

Project Progress Summary

Section 1: PROJECT IDENTIFICATION Information to be provided for project identification		NOT CONFIDENTIAL	
Title of the project The Sustainable Production of Plant-derived Indigo			
Acronym of the project SPINDIGO			
Type of contract RS (Research and technological development)		Total project cost (in euro) 3 585 537	
Contract number QLK5-CT-2000-30962 (1)	Duration (in months) 42 Months	EU contribution (in euro) 2 806 767	
Commencement date 1 January 2001		Period covered by the progress report 1 January 2003 – 31 December 2003	
PROJECT COORDINATOR			
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Key words (5 maximum - Please include specific keywords that best describe the project.). agro-technical, non-food (industrial) crops, dyestuff, natural, plant biochemistry			
World wide web address (the project's www address) http://www.spindigo.net			
List of participants Provide all partners' details including their legal status in the contract i.e., contractor, assistant contractor (to which contractor?).			
1 The University of Reading (UREADAB) co-ordinator Professor Philip John School of Plant Sciences, The University of Reading, Whiteknights, Reading, Berks RG6 6AS UK. p.john@reading.ac.uk			
2 University of Bristol (UNIVBRIS) contractor Drs David Hill, Kerry Gilbert, David Cooke School of Biological Sciences, Long Ashton Research Station Long Ashton, Bristol BS41 9AF UK. kerry.gilbert@bbsrc.ac.uk			
3 Thüringer Landesanstalt für Landwirtschaft (TLL) contractor Dr habil. Armin Vetter Thüringer Zentrum Nachwachsende Rohstoffe der Thüringer Landesanstalt für Landwirtschaft, Apeldaer Strasse 4, Dornburg 07778, GERMANY. TLL-Dornburg@t-online.de			
4 LIVOS Pflanzenchemie (LIVOS) contractor Dr Ulla Eggers LIVOS Pflanzenchemie, Forschungs-und Entwicklungs-gesellschaft mbH & Co KG, Auengrund 10, OT Emern D-29568 Wieren, GERMANY. Projekte@LIVOS.de			
5 Gorham & Bateson (Agriculture) Ltd (GANDB) contractor (to 31 October 2002)			
6 Express Separations (EXPRESS to 30 September 2002) (now Critical Processes Ltd, Partner 11) contractor			

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10 Fundación Cultural y de Promoción Social Caja Rural Valencia (FCRVAL) **contractor**
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11 Critical Processes Ltd (CRITPRO) **contractor (from 1 October 2002)** Mr Peter Hammond
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Section 2: Project Progress Report

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(2 pages maximum. Use short sentences. Be factual. Avoid technical terms as much as possible)

Objectives:

The aim of the project is to introduce indigo-producing crops into the agricultural systems of the EU so that naturally sourced indigo will supply at least 5% of the European indigo market by 2005, and continue to increase market share, to the long-term benefit of European farmers and the environment. To achieve this aim, the project sets itself the following linked scientific and technological objectives: identification of appropriate indigo-producing crops for particular regions; development of a mobile, simple-to-operate, continuous-feed, farm-based equipment for the extraction of indigo from the harvested leaves; development of a simple process for the on-farm purification of the extracted indigo to at least 90% purity; standardisation and quality control of the natural indigo product; standardisation of the crop to improve yields; finally, an assesment of the environmental impact of plant-derived indigo.

Results and milestones:

In the first three years of the Project we have grown indigo-yielding crops in Spain, Italy, Germany, UK and Finland. The crops have been woad (*Isatis tinctoria*), Chinese woad (*Isatis indigotica*), and polygonum (*Polygonum tinctorium*). Using the key yield parameters of leaf weight and indigo yield per unit leaf weight, we have compared genetic lines from a variety of sources; analysed the relationship between indigo yield and the main environmental parameters of air temperature, global radiation, day-length, rainfall, and photosynthetically active radiation (PAR). We found that woad grows well in all the climatic zones examined, with yields of indigo up to 100 kg/ha; Chinese woad gives higher yields, but is less reliable because of bolting and disease susceptibility; while polygonum yields well, and is more suited to Central Europe and the Mediterranean, but tolerates neither drought nor very high temperatures. To maximise economic yield for both crops, we have identified for each climatic zone the optimum times for sowing, and the optimum times for harvest (up to four harvests per year are possible). Other agronomic factors investigated over the three years are: nitrogen fertiliser rates, irrigation requirements, row spacing, and herbicide treatments.

Using traditional breeding methods high-yielding strains of woad have been selected.

An HPLC-based technique for measuring the indigo precursors in woad and polygonum has been developed, and published as: Gilbert *et al* (in press) *Quantitative Analysis of Indigo and Indigo-Precursors in Leaves of Isatis spp. and Polygonum tinctorium*. Biotechnology Progress; Angelini *et al* (2003) *A new HPLC-ELSD method to quantify indican in Polygonum tinctorium L and to evaluate B-glucosidase hydrolysis of indican for indigo production*. Biotechnology Progress 19, 1792-1797.

The factors that determine seed production such as vernalisation and day-length, have been identified, and sufficient seed can now be produced within the Project for foreseeable future crops of woad and polygonum.

Mobile farm-based extraction machinery designed to handle a high through-put of woad has been developed. Woad and polygonum have also been extracted using non-specialised equipment. Both yield and purity require improvements for the maximum economic benefits to be gained. Novel technology for extraction is also being developed.

Indigo produced in the Project has been used in test dyeings to DIN standards with natural fabrics and unconventional materials. The results compared well with the synthetic product and the present limited commercial sources of natural indigo. In line with the value of our indigo as a natural, sustainable product we have identified natural auxiliary agents for dyeing.

Natural does not necessarily mean *sustainable*; and to back up our *sustainability* claim, an Environmental Impact Assessment (EIA) of the whole process of natural indigo production has been made in draft form.

Benefits and beneficiaries:

The progress made in the first three years of the Spindigo Project means that collectively Project Partners (www.spindigo.net) can now claim to have a greater concentration of expertise on natural indigo production than can be found anywhere else in the world.

In Year 1 of the Project our natural indigo was used by the London-based fashion house, Boudicca, for designs launched at London Fashion Week. This early success was followed up in Year 2, when Karada, a leading Italian fashion house used our indigo in a new line (Corpo Nove) of natural fibre men's jackets. In Year 3, the Italian knitwear designer, Mely's Maglieria, chose our indigo for their new Kos Collection (www.koscollection.com), and our indigo was chosen to dye materials for the International Exhibition *Grüne Woche* in Berlin in early 2004.

The message we receive from the fashion and textile industries is that if we can develop the means to produce sufficient natural indigo of a high enough quality from European growers, then the market is there.

Future Actions (if applicable):

In the final period of the project in 2004 we will pass on the knowledge we have gained by producing Agronomic Blueprints for the indigo crops. In both a web and printed format, these will advise farmers and growers on crop cultivation and indigo extraction. They will also help pass on the message of environmental responsibility and sustainability embodied in the completed Environmental Impact Assessment. The final year will also provide the opportunity for us to estimate cultivation and extraction costs and the likely price of the product; and to disseminate as widely as possible our findings.