

## Aberystwyth University

### *Perennial biomass cropping and use*

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## Appendix

Table S1. Details of projects that have supported the development of the PBC *Miscanthus* in UK and Europe, giving a breakdown of the topics covered and showing the R&D gaps.

Acronym	Project title	Years	Public Funder	Public:Private ratio	Pre-breeding	Breeding	Propagation	Agronomy	Harvest	Transport & Storage	Pre-treatment	Valorisation tests	Crop modelling & LCA
GIANT-LINK	Genetic improvement of miscanthus as a sustainable feedstock for bioenergy in the UK	2011-2016	UK: BBSRC & DEFRA	50:50 partners: CERES, Terravesta, Blankney Estates, Uniper (EON), and National Farmers Union.	Wild germplasm collection in Asia and characterisation	~500 exploratory pairwise crosses p.a. with progeny evaluation at four UK sites and one in Germany. First seed production experiments in USA & Catania Italy	clonal: rhizome and in vitro nodal plugs seed: direct field sown and via plugs	Plant and small plot scale at 4 trial locations in the UK, 1 in Germany and 2 in Italy first generation mulch film combined with weed control with different herbicides	standing crop in spring (Feb-March) by scientific quadrat	n.t.	n.t.	Proximate analysis for use in biopower by Uniper (EON)	Extended parameters and front end interface for the MiscanFor model to characterise indigenous growth conditions of breeding selections from wild Asia
OPTIMISC	Optimisation of Miscanthus as an energy crop in Europe	2012-2016	EU: FP7	90:10	diversity in abiotic stress resilience in wild accessions	n.t.	seeded & in vitro plug plants & rhizomes	Plot (5 locations) and Field scale (3 locations) hand and machine plug planting	in addition to spring quadrats, comprehensive assessment of quality (compositional changes) at four sites during ripening for four hybrids	n.t.	n.t.	AD ....	First attempts to link plot level plant available water and variation in yield
WATBIO	Development of improved perennial non-food biomass and bioproduct crops for water stressed environments	2011-2015	EU: FP7	77:23	Mutation-based breeding in Arundo donax, contribution to pre-breeding of miscanthus and poplar.	n.t.	n.d.	10,000 poplar trees plants in Italy under irrigated and rain-fed conditions. Field experiments with mutant lines of Arundo donax.		n.t.	n.t.	n.t.	Developing an ideotype for drought tolerance
OPTIMA	Optimization of perennial grasses for biomass production in Mediterranean area	2011-2015	EU: FP7	90:10	diversity in water stress resilience in wild accessions	n.d.	rhizomes	Experimental plots in changing soil water availability	standing crop in spring (Feb-March) by scientific quadrat	n.t.	n.t.	n.t.	Evidence of different mechanistic responses to drought (i.e., water use efficiency) in potential parents for breeding aimed at producing future seed-based drought resilient hybrids.
MUST	Miscanthus Upscaling Technology	2016-2019	UK: BBSRC & DEFRA	70:30	n.t.	Extensive field seed production experiments in Catania Italy	Seed sown plugs with different plug volumes	Adapted modular plug planting and mulch laying machines, plant spacings (densities) and measured planting speeds	Quantity and quality changes during overwinter ripening at a high altitude site in Wales	n.t.	n.t.	n.t.	n.t.
MISCOMAR	Miscanthus biomass options for contaminated and marginal land: quality, quantity and soil interactions	2016-2019	EU: FACCE, JPI	90:10	n.t.	n.t.	seed and rhizome	plug	how green cuts in autumn compare with brown cuts in spring	in silage	in silage	AD, fibres, pyrolysis	comparisons between modelled and observed yields
MAGIC	Marginal lands for Growing Industrial Crops: Turning a burden into an opportunity	2017-2021	H2020	90:10	n.t.	Testing GIANT LINK bred Miscanthus hybrids for water stress tolerance along with other perennial grasses in a field trial in Catania.	plugs, rhizomes	Experimental plots in changing soil water availability	standing crop in spring (Feb-March) by scientific quadrat	n.t.	n.t.	Structural polysaccharides, ADL, ash, NDS	Yield, quality and resource use efficiency (WUE, RUE) comparison
GRACE	Growing advanced industrial crops on marginal lands for biorefineries	2017-2022	EU: BBI	70:30	n.t.	Seed production in Catania, Italy and in the Netherlands	Novel methods to raise large quantities of seeded plug plants	~50 hectares planted in 10 locations with seed plugs (2018-2021 and ongoing) planting density & novel biodegraded and biodegradable mulch films	comparison of forage harvester chipping (direct) versus swath-to-bale (indirect) impacts of harvest time and hybrid types	no new innovations	specific to valorisation, mainly at scale	Bioproducts: fibres used in composites, chemical extraction including saccharification, bioplastics, bioherbicides...	MISCANFOR & new parameters
PBC4GGR	Perennial Biomass Crops for Greenhouse Gas Removal	2021-2026	UK: BEIS	100:00	n.t.	n.t.	n.t.	20 hectares of commercial scale trials with a monitored reference to conventional agriculture on a further 20 ha and plot scale trials to explore agronomic practice	Comparisons likely as for GRACE	as for GRACE	n.t.	n.t.	Near real time comparison on fluxes from areas converted to Miscanthus and Willow and agricultural reference areas
MISCANSPEED	Accelerating breeding	2022-2025	UK: BEIS	100:00	Developing Genomic prediction for moisture and ash contents	Recurrent selection for hybrid vigor enhancement							
NEXT STEPS	GAPS for future projects	2022-	n.a.	n.a.	Resilience traits for water stress and cold stress	Deployment of new plant breeding techniques in a maturing crop	Increasing plug plant establishment resilience at an affordable cost	Developing machinery for planting more reliably on marginal lands, and the control of weeds in a post glyphosate era	increasing the harvest capacity and options	optimising field collection, lorry loading and logistics	lignocellulose deconstruction	Optimisation of practical and economically viable product cascades	Better spatial and temporal knowledge of which crop should/could be grown where and the current and future needs for infrastructure to create bioeconomy opportunities

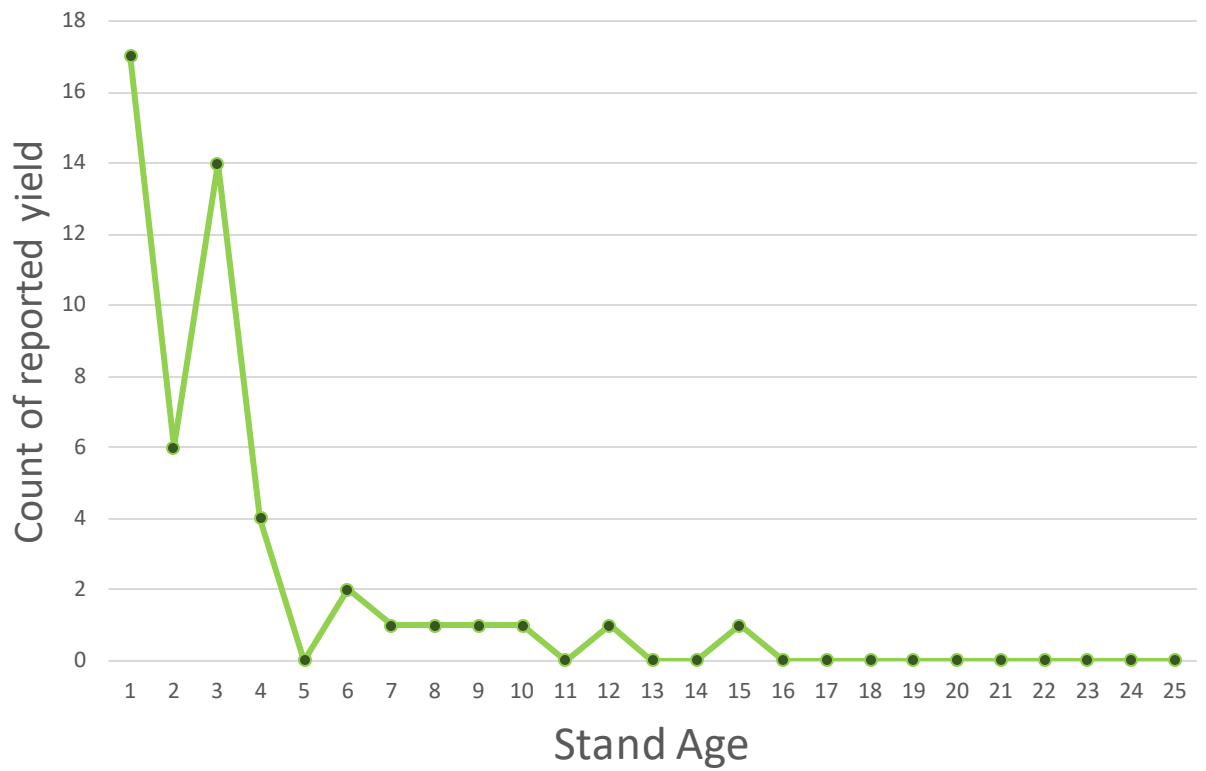


Figure S1. Number of reported yields by stand age for papers published on *Miscanthus* as an example PBC from 1992 to 2022.