Title: The Science behind Ecological Farming Practices

Subtitle: Building Organic Bridges between Traditional systems and the Future

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Summary Traditional farming is based upon ecologically sustainable practices. Recent scientific research is beginning to reveal that these time-tested practices are synergistic with the biological functioning of plants, insects and microbes that constitute the agro-ecosystem. This paper describes the science which underlie traditional farming practices, and renders them truly sustainable for the future.

Introduction & Background Agriculture dominates human activity across the world; therefore the practices that agriculturists follow deeply mark the land and life forms on that land. Most traditional farming practices are based upon ecologically sustainable principles and remain "low Input" as compared to the "high input" technology-driven modern agriculture. Scientists are now beginning to elucidate the mechanisms involved in the response of plants to stress, disease, and their interaction with other organisms in their environment. These studies indicate that if an appropriate habitat is created which encourages biodiversity and multiple cropping in agricultural fields, nutrition and disease management can be achieved without the use of toxic chemicals.

Main Chapter In India, animal husbandry is intrinsic to organic farms and there are many preparations from products of cows for enhancing crop nutrition, protection against diseases, and increasing yields. Panchakavya is a traditional mix made from 5 basic ingredients from the cow: cow dung, cow urine, ghee, curd and milk. It is often customized by addition of ripe fruits, coconut water, molasses to enhance its efficacy. Its regular use at dilutions of just 3% has shown significant increase in yields across a range of crops from fruits and vegetables, to cereals and tubers. The ingredients are mixed in specific proportions and allowed to ferment. Lab analysis of the preparations 15 days into the fermentation period has shown significant increase in concentrations of major and micronutrients, of available Nitrogen (>65%), Phosphorus (>45%), Potassium (>75%), Organic carbon (>22%), increase in plant growth-promotory hormones like gibberellins, and IAA (indole-acetic acid). Populations of beneficial bacteria like azotobacters, azospirillum, phosphobacteria, pseudomonas, increase logarithmically. GS-MS analysis of Panchakavya has shown enhanced levels of fatty acids, alkanes, and alkaloids some of which act as protective agents against pathogens.

Soils Traditional farming focuses on enriching the soil. The tropical rain forest soils, though fragile, are extremely rich in microbial diversity and other forms of life. Whereas insects and their grubs, earthworms and other similar soil inhabitants breakdown large particulate matter, the fungi and bacteria mineralize and provide nutrients to the plants. Composting enhances soil microbial diversity and contributes to an active buildup of humus and organic matter. On our farm, composting all farm waste and weeds, is an intrinsic part of agricultural practice. It is supplemented with EM (Effective microorganisms) which is a mixture of bacteria that can be cultured using molasses and added to significantly speed up breakdown of organic matter.

Mycorrhiza Fungi form a vital and intrinsic part of the forest ecosystem. The entire forest below-ground is interconnected by an extensive expanse of fungal mycelium which can spread up to several thousand square kilometers. The mycelium runs through the soil wrapping itself around the roots and literally extends their reach to wider and greater depths which can be tapped for nutrients. Mycorrhiza are soil-borne fungi that associate intimately with plant roots and interface soil nutrition uptake by the plants. Arbuscular mycorrhizal fungi (AMF, belonging to the division Glomeromycota) are vitally and intrinsically associated with several cultivated and wild species of plants. AMF produce a glycoprotein called Glomalin which is one of the major stores of iron and carbon in the soil and provides a significant source for carbon sequestration. Glomalin also attaches to particles of minerals (sand, silt, and clay) and organic matter, forming clumps. The resulting, more stable soil structure resists wind and water erosion, harbors more beneficial microbes, and offers better water retention capacity. High glomalin content can be maintained through low tillage and good soil management practices. Use of heavy machinery in the fields, and fungicides and other chemicals destroy natural populations of mycorrhizas.

Plant Defense AMF also play an important role in stimulating the plants' natural defense mechanism . Their association with cultivated and wild plants results in enhanced production of defense-related compounds like alkaloids and phytoalexins. Plants associated with AMF also show enhanced production of jasmonates when under pest attack. Jasmonates are pivotal in activation of genes involved in plant defense responses such as those coding for proteinase inhibitors, enzymes of synthetic pathways of phytoalexins, and other compounds (volatile organic compounds, terpenoids, tannins, etc) . As would be expected, positive effects of AMF on plant defense, as a result of increased nutritional status, is stronger in traditional low-input organic agricultural systems than in chemical high-input systems. Phytoalexins are synthesized by plant cells as a defense response to bacterial or fungal attack**.** They are broad spectrum inhibitors and are chemically diverse in different plant species. They inhibit pathogens by either damaging cell wall or membrane, disrupting cellular metabolism or inhibiting reproduction. Phytoalexins can also be triggered by spray-applications of various plant extracts often used by organic farmers for pest control.

Conclusion

Evidence from research labs across the world are beginning to reveal that traditional farming practices are based upon ecological principles. Such practices encourage biodiversity. On organic farms such as ours which have no trace of chemicals around, parasitic insects colonize native plant species and play significant roles in balanced pest-predator relationships. Use of chemicals and pesticides have degraded lands and water bodies all over the world. It has become essential for survival of human and other species to revert back to holistic farming practices.

Ecological practices followed on our farm, slides showing photographs and schematic figures will be used to explain the scientific concepts described in this paper.