Prof. RMG Rajapaksa on Innovations, Commercialisation etc.

rmgr@pdn.ac.lk <rmgr@pdn.ac.lk>
To:Vijaya Kumar,Chandre dharma-wardana,Siri Munasinghe
Cc:B.F.A. Basnayake,Prof. Meththika Vithanage,Nimal Chandrasena,Chandra Dissanayake,Buddhi Marambe etc
Sat., Dec. 18 at 9:57 p.m.

1. I would like to endorse what Professor Vijaya Kumar talked about on research funding. Sri Lanka is perhaps the country that gives least research funding when compared to that of even nearby Asian countries. Yet, we produce substantial research outputs. Problem is not the research outputs and innovations but converting them to commercial products. Over the last 35 years we have been working in several multidisciplinary research projects as detailed below producing considerable innovations, yet, only the environmentally friendly, reusable, face mask with superhydrophobic outer layer capable of shedding aerosol droplets just like the lotus leaf is doing, electrostatic and mechanical filtration plus antimicrobial (capable of destroying bacteria and viruses including SARS CoV-2) middle layer, and superhydrophilic innermost layer capable of absorbing carbon dioxide and moisture in the exhaled air and quickly removing from the headspace between the face and the mask, that we call RESPIRONE NANO AV 99 face mask went into the market. Converting an innovation to a commercial product require a substantial scaling up and integration with industrial production type of research. Fortunately, we were able to get both these supports for the face mask and hence it went to the market without much of a hassle. However, it took over an year to get the NMRA certificate. This is because of the bureaucracy of the relevant state-sector organizations, and competition between importers of the face masks. This is not the only invention we did.
2.

   1. We worked for 6 years to convert bacteria sludge of the wastewater treatment plants of glove dipping industries in Sri Lanka to organic fertilizer by chemically removing heavy metals and excess zinc and aluminium present in the bacteria waste. As you know, organic fertilizers also contain toxic substances such as heavy metals. The heavy metals present in raw materials used in organic fertilizers must be removed before using them for organic fertilizer production or else the fertilizer may be organic but toxic. We used acid leaching as well as removal of heavy metals using chelating agents such as HMDP where any HMDP remaining gives P also. We then determined the C:N ratio to be 6:1 meaning that the bacteria sludge contains much more N than that is required for fertilizers. We, therefore, diluted N using dry plant leaves and other raw materials. Also, we used animal dungs to adjust the required C:N ratio, NPK and micronutrients. Again, we tested all the raw materials not only for their nutritional value but also possible toxins such as heavy metals and if toxins are present they were removed. Different formulae of these raw materials were prepared and converted to organic fertilizer following all the steps and measuring required quantities over the entire period of maturing and fertilizer production. The fertilizer thus produced was tested for its nutritional value as well as heavy metals and having assured the required nutritional values and the absence of heavy metals or the presence in much lower quantities below the allowable limits the fertilizer was applied to selected papaya, bitter gourd and snake gourd plantations. The soil of the plantation, plant parts and fruits and vegetables were tested for heavy metals and assured that they are not present in considerable amounts to pose health risks. Meantime, we analyzed some organic fertilizers available in the common market and found out that they contain heavy metals in higher amounts though still within allowable limits. This project was funded by the industry and hence we had sufficient funding and access to all required instruments, labour and funding for outsourcing to do some tests. It is a very important project under the present circumstances though the cost of production of the heavy metal removed fertilizer is considerably high. This means that although this fertilizer is an assured one for quality its adaptability to general situations like for common farmers is low due to its high cost. We recommend this fertilizer for a selected organic farming to produce toxin-free vegetables and fruits for export market. We are currently engaged in discussions with a commercial partner for this purpose.

[CDW: Although people worry about “heavy metals in fertilizers, be they organic or inorganic, whether the heavy metals will have an impact in changing the concentration of the heavy metal level in the soil when it is distributed to a depth of the plough blade (20 cm) over an area of one hectare (i.e., a volume of 20000 cubic meters) should be calculated. Then it is found that even for the most polluted inorganic fertilizer, the incremental change in the heavy metal concentration is merely a few parts per trillion. So, even if you apply that fertilizer for a thousand years the change is of the order of parts per billion, and this is assuming no leaching.
So, this worry about “heavy metals” is a red herring, at least for inorganic fertilizers. So, if you skip the step of removing heavy metals, RMGR’s fertilizers will be less expensive to manufacture, and still quite useful. See Environmental Geochemistry and Health, 2018 Article on this subject from the Cornell archive:
https://arxiv.org/abs/1802.07338]

2. We converted almost all local minerals to highly value-added nanomaterials for various applications.
2.1 Eppawala apatite was converted to pure hydroxyapatite nanomaterials and used them to make custom-made prostheses bio-compatible, osteo-integrating, non-toxic and non-corroding in corrosive body fluidic environments. Two such prostheses manufactured were transplanted in needy patients by our orthopaedic surgeons after taking necessary ethical clearances. Although, this is very important project that can be upscaled using 3_D or 4_D printing technologies, we did not get any financial support to go forward nor did we have any commercial partner to take over. As such, this project did not go beyond this demonstration of the proof of principle.

2.2 We converted local graphite to expanded graphite and graphene products. The expanded graphite we produced have unique physical properties of high electrical conductivity, extremely high porosity capable of absorbing 120 g of spilled oil by 1 g of expanded graphite when compared to that of currently used biochar that has the absorption capacity of only 6 g of oil per 1 g. We demonstrated this during the Xpress Pearl Ship wreck though it did not go far. Fortunately, we now have a commercial partner interested in producing these expanded graphite nets for recovering oil spills frequently happening in the sea. Shame is that Sri Lanka is one of five countries in the world having highly pure vein graphite naturally occurring though we are the only nation who is selling these nature's treasures ever since the second world war. Even the Madagascar, another country having natural vein graphite is careful not to sell their resources for cheap money.

2.3 We converted ilmenite present in our mineral sands to pure titanium dioxide and iron oxide nanoparticles by developing a very low-cost process. This conversion usually requires over thousand degrees of centigrade temperatures and the use of concentrated sulphuric acid or concentrated hydrochloric acid in the standard industrial processes known as sulphate/chloride process. As such, it is highly energy incentive and environmentally hazardous. We developed a rotating autoclaving procedure that can breakdown ilmenite structure at 170 C as opposed to 1000 C using dilute hydrochloric acid. We were able to produce phase-specific TiO_2 nanoparticles by separating Ti and Fe components. The Fe component was converted to magnetite, hematite and zero-valent iron nanoparticles. The waste generated is only a sodium chloride solution where NaCl can also be recovered in a saltern to give no waste except water.

We have two local patent and one WIPO patent applications. We have negotiated with the Ministry of Industries though the progress is very slow.

2.4 We converted dolomite into pure calcium carbonate and magnesium oxide nanomaterials and silica. The nanomaterials developed were tested for various technological applications. For this project, we had the blessings of the NSF to give us two research grants, an ordinary research grant to carry out lab scale study and having obtained successful results we were awarded a technology grant to scale up and integrate with industries. The necessary industrial processes were developed at our Chemical and Process Engineering Department (Spinning disc type reactors) and we produced superhydrophobic calcium carbonate in large quantities. Also, the nanomaterials developed were shown to be ideal non-toxic carriers for anticancer drugs to deliver the drugs to cancerous sites to eliminate their cytotoxicity to healthy cells, to reduce dosage and to maximize their bio-availability and efficacy. We demonstrated these with cisplatin, doxorubicin, Taxol and vinblastine. However, we are yet to find suitable commercial partners to proceed with these inventions.
These are some of the inventions we made.

3. We collaborate with 12 SL industries: ATG, TEEJAY, Bogala Graphite, CODEGEN, Varna, Sarasavi, Isabella, LTL, and so on and develop new inventions. Fortunately, with the industrial support we were able to work smoothly producing several commercial products. Some are now exported to EU, UK and US markets.

So my final word is that if we want to convert an invention to a commercial product we need backing of private sector industries. However, state support is also important in terms of publicity etc.
Gamini RAJAPAKSE