Choose Plant Science For Sustainable Future

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What can we do about a growing human population, increasing demand for food and a shrinking supply of resources and perhaps most importantly the threat of climate change? Understanding plant biology and ecology is now more important than ever before if we are to find solutions for these critical 21st century challenges.

Plant science is a rapidly progressing multidisciplinary study of plants. When I first started my journey as a researcher I found everything in my field was developing at an overwhelming speed. Previously unknown pathways were being discovered almost weekly, regular scientific conferences were offering absolutely new content, and it appeared that every issue of coveted journals had to have at least one paper on my topic of study. To answer my curiosity about the impact of this research field, I started a quest to find the burning questions that plant science is addressing. How biologists approach them and how they stumble upon answers stretching from common sense to complicated regulatory mechanisms?

The questions plant science is addressing:

1.Food to feed billions:

Plant biology is a broad and diverse field with potential to preserve future well-being of this planet and its inhabitants. The expanding world population is set to be over 9 billion by 2050 and will require abundant food and resources to survive.

To keep pace with growing food demands the agricultural capacity must be doubled from its existing levels. The research in plant science is advancing to maximise food production from existing arable land. This approach is beneficial to safeguard rainforests from being converted into cultivated land. The researchers are not only focusing on the yield of crops, but also on other desirable features such as improving the quality, nutrition, and shelf-life of food.

Across the globe, there are combined efforts to develop an effective plant breeding program for major crops. Plant scientists are exploring options to improve current agronomic practices, soil management and cropping system. Researchers are also finding ways to reduce yield loss due to pests, disease, and weeds by breeding resilient varieties. There are ongoing efforts to increase abiotic stress tolerance, photosynthetic efficiency, and fertilizer efficacy in crops. However, to be successful in our goal of sustainable agriculture we need significant investment in agricultural science and active engagement of young innovative minds.

- Plant science research is focused on maximising food production.
- Improving quality, nutrition and shelf-life food
- Improving current agricultural practices
- Developing disease and stress resistance crop varieties

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2.Tackling the energy crisis and climate change:

The global carbon cycle involves carbon production by photosynthesis, accumulation in the soil and oceans, and release from the geological and biological resources. However, human activities and deforestation have upset the balance of the carbon cycle in our ecosystem. At present, fossil fuel combustion generates more than 80% of annual energy consumed globally.

As a result, contributing enormously to global warming and biological species extinctions. Incidentally, the trail to find the most environmentally sustainable way for energy production also ends with plant-based solutions. Biofuel energy produced from biomass rich cellulose crops (maize, sugarcane and Agave) is energy-dense and compatible with the current petroleum-based energy setup. To further reduce our global carbon footprint, there is a substantial research interest in the development of microalgae (unicellular aquatic plants) due to their tremendous potential to capture CO2 emissions and produce biofuels.

Rewarding Research: Microalgae could be the source of next generation fuel while simultaneously absorbing CO2 from the atmosphere.

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3.Protecting biodiversity and improving global health.

Biodiversity refers to the original components of our crops, and farmed livestock. The continuous genetic improvement in these constituents ensures adaptation and flexibility to the current and future needs. Agricultural biodiversity is vital for the productions systems reinforcing ecosystem progression such as pollination, soil erosion aversion, water, and nutrient cycling. The plant research community is alarmed by the loss of diversity from agro-ecosystems which will have negative effects on human health. Research efforts are undergoing to increase resilience of agricultural ecosystems and simultaneously reducing our ecological footprints. Scientists are utilizing diversity in crop system to help cope with the pests and diseases as well as improving soil quality. The success in these efforts is going to be a win-win option creating benefits to both biodiversity and human health.

'Ecoagriculture': Plant scientists are coordinating biodiversity conservation to reduce intense agriculture footprint on our landscapes

How biologists approach the problems:

It all starts with –the formulation of hypothesis

The amazing pace of advance in our understanding of plant biology is, perhaps, due to the development of new tools and methods. However, everyone should agree, that mere techniques without ideas are featureless. Biological research across the spectrum has started and developed quite similarly. As a matter of fact, all big discoveries were the result of detailed hypothetical framework. At first, scientists deliberate about a problem and postulate hypothesis. Next step is to test the hypothesis that involves advanced (cool!) techniques, operating equipment, conducting tests, and recording data. The selection of experiments is decided based on biological question that needs to be answered. The fundamental biology is built around the principles of genetics playing substantial role in the plant's exploratory science.

Precision genome editing is a paradigm shifting tool being used in crops to improve stress tolerance, improve nutrition quality, shelf life, and disease resistance, and much more not yet imagined. Leveraging these techniques effectively, however, requires the ability to identify target genes for desired modifications. This knowledge originates from the imperative 'basic research' discipline of plant biology. Basic research envisions to describe the plants and its components and how they might behave when modified on gene-by-gene basis. The gene and pathway function is deduced using genomic, transcriptomic, proteomic, biochemical, cell biological, and phenomic data sets. The information generated from here can be used to validate initial hypothesis allowing iterative improvements in plant sustenance.

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Careers in Plant biology:

The perception of plant science as of low status compared to biomedical disciplines is now transforming. Plant science encompass diverse, satisfying and 'plantastic' career options. For a career in this field, students should select college courses in plant pathology, entomology, molecular biology, biochemistry and plant physiology. Practical training through laboratory coursework and research experience in established academic or industrial labs are highly effective in building awareness of opportunities in this field. Students should look for experimental training opportunities from undergraduate level itself to gain necessary research experience.

To conduct basic research or to advance to jobs directing applied research, a master's or doctoral degree is required. Advanced degree programs in plant science include classroom and fieldwork, laboratory research, and a thesis or dissertation based on independent research. Plant scientists gets plenty of work opportunities in universities, laboratories, environmental agencies, and biotechnology & pest management companies, among others. Without sounding dramatic there are significant changes in the field of plant research round the corner. Hopefully, we will start to see people with knowledge of crops, ecology and biodiversity valued more.

Glossary

Heat engine – a technology used to convert heat into mechanical power or electricity

Heat pump – a technology that upgrades heat to a higher temperature for heating purposes.

Chiller – a technology that uses heat to provide a cooling effect.

Efficiency – the ratio of how much electricity is generated by a heat engine to the amount of heat input.

Find out more

BBC news article on using waste heat from the London Underground: www.bbc.co.uk/news/uk-england-london-49482840

UK government report on waste-heat recovery in UK industry: www.gov.uk/government/publications/the-potential-for-recovering-and-using-surplus-heat-from-industry

UK government Heat Recovery Support Programme: www.gov.uk/government/consultations/industrial-heat-recovery-support-programme

About the authors

After stumbling into the field of engineering after enjoying maths, physics and product design at school, I went to university to undertake a degree in mechanical engineering. This left with me a passion for renewable energy and I haven't look back since. I now work as a researcher developing new technologies that can reduce our impact on the environment.