

SCIENCE AT STAKE

The debate and discourse about the directions of Bio-film-Bio-fertilizer (BFBF) and "Organic Agriculture" in general have vacillated between valid and been unworthy of the scientists. People appear to be wholly polarized and unable to reconcile.

Despite a volume of correspondence, the proponents failed to acknowledge what Dr. Chandre Dharmawardena first said, with which I agreed, while showing the evidence – that "bio-Fertilizer" research is in its "infancy". It really is - at this moment in time.

The two articles I provided gives ample evidence of how much is known and not known and indeed point to future directions for research.

(a) Mitter EK, et al. (2021). Rethinking Crop Nutrition in Times of Modern Microbiology: Innovative Biofertilizer Technologies. *Front. Sustain. Food Syst.* 5:606815. doi: 10.3389/fsufs.2021.606815

(b) Ye, L. et al. (2020). Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. *Nature Scientific Reports* | (2020) 10:177 | <https://doi.org/10.1038/s41598-019-56954-2>

I think I am right in thinking that the discourse began with a robust defence and an accusation that Dr. Dharmawardena and other "expatriates" have no idea about Sri Lanka's agriculture and the "bio-fertilizer" work that has been done by SL Scientists over a long period.

Part of this claim is valid for one simple reason. There is hardly any significant research article or report from SL on "bio-fertilizers" available for "expats" to appreciate such contributions.

As I pointed out, some of the most recent BOOKS on "Bio-fertilizers" (published in 2019, 2020, 2021) have no contribution from SL. I pointed out the contributors to these books are 95% Indian researchers. It indicates a "trend" in India.

It would have been good if SL scientists also published sufficiently regularly in International Journals to be "picked up" by Indians and others. If you read the Chapter synopses of each book, they indicate an evolving science, a "hope" for the future, more than a widely-applicable practical solution.

The books also worryingly show a global new trend in publishing; hardly any critical review of Science; instead, profits from publishing by giants like Wiley and Springer via subsidiary companies. There are a few other books also available on the topic; maybe others too will emerge soon.

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|  |  |  | <p>The researchers, presumably with good intentions, write these chapters repeating the same stuff. It is a worrying trend. As a Journal Editor, I have dissuaded my contributors not to reference these uncritical books but to refer to more seriously-reviewed journal articles.</p> |
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One of the last posts (Dr. Chris Dharmakeerthi) thanked the local group of professors for their hard work and implied that those who contributed to the conversation did not have any "bio-film" expertise. That bit is also valid. But the implication that 'expats' cannot make a contribution is

unfortunate. Perhaps, it would have been fair for Dr. CD to have acknowledged the other "expat" Dr. CD's vast experience in Science that SL can further benefit from. Those words only show how impossible it is to have a balanced discussion.

1. I pointed out how "Allelopathy", a sub-theme of Weed Science, went through a similar 40-year phase before finally settling on the most significant outcome of using allelochemicals as "templates" to produce "novel" herbicides. Considerable progress has been made (Natural Products from plant resources).

2. The advances of phytochemistry occurred irrespective of Allelopathy, but as I personally experienced myself in SL and overseas, some serious impetus was provided by our interests in characterizing allelochemicals. Allelopathy owes its success and emergence as a science to the Phytochemists for cracking the bio-active molecules and groups.

3. The uses of allelopathic crop residues still continue, albeit without much hoo-ha, within the space of cover crops, green manures and mulching options during fallows; they are valid applications. Allelopathic crop varieties (they do work, but where are they?); "botanical herbicides" (mostly ineffective), etc., have been researched to death but came up with not much success.

4. My point is, proving 'causes-and-effects' with allelochemicals was vital; it took a long time and 'understanding the science lagged a long way behind practical applications'. Thanks to the Science behind Allelopathy, we now know we have a huge knowledge base on secondary plant metabolism, secondary metabolites, plant defences, compounds produced under stress, and phytochemicals with high bio-active potential. "Bio-Fertilizers" are very much at that stage of its Science. To apply it country-wide, in all types of crops and situations, as a solution to SL's agriculture is unscientific.

5. With BFBF, the proponents say that the research goes back to about 10-15 years or more. We must accept this statement. However, we have not seen compelling "bench-top" studies or well-controlled glasshouse or greenhouse studies or "small-plot" experiments on these treatments using some suitable substratum and test species. That is the only way to prove their consistent, measurable and reproducible effectiveness.

6. "Reproducibility" of the results with BFBF remains unproven. It should be of great concern even after years of research and should be rectified with proper experiments. Without calling 'expats' "kuhaka" for asking pertinent questions, perhaps we can have a conversation about how to go about "proving the concepts" of 'bio-films'. There is a great deal to learn from the work already done elsewhere.

7. Reading through some of the material submitted, published and/or unpublished, I am at a loss to understand why the proponents of BFBF did not look at the actual "mineralization" processes claimed to occur in soil (nitrification, denitrification, phosphorus mineralization, or any other).

8. Also, it is necessary to describe the composition of BFBF explicitly. Without such information, these papers will never be accepted by reputed International Journals. The claimants say that the BFBF technology is protected by a Patent?

9. If empirical studies have been done within the Ph.D. or M.Sc. dissertations of the proponents' students and not yet published, I encourage people to do so before long. In their absence (this discourse failed to put forward any such evidence), I must say that the "proof of concept" approach has not been followed and "causes-and-effects" remain unproven. Presumed or actual yield increases that appear to have been obtained in the large-scale, multi-district Field Trials are affected by such a myriad of factors that it is hard to determine consistent, reproducible results. "Promising results" would be the only way to describe it, as done for the past 12 years.

10. May I draw attention again to Allelopathy. This sub-discipline of Weed Science went through such an initial period, for about 10 years, until in the mid-to-late- 1980s, it used the Koch's postulates from Plant Pathology to "prove" that phytochemicals released to the environment by "donors" do inhibit or stimulate "recipients" who are exposed to them. Much of the debates then died down. The sub-discipline expanded its horizons into natural products and phytochemistry as the most significant future directions.

11. Alarms go off in my mind regarding the "conflicts of Interest" of the scientists involved. IFS and funding sources surely will have something to say about this? Nowadays, renowned global journals require an explicit statement on conflicts of interest and funding sources. SL scientists should also follow these international guidelines.

12. I must question the ethic of planning to make money from agricultural research conducted by students and possibly, supported by any number of people (farmers, agriculturists, etc.). The latter derive no benefits if the patent makes money at a future date. For that reason alone, such practices are prohibited in the Universities and Institutions in Western Europe, Australia and the USA. Breaches could lead to severe repercussions such as instant dismissal. If the SL scientists want information on "propriety" and "what is right and what is wrong" in scientific "ethics" and practices, there is a wealth of information available.

13. Towards the latter part of the 'conversation', comments arose about "biochar", combinations of "biochar" with BFBF with or without mineral fertilizers, etc. Discussion swayed into pollutants, including PAHs and others like heavy metals.

14. In these discussions, I received private e-mails and questions from SL regarding the suitability of using Salvinia and Water Hyacinth from various lakes as biomass that can be converted into "Organic Fertilizer". I asked for SL Standards on "Organic Compost" and politely pointed out how deficient they are. In SL, there are NO STANDARDS for the processes of 'producing' Compost or what its composition should be (what is not acceptable). That is why the material given to farmers in bags contain rocks and glass! How awful is the plight of the farmers – when we get it wrong?

15. Producing "biochar" itself is a challenging process, and its quality depends on the source materials, as the "expat" Dr. CD pointed out. Even in Australia, where there is an enormous wood-chip industry (Eucalyptus and Chinese Tallow types of hardwood, Pinus softwood, etc.), 'bio-char' is not a big business; it is a marginal "niche" market, which exists because of those species that can "coppice".

16. I have no objection to using biochar' in agriculture where it is needed. It may improve certain soil conditions, but the effects depend on the source of material, sites and a myriad of other factors. I doubt its value in flooded and irrigated lowland rice. To consider producing 'biochar' from rice husks and or coconut husks, invasive species (which abundant species? Lantana? Chromolaena? Guinea grass? Tithonia? Gliricidia? or any other vegetative matter) requires a life-cycle cost-benefit analysis.

17. Producing biochar' also requires an environmental, social and sustainability analysis. I hope these will be done to the degree needed before making country-wide recommendations with unknown future supply implications. Pyrolysis to produce the temperatures for biochar itself may be untenable as a long-term, island-wide option, but that depends on those sustainability assessments.

There are many other aspects and implications of the hasty fertilizer and pesticide bans in SL and the future challenges agriculture faces. But the tenor of the discussions (biodiversity?), which swayed so far away from BFBF, showed how even trained scientists can lose track and indifferently move from one topic to another. I used to be highly critical of such 'students' during my time at Colombo University.

I will end by saying that the views of the people who made contributions to this conversation are too polarized. As I flippantly but politely said previously, Kipling's well-published line": *Oh, East is East, West is West - Never the Twain Shall Meet*" is appropriate.

The views expressed cannot readily be reconciled on BFBF until and unless more scientific data are published in reputed journals, outside Sri Lanka, under the scrutiny of international reviewers.

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