NU-Farms: Applying sustainability, precision science and innovation to improve decision making at the field, farm and societal scale

Forty percent of the earth's terrestrial surface is farmland, with this **5 billion ha resource** being vital to sustaining societies, ecosystems, and future planetary health. Impacts of intensive agriculture on **shared global challenges** of climate (SDG 13), pollution (SDG 6), biodiversity (SDGs 14&15) and societal inequalities (SDGs 1-3) are clear, but with potential to transition to future farming systems that could contrastingly **co-deliver our nutritional needs while restoring our natural capital.**

Newcastle University Farms encompasses **800ha** of Red Tractor assured mixed arable and grazing operations, with a commercial dairy herd (320 cows) and pig enterprise (140 sows plus finishers). Spread across three sites in Northumberland (Nafferton: 314ha, Cockle Park: 271ha, and Ouston: 207ha), the farms marry **commercial, research and teaching objectives**, underpinning a vision to "*provide an **open innovation platform** enabling researchers to work with farmers, industry, and environmental and government stakeholders*". Led by complementary and co-developed commercial and academic strategies, the farms facilitate **evidence-based innovation** in core theme areas, including: resilient and regenerative farming; novel crops and inputs; high welfare and precision practices; digital and molecular 'smart surveillance' for biodiversity, soil, crop, emissions and livestock monitoring; and agri-food system governance and safety. **Independent and collaborative** on-farm R&D in these subjects is currently being supported through EU, UKRI, Defra, DESNZ, HEIF, the Elizabeth Creek Trust, and a range of other public, private and charitable bodies, with the farms currently underpinning >£4m of R&D funding awarded to the university.

Our **fifteen experimental farm 'platforms'** focus on strategically important topics, from designing production practices in our Nafferton Factorial Systems Comparison to build natural capital and maximise soil, crop and ecosystem services, to sustainable grazing management and in-field phenotyping of arable and biomass crops. Many of these platforms are of national and international importance, including our Hydrologically Isolated Plots and Palace Leas Hay Meadow, established in 1896 and recognised as "***the world's longest-running grazing and hay cutting experiment***". Following £2m of investment in 2014, these are supported by on-farm laboratories, glasshouses and events facilities, utilised for teaching, research and knowledge exchange by NU and our partners. Linking to our commercial dairy at Nafferton, Cockle Park is also home to a **suite of animal science facilities**, including Porcine and Poultry Research Units and a Gait Lab. These embed sensor technology throughout to develop digital solutions to deliver the **highest standards** of livestock welfare and productivity, with non-intrusive methane monitoring sensors fitted to our milking parlour at Nafferton in 2023. With links to the Faculty of Medical Sciences, a further £0.4m has been committed to create an 'Animal Technical Facility' at Cockle Park, extending our capabilities in this area.

NU-Farms are fundamental to our founding partner status (2016) in **two national agritechnology centres**, hosting C-Dial for the Centre for Innovation and Excellence in Livestock (£3.3m invested at Cockle Park), and serving as a base for the Centre for Crop Health and Protection's Precision/Regen Ag portfolio and lab-to-field laboratories (£1.2m invested). NU are also **founding partners** of the £16m N8 Research Partnership, operate a joint Institute of Agri-Food and Rural Innovation with Fera Ltd, and are a LEAF Innovation Centre. Here our farms provide a **hub for validation, demonstration and knowledge exchange**, as they do for our numerous other private (e.g. UNDO – enhanced rock weathering), public (e.g. Defra – mob grazing), RTO (e.g. CEH - Biomass Connect) and NGO/charitable (e.g. SOS – Farming for Carbon and Nature) network partners, driving industry innovation, scientific advancement and policy development.

NU-Farms and their data streams are utilised by our **multi-disciplinary researchers** across a diversity of academic units within our School of Natural & Environmental Sciences (home to 135 academic staff and in excess of 2,000 students), including Agricultural Production Systems, Animal Sciences, Earth Sciences, Molecular Biology, Ecology, Modelling, Evidence & Policy, Agriculture, Resilient Food Systems & Environment and Rural Studies. Additional links exist to the Schools of Engineering and Computing, for example through the Borehole Array at Cockle Park and BIONICS Research Embankment at Nafferton. Our NUCoREs, Centre for Rural Economy and National Innovation Centre for Rural Enterprise provide award-winning cross-faculty platforms to further collate our interests around food, farming and rural socio-economics. The farms formed a core component of NU's REF2021 UoA6 submission, are embedded within our Climate Action Plan, are **informing government policy** through our Defra-funded SFI pilot at Ouston, and are developing **natural capital markets** with multiple PLCs on carbon and Biodiversity Net Gain. Notably, the first private-public Payment for Ecosystem Service scheme was developed with **leading researchers** based at Cockle Park.

Assisted by an **industry-facing Farm Board**, dedicated on-farm support is provided through an experienced and leading commercial team, managed by our Farm Director, core administrative staff, and on-site technical teams. This facilitates **diverse on-farm pedagogic delivery**, from student field trips and dissertation projects to fully-funded summer scholarships/placements and entirely farm-based teaching modules, helping to underpin NU's position in the 2024 Complete University Guide as the third best UK provider of Agriculture & Forestry degrees. Interactive maps of Cockle Park and Nafferton support virtual learning and remote engagement, and an **NU-Farms Academic Strategy Group**, chaired by a Director of Farms Research, further facilitates teaching, research and outreach activity, connecting and catalysing commercial and academic endeavours and promoting NU-Farms internally and externally. Through this group, NU-Farms

delivers a student dissertation brochure, calendar of on-farm events and external exhibits, annual Open Days, coffee mornings, Farm Forum meetings, and quarterly publication of the NU-Farms Bulletin.

Table of NU-Farms field-based teaching and research platforms, showing their purpose, location and main academic contacts

Platform	Purpose	Site	Main Contact(s)
Nafferton Factorial Plots (QLIF)	Compare production practices and tillage	Nafferton	Dave George
LowP Plots	Useful for biostimulant projects	Nafferton	Dave George
Hydrologically Isolated Plots (HIPS)	Allow projects in isolated hydrological plots	Cockle Park	Mark Whittingham James Standen
Palace Leas	Impacts of historical nutrient regimes	Cockle Park	Darren Evans Simon Peacock
Tillage plots	Impacts of tillage types	All sites	James Standen
Mob grazing	Compare grazing regimes	Nafferton/Cockle Park	James Standen Mark Whittingham
Diverse pasture	Compare grazing sward diversity	Nafferton	Hannah Davis
Agroforestry	Impacts of agroforestry	Cockle Park	Marion Pfifer Yit Arn Teh
Willow Coppice	Allows projects on willow coppice	Cockle Park	Rachel Gaulton
Bore Hole Array	Projects on underground heat sourcing	Cockle Park	Mark Ireland
Carbon Capture plots	Projects on carbon capture	Cockle Park	David Manning
SFI Pilot	Test and trial site for soils standards	Ouston	James Standen
Enhanced rock weathering	Carbon capture and cropping using ‘rock dust’	Nafferton	Yit Arn Teh / David Manning
Biomass platforms	Demonstration and validation of biomass crops	Cockle Park	Yit Arn Teh / Dave George
Dairy methane sensors	Assess methane from dairy herd during milking	Nafferton	Sam Wilson / Hannah Davis