EUREKA PROJECT E!2386 - CEREQUAL

1. General description

Project	E! 2386 - CEREQUAL	**Status**	Announced - 28-JUN-2001
Title	**Molecular Breeding Tools For Quality Improvement In Cereals Supporting Sustainable Agriculture**		
Class	Project	**Technological area**	Medical and Biotechnology
Start date	01-OCT-2000	**End date**	01-OCT-2005
Duration	60 months	**Total cost**	19.5 Meuro
Partner sought	No		
Summary	A Eureka Consortium Of Scientists From Research Institutions And 8 Leading Plant Breeding/Biotechnology Companies Will Apply Innovative Molecular Techniques To Solve Urgent Quality Problems In The Most Important European Cereals.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Implementation phase	19.5	60
Total	**19.5**	**60**

Member contribution

Member	Contribution	Position	Since
France	**51.30%**	**Contact Member**	**12-SEP-2000**
Germany	42.00%	Participating Member	28-JUN-2001
Austria	6.70%	Joining Project	21-DEC-2001

Participants

Company	Country	Type	Role
BIOGEMMA S.A.S.	**FRANCE**	**Large company**	**Main**
INRA/INSA LYON BIOLOGIE 406	FRANCE	Research Institute	Partner
KWS SAAT AG	GERMANY	Large company	Partner
MAX-PLANK-INSTITUT FUER ZUECHTUNGSFORSCHUNG	GERMANY	Research Institute	Partner
BAYRISCHE LANDESANSTALT F. BODENKULTUR UND PFLANZENBAU PZ6B	GERMANY	Research Institute	Partner
UNI.HOHENHEIM/FORSCH.SCHWERPUNKT BIOTECH.U.PFLANZENZUECHTUNG	GERMANY	University	Partner
BAYRISCHE LANDESANSTALT F. BODENKULTUR UND PFLANZENBAU PZ4A	GERMANY	Research Institute	Partner
MUT - LEHRSTUHL FUER PFLANZENBAU UND	GERMANY	University	Partner

Participants

Company	Country	Type	Role
PFLANZENZUECHTUNG TECHNISCHE UNIVERSITAET MUENCHEN H.HEINE UNIV./LEHRS.ENTWICK.U.MOLEKULARBIOLOGIE DER PFLANZEN HEINRICH HEINE UNIVERSITAET	GERMANY	University	Partner
LIMAGRAIN GENETICS GRANDES CULTURES S.A.	FRANCE	Large company	Partner
EURALIS SEMENCES S.A.	FRANCE	Large company	Partner
NICKERSON INTERNATIONAL RESEARCH GEIE	FRANCE	Large company	Partner
UNIV. PARIS-SUD/INSTITUT DE BIOTECHNOLOGIE DES PLANTES UNIVERSITE PARIS-SUD ORSAY	FRANCE	University	Partner
INRA NANTES UNITE DE BIOCHIMIE ET DE TECHNOLOGIE D.PROTEINES INSTITUT NATIONAL DES RECHERCHES AGRONOMIQUES	FRANCE	Research Institute	Partner
INRA ANTIBES PHYTOPATHOLOGIE INSTITUT NATIONAL DES RECHERCHES AGRONOMIQUES	FRANCE	Research Institute	Partner
INSTITUT NATIONAL AGRONOMIQUE PARIS-GRIGNON (INA-PG)	FRANCE	Research Institute	Partner
UNIVERSITE DE PARIS/DEPARTEMENT DE BIOLOGIE UNIVERSITE DE PARIS VI	FRANCE	University	Partner
RAGT S.A.	FRANCE	Large company	Partner
INRA - UNITE GENETIQUE AMELIORATION DES PLANTES FOURRAGERES INSTITUT NATIONAL DES RECHERCHES AGRONOMIQUES	FRANCE	Research Institute	Partner
SAATZUCHT DONAU GESMBH & CO KG (SZD)	AUSTRIA	SME	Partner

2. Project outline

Project description

In previous years, significant progress has been achieved in wheat and maize breeding. This relates mainly to yield and yield stability under unfavourable environmental conditions. Well adapted, high yielding varieties are available for many different environments to date, leading to the predominant role of wheat and maize in European (and other) agrosystems. Many factors indicate that the importance of these cereals will increase even further in future.
Solutions are therefore urgently required for still persisting quality problems in wheat and maize production. However, these problems relate to complex traits which are determined by a whole array of wheat and maize genes. It is a difficult challenge to identify all genes involved in a complex trait and combine genes/alleles by modern breeding approaches such that optimal alleles are combined in elite varieties. Moreover, the genetic variation in wheat and maize might not be sufficient to achieve the desired improvements. There is therefore a need to extend the genetic variability in wheat and maize by genetic engineering, using gene pools of different organisms. Thus, a combination of marker-assisted breeding and genetic engineering is the most promising strategy to solve urgent quality problems while improving the environmental compatibility of wheat and maize.
The EUREKA Consortium will apply these innovative tools to establish:
(i) silage maize with improved digestibility and ingestibility,
(ii) N-efficient low input maize prototypes,
(iii) insect resistant maize prototypes, and
(iv) Fusarium-resistant maize and wheat breeding lines with little or no mycotoxin load. The relevance of these problems and the scientific strategies are explained in more detail in the annex.
In this strategic programme, internationally acclaimed scientists from public research institutions in GERMANY and FRANCE together with eight world-leading plant breeding and plant biotechnology companies combine their know-how to provide highly innovative solutions to quality problems in wheat and maize, beneficial to breeders, farmers and end-consumers.
Keywords: maize/wheat breeding, molecular markers, genetic engineering.

Technological development envisaged

With respect to crop plants, most molecular genetic research today applying molecular markers and genetic engineering is focused on traits with monogenic inheritance. However, nearly all economically important agricultural traits are of polygenic inheritance. This is also true for the quality traits under investigation in this programme. This means that polygenic or 'quantitative' traits are determined by the complex interaction of synergistic and antagonistic genes, which in addition are

very strongly influenced be environmental factors. Thus, the identification of all individual genes of these networks is much more difficult than identifying a single gene for a monogenic trait.
Our project aims to extend molecular genetic breeding strategies to quantitative characteristics by marker-assisted breeding and genetic engineering. The combination of both marker-assisted breeding and genetic engineering is a very promising strategy in order to solve urgent quality problems in the economically most important European cereals, wheat and maize.
The programme will employ molecular techniques such as differential expression analysis and substractive methods to identify and clone candidate genes for the traits of interest from wheat and maize. In addition, genes from heterologous sources will be cloned and functionally analysed by transformation. This will make it possible to establish novel mechanisms for quality improvement, which cannot be introgressed by breeding. During the programme, a comprehensive collection of functionally characterized genes involved in the manifestation of quantitative traits will be supplied, together with novel (synthetic) monocot promoters and refined protocols for cereal transformation. The most promising genes will be transformed into wheat and maize and transgenic prototypes will be established. After in depth characterization these prototypes can be integrated directly into the commercial partners' ongoing molecular breeding programmes, thus complementing molecular breeding with transgenic approaches.
In addition, refined genetic maps in wheat and maize will be constructed using currently available markers and converting candidate genes into novel markers. In particular, SNP (Single Nucleotide Polymorphism) markers for functionally different alleles will be developed and used as an efficient high-throughput breeding tool allowing fast genotyping of large populations and the rapid introgression of combinations of optimal alleles into elite varieties. Thus, the programme will add new selection tools which are less dependant on biotic and abiotic factors influencing the plantsÂ´ phenotype, but are more based on genotypes.
In addition to conventional phenotypic selection, breeders will have a better picture on the genetic composition of their breeding material. This will make a much more accurate selection and accelerate breeding progress possible.
A key factor for success is that all partners with excellent expertise will cooperate within a complementary, synergistic programme. This will permit the comprehensive dissection of genetic networks which determine quality traits in wheat and maize.

Markets application and exploitation

The commercial product of wheat is predominantly grain, which is used for animal feed and human nutrition. With maize, silage maize varieties are used entirely as animal feed (especially cattle), whereas grain maize, in addition to being an important component of animal feed, is also used for human nutrition and technical applications.
Wheat and maize are the most important cereals in Europe,

GERMANY and FRANCE being the predominant producers of wheat and maize. Further improvement of quality traits in wheat and maize is of utmost importance in order to maintain effective and environmentally friendly agrosystems. Increased environmental awareness of the general public enforced legislative restrictions on the use of fertilizers and pesticides. In addition as a consequence of the 'Agenda 2000' the acreage of wheat and maize is expected to grow further in future, while market prices are expected to decrease. Thus, cost efficient and environmentally-compatible varieties will be demanded by farmers, which
1. effectively use fertilizers, particularly nitrogen,
2. are resistant to pathogens and thus require less pesticide treatment, and
3. provide optimal nutrient and energy availability allowing a reduction of feeding costs for high performing livestock.
Plant breeders offering wheat and maize varieties which meet these demands will have competitive advantages not only within the EU but also in other highly developed agrosystems, especially in North America. This is why the improvement of quality traits in wheat and maize has become an internationally highly competitive area in which European breeders have to compete with oversea competitors. Although we are not fully aware what the competition is doing, it is known that for example a large breeding company in the US is working on an 'in planta' detoxification strategy for Fusarium toxins in maize applying genetic engineering. We think, however, that the resistance strategies proposed by this EUREKA Consortium are superior to any detoxification, because it prevents the initial infection of plants thus averts mycotoxin production and helps to control spreading of Fusarium. Close collaboration between molecular geneticists, quantitative geneticists, and practical breedersin this project will ensure the direct transfer of know-how from more basically oriented research to practical breeding. Immediate transmission of all research results into practical breeding is warranted due to ongoing activities of the partners in maize and wheat breeding and the tight networking among all partners. LIMAGRAIN, GEIE NICKERSON, RAGT, KWS and LOCHOW-PETKUS have excellent populations/ germplasms available and many years' experience in marker-assisted breeding and genetic engineering of cereals. Rapid introgression of relevant alleles into elite varieties will be achieved by marker-assisted breeding and genetic engineering. The results of the programme will be beneficial for breeders, farmers and end-consumers.

Project codes

BSI

AK	research
BX/BY	biological analysis and testing
C/E	science
EN/EZ	biology
HB/HV	agriculture

NACE

01	Agriculture, hunting and related service activities
7310	Research and experimental development on natural sciences

NACE

and engineering

3. Main participant

Company	**BIOGEMMA S.A.S.** Edouard Colonne, 01 750 01Paris FRANCE Tel +33 1 55 34 94 02 Fax +33 1 55 34 94 01 www.limagrain.com
Contact	**DR. MICHEL DEBRAND** General Manager Tel Fax michel.debrand@biogemma.com
Organisation type	Large company
Participant role	Main

Contribution to project

Will manage the programs dealing with corn resistance to pests and disease. It will be the leader as regards paint resistance to ear rot.

Expertise

4. Partner

Company	**INRA/INSA LYON BIOLOGIE 406** (Cedex) Batiment 401, Avenue Albert Einstein, 20 696 21Villeurbanne FRANCE Tel +33 4 72 43 84 76 Fax +33 4 72 43 85 34 www.inra.fr
Contact	**MR. YVAN RAHBE** Tel Fax rahbe@jouy.inra.fr
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Their laboratory will carry out extensive preliminary screening of maize and graminaeae seeds for the isolation of peptides with anti-fungal activities.

Expertise

4. Partner

Company **KWS SAAT AG**
Grimsehlstrasse, 31
37555Einbeck
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www.kws.de

Contact **DR. GUENTHER STRITTMATTER**
Head Of Research And Breeding

Tel +49 5561 311 481
Fax

g.strittmatter@kws.de

Organisation type Large company
Participant role Partner

Contribution to project

It will coordinate the projects on: (i) 'silage maize digestibility' and (ii) 'N-use efficiency in maize'.

Expertise

4. Partner

Company **MAX-PLANK-INSTITUT FUER ZUECHTUNGSFORSCHUNG**
Carl-Von-Linne-Weg, 10
50829Koeln
GERMANY

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Contact **DR. PAUL SCHULZE-LEFERT**
Director Mpiz (1.8)

Tel
Fax

schlef@mpiz-koeln.mpg.de

Organisation type Research Institute
Participant role Partner

Contribution to project

Paul Schulze-Lefert's objective will be the generation of synthetic, pathogen-responsive promoters in grasses that exhibit novel spatio-temporal gene activation patterns at sites of attempted pathogen infection.

Expertise

4. Partner

Company **BAYRISCHE LANDESANSTALT F. BODENKULTUR UND PFLANZENBAU PZ6B**
Voettingerstrasse, 38
85354Freising
GERMANY

Tel +49 8161 714 065
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www.lbp.bayern.de

Contact **DR. LORENZ HARTL**
Laborleiter

Tel
Fax

lorenz.hartl@lbp.bayern.de

Organisation type Research Institute
Participant role Partner

Contribution to project

QTL mapping: The two winter wheat populations each with 160 to 170 lines will be increased to F8- and F9-. derived recombinant inbred lines during Summer 2000.

Expertise

4. Partner

Company	**UNI.HOHENHEIM/FORSCH.SCHWERPUNKT BIOTECH.U.PFLANZENZUECHTUNG** Fruwirthstrasse, 21 70599Stuttgart GERMANY Tel +49 711 459 2690 Fax +49 711 459 3841 www.uni-hohenheim.de/i3v/00000700/00320041.htm
Contact	**DR. THOMAS MIEDANER** Project Leader Tel Fax miedaner@uni-hohenheim.de
Organisation type	University
Participant role	Partner

Contribution to project

Will field test a total of 1,500 lines in 2,300 field plots at UH with artificial inoculation during mid- flowering, multiple ratings of the disease symptoms and harvest representative grain samples.

Expertise

4. Partner

Company	**BAYRISCHE LANDESANSTALT F. BODENKULTUR UND PFLANZENBAU PZ4A** Voettingerstrasse, 38 85354Freising GERMANY Tel +49 8161 713 633 Fax +49 8161 714 305 www.lbp.bayern.de
Contact	 Tel

Fax

Organisation type Research Institute
Participant role Partner

Contribution to project

Will carry out field trials, organise and conduct chemical analyses, develop Near-Infrared-Reflection-Spectroscopy NIRS) calibrations and perform statistical analyses of data from field trials and map QTLs.

Expertise

4. Partner

Company

MUT - LEHRSTUHL FUER PFLANZENBAU UND PFLANZENZUECHTUNG TECHNISCHE UNIVERSITAET MUENCHEN
Arcisstrasse, 21
80333Muenchen
GERMANY

Tel
Fax

Contact

Tel
Fax

Organisation type University
Participant role Partner

Contribution to project

In more detail, Dr. habil. Thomas Luebberstedt will assist detection and characterization of QTL for silage quality traits in four different, double-haploid or recombinant inbred line mapping populations.

Expertise

4. Partner

Company

H.HEINE UNIV./LEHRS.ENTWICK.U.MOLEKULARBIOLOGIE DER PFLANZEN HEINRICH HEINE UNIVERSITAET
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Contact **PROF. DR. PETER WESTHOFF**
Lehrstuhl Entwicklungs-U. Molekularbiologie Der Pflanzen

Tel +49 211 811 2338
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west@uni-duesseldorf.de

Organisation type University
Participant role Partner

Contribution to project

The laboratory of the PI includes all the needed equipment to perform first-rate molecular biological studies. The PI has longstanding experience in the molecular biology and genetics of plants.

Expertise

4. Partner

Company **LIMAGRAIN GENETICS GRANDES CULTURES S.A.**
Avenue Des Landais, 24
631 70Aubiere
FRANCE

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Contact **MS. NATHALIE FOISSET**

Tel +33 4 73 42 79 72
Fax +33 4 73 27 57 36

nathalie.foisset@limagrain.com

Organisation type Large company
Participant role Partner

Contribution to project

The company possesses expertise in conventional plant breeding and in biotechnology applied to plant breeding (routine use of RFLP, AFLP, SSR construction of genetic maps and DNA markers for MAS).

Expertise

4. Partner

Company	**EURALIS SEMENCES S.A.** (Not Available), 642 30Lescar FRANCE Tel +33 5 62 13 64 14 Fax +33 5 62 13 64 13 www.euralis.fr
Contact	**MR. PATRICK VINCOURT** Tel Fax
Organisation type	Large company
Participant role	Partner

Contribution to project

Will prepare several crosses for QTL of resistance analysis in corn and also characterize these QTLs and determine a set of tightly linked markers that they will use in a MAS approach.

Expertise

4. Partner

Company	**NICKERSON INTERNATIONAL RESEARCH GEIE** Rue De L'Egalite, 05 281 30Chartainvilliers FRANCE Tel +33 2 37 32 70 02 Fax +33 2 73 32 41 22 www.limagrain.com
Contact	**MR. PASCAL FLAMENT** Tel

Fax

pascal.flament@limagrain.com

Organisation type Large company
Participant role Partner

Contribution to project

Will produce the crosses/segregating population of spring and winter wheat genotypes (dihaploid lines); field evaluation of disease resistance of these to fusarium will allow QTLs to be mapped and markers to be developed.

Expertise

4. Partner

Company **UNIV. PARIS-SUD/INSTITUT DE BIOTECHNOLOGIE DES PLANTES UNIVERSITE PARIS-SUD ORSAY**
(Cedex) Batiment 630,
914 05Orsay
FRANCE

Tel +33 1 69 33 36 67
Fax +33 1 69 33 36 37

Contact

Tel
Fax

Organisation type University
Participant role Partner

Contribution to project

Their task will be to isolate candidate genes and map them on QTLs. It will also screen ESTs libraries to select clones specific to the interaction between resistant corn lines and fusarium.

Expertise

4. Partner

Company **INRA NANTES UNITE DE BIOCHIMIE ET DE TECHNOLOGIE D.PROTEINES INSTITUT NATIONAL DES RECHERCHES**

AGRONOMIQUES
(Not Available),
443 16Nantes
FRANCE

Tel +33 2 40 67 50 32
Fax +33 2 40 67 50 25

www.inra.fr

Contact **MR. THIERRY GUEGUEN**

Tel
Fax

gueguen@nantes.inra.fe

Organisation type Research Institute
Participant role Partner

Contribution to project

Will purify peptides/proteins having biological activity; anti-fungal peptides/proteins of mycotoxins biosynthesis. Micro-sequence these peptides to design specific oligo- nucleotide primers necessary to isolate full coding sequence

Expertise

4. Partner

Company **INRA ANTIBES PHYTOPATHOLOGIE INSTITUT NATIONAL DES RECHERCHES AGRONOMIQUES**
(Not Available),
066 06Antibes
FRANCE

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Contact **MR. ERIC GALIANA**
Head Of Group

Tel
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galiana@salis.antibes.inra.fr

Organisation type Research Institute
Participant role Partner

Contribution to project

Will use peptidic extracts from corn to evaluate their biological activities against fusarium sp. and other corn pathogens.

Expertise

4. Partner

Company	**INSTITUT NATIONAL AGRONOMIQUE PARIS-GRIGNON (INA-PG)** (Not Available), 780 26Versailles FRANCE Tel Fax www.inra.fr
Contact	**PROF. FREDERIC MARION-POL** Proferssor Of Zoology Tel Fax marion-pol@rsbs.anu.edu.au
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Will screen different germplasm for their ecdysteroid content and then determine the pattern of activity of these hormone-like products against insect pests of corn.

Expertise

4. Partner

Company	**UNIVERSITE DE PARIS/DEPARTEMENT DE BIOLOGIE UNIVERSITE DE PARIS VI** Rue D'Ulm, 46 750 05Paris FRANCE Tel +33 1 44 32 36 39

Fax +33 1 44 32 39 10

Contact **MR. RENE LAFONT**

Tel
Fax

rlafont@biologie.ens.fr

Organisation type University
Participant role Partner

Contribution to project

Will work on screening for ecdysteroid content in collaboration with INS-PG.

Expertise

4. Partner

Company **RAGT S.A.**
(Not Available),
120 33Rodez
FRANCE

Tel +33 5 65 73 41 00
Fax +33 5 65 73 41 98

Contact **MR. CLAUDE GRAND**

Tel
Fax

cgrand@ragt.fr

Organisation type Large company
Participant role Partner

Contribution to project

Leader of the silage quality improvement programme. It will analyse populations of maize exhibiting different characteristics and then characterize the QTLs of this trait and validate the involvement of candidate genes.

Expertise

4. Partner

Company	**INRA - UNITE GENETIQUE AMELIORATION DES PLANTES FOURRAGERES INSTITUT NATIONAL DES RECHERCHES AGRONOMIQUES** Route Des Saintes, 79Lusignan FRANCE Tel +33 5 49 55 60 32 Fax +33 5 49 55 60 03 www.inra.fr
Contact	**MR. YVES BARRIERE** Directeur De Recherche Tel Fax barriere@lusignan.inra.fr
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Will perform silage quality analysis on ingestibility and develop a specific method for the reliable measurement of this trait. They will also provide the data for the QTL analysis of ingestibility.

Expertise

4. Partner

Company	**SAATZUCHT DONAU GESMBH & CO KG (SZD)** Saatzuchtstrasse, 11 2301Gross Enzersdorf AUSTRIA Tel +43 2215 248 133 Fax +43 2215 248 139
Contact	**MR. JOHAN BIRSCHITZKY** Tel +43 2215 248 130 Fax johann.birschitzky@saatzucht-donau.at

Organisation type SME
Participant role Partner

Contribution to project

Will contribute to the project with the help of molecular markers for resistance QTLs originating in exotic, i.e. not well adapted spring wheat varieties.

Expertise