John Innes Centre

Unlocking Nature's Diversity

Next Generation Research Facilities

Briefing Document

6th September 2017

BACKGROUND

Unlocking Plant and Microbial Diversity

The John Innes Centre (JIC) and The Sainsbury Lab (TSL) are internationally recognised as leaders in plant and microbial sciences. During the past two decades, pioneering research at the JIC has revealed at a molecular level the extraordinary richness and complexity of genetic diversity in plants and microbes. The challenge in the near future is to understand the interplay between genetic diversity and the environment, and how this leads to the diversity of phenotypes (physical characteristics) we observe. Understanding how to unlock nature's diversity will help us to meet the needs of humankind and the planet in a sustainable way.

The JIC's science vision is to build from a foundation of genetics to an integrated level of understanding of plants and microbes in their environment. Our partnership with TSL is key to achieving this vision, a vision that requires a combination of genetic and molecular approaches with ecological principles, creating new opportunities for partnerships across the Norwich Research Park, collaborating with other national and international centres of academic and applied excellence, and strategic alliances with partners in China and Sub-Saharan Africa. Establishing these global partnerships will leverage JIC's contribution to addressing the challenges placed on our food production systems by population growth and climate change which, by 2050, will mean ever greater demands on limited natural resources such as fresh water, rock phosphate and fossil fuels.

Our research has major strategic impacts: JIC's contribution to global wheat productivity is estimated to be worth £8.7 bn p.a. and our research on actinomycete-derived antibiotics is estimated to support additional global sales revenue potential of £247 M p.a. The value for money of JIC research is £12 GVA to the UK economy[1]. This combination of scientific excellence and strategic impact places JIC at the forefront of plant and microbial sciences, not only in the UK, but internationally. We strive to continue our leadership for the decades to come.

The JIC 2050 Science vision

Humans depend on the diversity of plant and microbial products for food, nutrition, fuel, drugs and industrial feedstocks. We know that diversity arises through genetic and environmental variation, but the mechanisms by which this variation leads to specific phenotypes are largely unknown. This lack of understanding means that we have only been able to access a tiny fraction of plant and microbial diversity. Genome sequencing has revealed an extraordinary richness and complexity of variation within populations and between species, yet we can't relate most of this variation to the phenotypes we observe.

Over the next 30 years we foresee a revolution in our understanding of plant and microbial diversity and the application of this diversity for the benefit of mankind. The past 20 years have focused on defining individual genetic pathways that contribute to a specific trait. The challenge in the near future is to understand how the combined action of genetic pathways creates the complexity of an individual cell and how cells interact to form an organism. This integrated understanding will explain how genotypes define phenotypes and how subtle genetic changes can have profound organismal impacts. Instead of relying solely on phenotype-led breeding or blind screens of plant and microbial products, we will be able to guide and predict the way genes may be varied and combined to meet the needs of

[1] The Impact of the John Innes Centre - 2013

mankind. The JIC is ideally positioned to drive this new scale of research, with strengths in developmental genetics, mathematical modelling, chemical diversity, crop genetics and genomics. This new organismal scale of understanding, underpinned by an understanding of genetic diversity, will enable more predictive biology, feeding into synthetic biology, crop breeding and crop and microbial engineering to provide a spectrum of opportunities for improvements in sustainable agriculture, human health and bio-based industries.

Plants and microbes do not exist in isolation, whether they function within a natural ecosystem or within a man-made environment. Understanding the behaviour of plants and microbes and improvement of their performance for agriculture and human health requires a deep mechanistic understanding not only of the organism, but also of the organism within the context of its environment. Advances in genetics and in genomics means that molecular research is no longer restricted to single species in the laboratory, but can span biological scales, linking deep mechanistic understanding of the organism to its functioning in complex ecosystems. The coherent principle at the John Innes Centre is genetics and the study of genetic diversity. We will build from this foundation, first to an organismal understanding of species, then integrated into an ecosystem level of understanding of plants and microbes in their environment.

Our vision requires a bridging of the remits of diverse research councils and charities, such as the BBSRC, NERC, MRC, and the Wellcome Trust. This will create many new opportunities for strategic applications and deliver much needed advances in scientific understanding and application. We are already building the partnerships necessary to enable this research and ensure its impact, with close integration across the Norwich Research Park, collaboration with other national and international centres of academic and applied excellence, and strategic alliances with the Chinese Academy of Sciences and Bioscience for Eastern and Central Africa.

A New Generation of Research Facilities

JIC is a world-leading institute, which in order to remain fully competitive, requires an estate that is commensurate with its scientific vision and its global stature. JIC is renowned for its excellence in blue skies fundamental science in plant and microbial science. Predicting where this science will lead us is extremely difficult. One of the challenges of this project is creating research infrastructure that will provide the flexibility to develop innovative ways of working that are receptive to new technologies and unconstrained by traditional disciplinary boundaries, thereby ensuring it is future-proofed for many decades to come. The current campus remains a pleasant working environment; many of the buildings are tired, dated and no longer fit for purpose in the new era of multidisciplinary science. Our sustained success in winning external scientific funding has resulted in an increase in staff creating an over-crowded working environment. JIC requires large-scale modernization of its infrastructure in the context of the emerging Norwich Research Park campus, to sustain its leadership position and deliver its maximal impact for the UK bio-economy, UK food-security and international sustainable development goals for decades to come.

The estate dates from the mid-1960s and has, since the late 1980s undergone extensive expansion in buildings through the addition of three large science buildings, additional library and administration space, a Conference Centre, and insectary. The total estate comprises approximately 28,000 m^2 of laboratory and offices with a further 9,000 m^2 of plant growth facilities. The newer science buildings place greater emphasis on larger, more flexible shared laboratory spaces, while smaller compartmentalised laboratories dominate in the older buildings. JIC has developed a science vision that depends on multidisciplinary teams,

integration, and greater continuum between dry and wet science exemplified by developments in computational biology, plant growth and specialist analytical facilities. An estate that is able to facilitate delivery of this vision by providing future-proofed flexible accommodation is essential.

Of major concern is the issue of energy efficiency with the older science buildings and much of the plant growth facilities. With continuous pressure on recurrent budgets through energy costs, it is essential that energy efficiency is addressed.

To realise our vision, we need modern facilities that will house our diverse research activities under one roof, are custom designed for research that is far more multidisciplinary, with seamless integration between large scale infrastructure, individual scientist wet lab spaces and computation.

The capital investment estimated for the new facilities is assumed to be in the region of £250M. This investment is for 34,562m^2 of research and office buildings, 5,162 m^2 of horticulture facilities, and a limited amount of new scientific equipment.

In summary, next generation infrastructure will enable us build on the scientific excellence that JIC is renowned for by attracting the brightest and best to JIC. It will enable us to operate at a quickening pace and show agility to seize new opportunities by encouraging multidisciplinary collaborations and facilitating interactions between researchers who would not have normally worked together. The building will accommodate collaborations not only between disciplines, and wet and dry science but also between sectors, institutions, people and our international activities. The location at the heart of the Norwich Research Park will highlight the importance of a place where people and organisations benefit from mutual proximity. Together all of this will encourage openness and engagement with industry and the international scientific community and will continue to provide a focal point for the considerable talent and knowledge in the area while playing its part in the life of the local community.

Professor Dale Sanders, ScD, FRS
Director, John Innes Centre