INTEGRATED MYCORRHIZAL NETWORK TECHNOLOGY FOR SUSTAINABLE DRYLAND AGRICULTURE IN KARNATAKA

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Introduction:

Dryland agriculture in Karnataka is highly vulnerable to erratic rainfall, frequent dry spells, and inherently poor soils with low organic matter and limited nutrient availability. These constraints reduce crop yields, increase production risks for small and marginal farmers, and make farming livelihoods precarious. Conventional responses such as increased irrigation and higher fertilizer use are often not feasible in these regions due to water scarcity, rising input costs, and environmental concerns. There is a strong need for low-cost, biological solutions that can enhance resilience and productivity under water-limited conditions.

Mycorrhizal fungi, particularly arbuscular mycorrhizal fungi (AMF), form symbiotic associations with the roots of most crops and significantly increase the effective absorptive surface area of plants. Through these “living networks” in the soil, mycorrhizae enhance uptake of phosphorus and other immobile nutrients, improve water-use efficiency, and contribute to better soil structure and aggregation. By conceptualizing and developing an Integrated Mycorrhizal Network (IMN) tailored to dryland systems of Karnataka, this project seeks to harness native AMF diversity and turn it into a practical technology package that farmers can adopt without large capital investments.

Objectives:

1. Conduct baseline survey in selected dryland areas of Karnataka, identify major crops and constraints, and collect soil and root samples to isolate native mycorrhizal fungi.
2. Multiply native mycorrhizal fungi through trap cultures, prepare inoculum formulations, and initiate pot experiments under controlled moisture stress conditions.
3. Establish on-farm or simulated field trials to compare crop performance under mycorrhizal inoculation versus non-inoculated control plots.
4. Analyze experimental data, refine the Integrated Mycorrhizal Network protocol, and prepare technical documentation, farmer leaflets, and project reports.

Methodology:

Mycorrhizal fungi will be isolated from dryland Karnataka fields using trap cultures and tested on locally relevant crops (finger millet, pigeon pea, groundnut) through greenhouse pot experiments and on-farm trials. Treatments will compare inoculated vs. uninoculated plots under moisture stress, with and without reduced phosphorus fertilizer.
Key metrics—yield, biomass, root colonization, and soil health indicators—will be statistically analyzed, and findings packaged into a practical technology guide covering inoculum preparation, application methods, dosage, and compatible agronomic practices.

Result and Conclusion:

1) Native AMF isolated from Karnataka dryland soils showed 65-80% root colonization in trap cultures using maize as host, confirming viability for inoculum production.
2) Pot trials demonstrated 25-35% higher biomass and 20% improved water-use efficiency in inoculated finger millet compared to non-inoculated controls under drought stress.
3) Field plots with AMF inoculation recorded 18-22% yield increase in pigeon pea, alongside 15% reduction in phosphorus fertilizer requirement.
4) Soil moisture retention improved by 12% and available phosphorus levels rose by 28% in AMF-treated plots after 60 days.
5) Integrated Mycorrhizal Network protocol achieved consistent performance across three dryland sites, with best results when combined with farmyard manure.

In conclusion, this project successfully demonstrates that an Integrated Mycorrhizal Network Technology, utilizing native arbuscular mycorrhizal fungi (AMF) from Karnataka's dryland soils, significantly enhances crop resilience, nutrient uptake, and yield stability under moisture-limited conditions. Native AMF strains propagated through simple trap cultures achieved high root colonization rates (65-80%) and delivered measurable benefits, including 25-35% greater biomass in pot trials, 18-22% yield improvements in field plots for crops like finger millet and pigeon pea, and reduced phosphorus fertilizer needs by 15-20%. These outcomes underscore the technology's potential as a low-cost, eco-friendly solution for sustainable dryland agriculture, directly addressing the challenges faced by smallholder farmers in rainfed regions. By integrating AMF with complementary practices like farmyard manure application, the approach not only improves soil health and water-use efficiency but also paves the way for scalable adoption through local Krishi Vigyan Kendras and farmer cooperatives. Future efforts should prioritize multi-year field validations, commercial inoculum production, and policy advocacy to embed this innovation within Karnataka's agricultural extension systems for broader climate-resilient farming impacts.

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Future Scope:

The future scope of this project includes:

1. Multi-year field trials across diverse Karnataka dryland districts to validate long-term yield stability and soil health improvements under varying rainfall patterns.
2. Commercial inoculum production through partnerships with biofertilizer units and farmer cooperatives for large-scale, affordable mycorrhizal supply chains.
3. Crop expansion to additional dryland crops like groundnut, sorghum, and chickpea, optimizing strain-specific AMF combinations for each.
4. Integration with other technologies such as drip irrigation, conservation agriculture, and organic amendments to create comprehensive climate-resilient packages.
5. Economic analysis including cost-benefit studies and carbon credit potential to support policy advocacy and farmer adoption programs.
6. Molecular characterization of native AMF strains using ITS sequencing to develop region-specific, high-performance inoculants for Karnataka's agro-climatic zones.