the technology. "I showed the commissioner how this works and he was intrigued by it," says Millin. "He's fully supportive of it and my efforts to secure funding to proceed with the research."

And, in China, Leon Hui is the CEO of the China Foundation for Desertification Control. Tasked with halting the spread of the Gobi desert, Hui has told Milin that his technology is under consideration for utilization in the effort to slow down desertification in China. Milin says, "In Leon's words, 'with the Milinator technology, we will make the whole desert green.' "

Fly Larvae as Feed

It has been much-lamented that the way food is currently produced is not sustainable; some critics are now saying that patting ourselves on the back because we recycle plastic, glass, tin and newspaper just isn't enough.

Some, including Milin, say there also has to be a more efficient way to handle biological waste – an effective method of reducing environmental impact and utilizing waste how and when we can.

To that effect, Milin is pleased that the Milinator's story doesn't end with Cyclorganic alone. There is more work in the pipeline, and this time the research focuses on how to use the second byproduct of his technology, fly larvae.

"The larvae used in the Milinator process become pupae about two days after separation from the fertilizer product if the temperature is about 30 C, but they could stay larvae for the whole winter under certain conditions."

In conjunction with Milin, Prof. Ira Mandell at the University of Guelph has funding to examine nutrient composition and microbial loads of fly larvae samples collected over the next year.

Says Mandell, "There is no work being conducted to examine the effects of feeding the fly larvae on animal performance [yet]. Instead, in the proposed work, we will evaluate the nutrient composition and microbial loads in the layer excreta and see how it is transformed by examining the nutrient composition and microbial loads in the insect larvae and the resultant fertilizer that is produced."

Mandell will evaluate fresh, frozen and dried larvae, as the latter will most likely be the prominent form in which the larvae be handled. It is already known that improper drying could cause problems. Extreme high temperatures can make nutrients unavailable for digestion, while inadequate drying can allow moulds to develop.

Notes Mandell, "[n South Africa] they are light years ahead of us in this field as they are producing maggot meal from abattoir waste."

Milin adds that when this research is complete, both he and Mandell are hoping to acquire additional funding for actual testing of the larvae and or/pupae as a feedstuff for pigs and poultry, and compare it to conventional feed ingredients.

"Nichelle Lomas obtained her master's degree last year on the subject of poultry manure conversion by fly larvae. This year she is starting her doctorate degree on the same subject and she will collaborate with Ira," notes Milin. "Nichelle will inoculate poultry manure with different pathogens and then process it by using fly larvae. I think that her work could perhaps be a first step in using fly larvae in the pharmaceutical industry."

NO COMPETITION

You may have heard of similar ideas that tell of using insects to compost manure; Milin is acutely aware of these, but stresses that what he's got is a system for handling large amounts of manure, quickly and efficiently.

"I have heard [a] South African story and also a Japanese story and Russian one ... and so on, but nobody is telling what technology they are using. Anybody could put organic waste in a tray and put some fly eggs in it and they would do the job. The problem is that handling a large amount of waste and making sure that every part of that waste is supplied with adequate amounts of fresh air and kept under proper temperature for larvae to properly do the job is much more complicated.

"Up to now I have not seen any technology that could do large-scale production, especially with manure. The South Africans work only with animal blood and viscera, as far as I know, and they talk only of producing larvae. Labour is cheap in Africa and they do not have to heat the process so they might be able to make it profitable on the smaller scale,

but my system would probably be even cheaper there because I could work on the larger scale with much less labour."

Milin notes that the Milinator technology does not rely on sale of larvae to be profitable and that any revenue from selling larvae and/or carbon credits would be just an extra profit.

Milin's patent is already approved in about 50 countries, which means that 50 patent offices around the world couldn't find any technology that is similar to his. "Most likely all [those] stories are just stories that tell of smaller operations. If they copy some part of my technology, then my lawyer would deal with that, but so far I have not seen any technology being described or data of the products being tested, just stories."

INTO THE FUTURE

Says Milin, "This environmentally friendly process has the potential to become a superior and sustainable solution for a very large portion of the Earth's pollution problems. Properly developed, my technology could completely eliminate all the problems associated with animal, poultry and human manure generated on our huge industrialized animal and poultry farming facilities and in our cities."

Milin says that he'd like to set up a small plant in Canada and use it for further research and as a training facility for future operators of Milinator technology (the next phase of the process is to secure licencees who would use the technology on-farm).

He says that there are no limits to how the Milinator concept could be adapted for use with other poultry and livestock, even municipal organic waste. "I strongly believe that any nation and any industry would gladly adapt this technology because it is environmentally friendly, clean, efficient, and of course, profitable." ■

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