

Importance of Nematology Research in Food Security

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Introduction

Food security remains one of the most pressing global challenges as the world population continues to rise while cultivable land and natural resources shrink. Achieving sustainable food production requires effective management of hidden constraints that reduce crop yield and quality. Among these constraints, plant-parasitic nematodes are often overlooked because they are microscopic and soil-borne, yet they cause enormous damage to agricultural crops. Globally, nematodes are responsible for annual crop losses estimated to be \$80 to \$157 billions (USD). Research in nematology plays a crucial role in understanding, managing, and mitigating these losses, thereby contributing significantly to food security.

Nematodes: Invisible threats to crop productivity

Plant-parasitic nematodes attack roots, bulbs, tubers, stems, and sometimes leaves of crops. Root-knot (*Meloidogyne* spp.), cyst (*Heterodera* spp. and *Globodera* spp.), lesion (*Pratylenchus* spp.), and reniform (*Rotylenchulus reniformis*) nematodes are among the most economically important species. These nematodes impair root function, reduce nutrient and water uptake, and predispose plants to secondary infections by fungi and bacteria. Because the symptoms often resemble nutrient deficiencies or drought stress, nematode damage frequently goes undiagnosed, leading to chronic yield losses. Nematology research helps in accurate diagnosis and awareness of these hidden pests.

Role of nematology research in yield protection

One of the primary contributions of nematology research is the identification of nematode species and their host range. Understanding nematode biology, life cycle, and population dynamics allows researchers to design effective management strategies. Research-based interventions such as resistant crop varieties, crop rotation, biological control agents, and eco-friendly nematicides help to reduce nematode populations below damaging levels. By minimizing yield losses caused by nematodes, nematology research directly supports stable and increased food production.

Contribution to sustainable and climate-resilient agriculture

Climate change is altering soil temperature and moisture regimes, often creating favourable conditions for nematode multiplication and spread. Nematology research provides insights into how nematode populations respond to changing climates and cropping systems. This knowledge helps in developing climate-smart management practices that are environmentally sustainable. Emphasis on biological and natural methods of nematode management reduces

dependence on chemical nematicides, preserving soil health and biodiversity, which are essential for long-term food security.

Enhancing soil health and ecosystem balance

Not all nematodes are harmful; many free-living nematodes play a vital role in nutrient cycling and soil ecosystem functioning. Nematology research helps differentiate between beneficial and harmful nematodes and assesses soil health using nematode community analysis. Healthy soils with balanced saprophytic nematode populations support better root growth, efficient nutrient use, and improved crop resilience. Thus, nematology contributes to both productivity and sustainability of food systems.

Supporting smallholder farmers and food availability

In many developing countries, smallholder farmers suffer significant yield losses due to nematodes but lack awareness and access to diagnostic facilities. Nematology research supports extension services by developing low-cost, farmer-friendly management practices. Adoption of these practices improves crop productivity and income, strengthening local food availability and livelihood security. Improved yields at the farm level cumulatively enhance national and global food security.

Future prospects of nematology in food security

Advances in molecular diagnostics, remote sensing, and precision agriculture are opening new avenues in nematology research. Early detection of nematode infestations and site-specific management can prevent large-scale crop losses. Integrating nematology with soil health management, biotechnology, and digital agriculture will further strengthen food production systems. Continued investment in nematology research is therefore essential for meeting future food demands.

Conclusion

Nematology research plays a vital yet often underappreciated role in ensuring food security. By addressing the hidden threat of plant-parasitic nematodes, it safeguards crop yields, promotes sustainable agricultural practices, and supports resilient food systems. Strengthening nematology research and its application at the field level is crucial for feeding a growing population while preserving soil and environmental health.

References

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