EU Concerted Action
'Genetic Improvement of Functional Traits in cattle' (GIFT)
Annual report 1997

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1. Introduction

The recognition of the importance of functional traits in cattle (health, fertility, metabolic stress, longevity; Groen *et al*., 1997), and the possible role of animal breeding in avoiding deterioration and possibly improving functional traits has lead to research activities in many EU countries. Research focuses on tool development (unambiguous trait definition, reliable trait recording and proper evaluation procedures) and tool implementation (optimisation of breeding programmes including production and functional traits). The current state of the art in these areas was reviewed at a workshop in Gembloux (INTERBULL bulletin no. 12, 1996). At this workshop it was decided to apply for EU subsidies to organise an international concerted action on genetic improvement of functional traits in cattle to stimulate an efficient use of resources for scientific work. The EU subsidies were granted and the 3-year concerted action was started January 1997. The objectives of the GIFT concerted action are:

- to bring together researchers and people from breeding organisations from member countries of the EU, and other countries with major interests in cattle production, to develop concepts for breeding of functional traits by defining breeding goals and strategies to achieve the goals;
- to enhance collaborative efforts for the further development of efficient recording systems and breeding value estimation procedures;
- to stimulate the exchange of existing knowledge about the genetic evaluation of functional traits;
- to develop recommendations for breeding programmes for functional traits.

Three main activities are organised to accomplish the objectives of the EU concerted action GIFT:

1. workshops: four initial workshops on definition, recording and genetic evaluation of traits related to the following groups of functional traits: health, fertility and reproduction, metabolic stress, longevity; an intermediate report workshop and a final report workshop;
2. visits: short visits for exchange of computer programs, inspection of

recording systems; longer visits for enhancement of collaborations on the development of programs/systems;
3. internet activities: installation of a home page.

This intermediate report summarises the activities in the first year, 1997, of the EU concerted action GIFT. A draft version of the report was discussed at the intermediate report workshop in Warsaw, August 23rd 1998, and recommendations were approved by the participants.

2. Activities

2.1. Initial workshop on health, Uppsala, June

43 participants attended the GIFT-workshop from 17 countries (see Appendix 1). A total of 20 papers was presented; for the programme, please see proceedings INTERBULL bulletin no. 15. Ruane *et al.* gave an overview of numbers of veterinarian treatments in Norway. They found that 53 % of all treatments were related to the mammary system (mastitis) and only about 2 % to laminitis and hoof infection. McDaniel pointed out that feet and leg diseases are often subclinical or not treated. The workshop on health of dairy cattle concentrated on these disorders: mastitis and locomotive disorders. Other causes of veterinarian treatments, reproductive disorders (10 %), disorders related to birth (8 %) and metabolic disorders (25 %) will be considered in two subsequent GIFT workshops.

Mastitis

Mastitis is an infection of the udder (mammary gland) mostly caused by bacteria. Three groups of pathogens are predominant causes for mastitis (Schukken): E. coli, S. aureus and nonagalactic streptococci. The pathogens produce different infection patterns, E. coli causing predominantly isolated clinical cases and S. aureus resulting mostly in subclinical and chronic infections. Streptococci produce an intermediate pattern. Heritable components of mastitis resistance are related to prevention of infection (opening of teat channel) and to immune response. Two types of immunity are distinguished (Schukken): innate immunity (primarily though macrophages) and adaptive immunity (lymphocytes). Possible selection criteria are clinical events of mastitis, somatic cell count (SCC) of the milk, udder conformation traits and markers of immune response. The first two criteria will be considered in more detail. Udder conformation traits will be of value in complementing genetic evaluations based on clinical mastitis and/or SCC.

Clinical mastitis is currently recorded and used for selection decisions in the four nordic countries (Table 1). The events of clinical mastitis recorded are veterinary treatments and culling of cows for mastitis. The reporting system may either be through the personnel of the milk recording scheme based on on-farm information systems (health cards) or directly through the veterinary service (Ruane *et al*.). The study of Heringstad *et al.* suggests that inclusion of cases of mastitis immediately before calving is important. The period of time should not encompass the full length of lactation to avoid inclusion of preventive treatments at the end of lactation. The time span from -10 days to [120-200] days of lactation was recommended by the workshop as optimal. Repeated events of mastitis (treatment or culling) are normally not treated separately.
The genetic model recommended for breeding value evaluation is a threshold sire model or a linear animal model. Genetic correlations of mastitis from different lactations (Luttinen and Juga) seem to be relatively high (around .9), and therefore the use of a repeatability model

seems to be preferable to treating mastitis in different lactations as different traits.

Table 1. Mastitis and somatic cell count. Recording (R) and Evaluation (E) by country (with a delegate participating in the Uppsala workshop).

Country	**Mastitis**	**Somatic Cell Count**
Germany		R/E
France		R/E
Finland	R/E	R/E
Denmark	R/E	R/E
Sweden	R/E	R/E
Netherlands		R/E
Spain		R
Belgium		R
Italy		R/(E)
USA		R/E
Czech Republic		R
Austria		R/E
Greece	(R)	R
Norway	R/E	R
United Kingdom		R/E
Canada		R/E
Ireland		R

Somatic cell count is routinely recorded in all GIFT member countries (Table 1), genetic evaluations are carried out in about half of these countries. The recording of somatic cell counts is nowadays mostly performed routinely on the milk samples used to measure fat and protein contents of milk from individual cows in the national milk recording schemes. In some countries this information is not stored into the cow-related databases so that the information is lost. The immediate suggestion fore these countries is to include the SCC information in their databases. The definition of a genetic trait from individual test day records is not straightforward. Different patterns of test day SCC during lactation point to different problems (clinical or subclinical mastitis) (Schukken).

Evaluation procedures for somatic cell count are run in only about half of the GIFT member countries, with two types of models currently used (one based on lactation "averages" and one on individual test day data). "Lactation average" models do not necessarily use the (weighted) mean of the SCS of single test days in a lactation, it could also be some function of SCS pointing to either clinical or subclinical mastitis. Models based on the results of individual test days have the advantage of accounting for short-term environmental effects like age of sample, calibration of measurement equipment, infection pressure in the herd. Programs for test-day models are currently being developed in Finland (single lactation) and Germany (multiple lactation).

The participants of the workshop defined the following areas of future research:

- Relationship between mastitis and somatic cell count: types of mastitis

(clinical - subclinical, linearity of the relationship

- Relationship between mastitis and udder conformation;
- Trait definition: binary vs. more detailed trait including the epidemiology, first vs. later lactations, genotype-environment-interaction for mastitis;
- Evaluation models: test day vs lactational model, and inclusion of environmental effects.

The participants recommended the inclusion of somatic cell score into the scheme of the national evaluations and also the international INTERBULL evaluations. Especially for traits with lower heritability, use of information from several countries should increase the accuracy of the individual sire proofs. It was recommended that all countries should try to work out a selection index for mastitis resistance based on direct (disease incidence) and indirect information (somatic cell count, udder conformation traits, milking speed), in order to obtain reliable selection tools.

The structure of the dairy industry in many countries is certainly going to change, as a result of

(1) the implementation of new milking technology (i.e., robot milking, with the possibilities of other and more frequently measured variables related to e.g. subclinical mastitis incidence),
(2) other ideas on the ownership of data recorded at farms (i.e., privately owned by farmer and available for e.g. genetic evaluations only after payment), and (3) more international breeding organisations (i.e., international testing of sires). These developments should enforce breeding organisations to be much more involved themselves in what type of information they want to be recorded on the farms where they test their sires, especially in the area of functional traits.

Locomotive disorders (Feet and leg problems)

Infections of the hoof cause much pain to cattle and reduce animal welfare. Such infections are also responsible for impaired production and reproduction of cows. The heritable causes for foot and leg problems may be divided in two groups: metabolic causes and anatomic causes (structure of body parts). Little is known about the metabolic causes and more research should be devoted to this area. Currently selection can be based either on the structure of the individual, on observed cases of lameness or on the way a cow moves when being healthy (locomotion). One important point to note is that about 90 % of lameness in dairy cattle is associated with the claws (McDaniel). Four types of records can be routinely collected to support breeding value estimation: incidence of veterinarian treatment for lameness, locomotion scores (lameness is "negative locomotion"), conformation scores, and hoof and claw measurements. Table 2 summarises recording of conformation scoring in different countries.

The definition of the breeding goal trait is difficult; Boelling defined it to be good locomotion, no lameness and avoidance of claw diseases. Concentration on clinical cases of lameness is not advisable as many cases of subclinical lameness have an impact on the profitability and welfare of a cow.

Different systems exist for scoring locomotion, whereas the scoring of conformation traits is well standardised between countries and breeds (by federations of herd books). Foot angle and rear legs, rear view are the conformation traits that have the highest correlation to feet and legs problems. With regard to hoof and claw measurements, rear claw diagonal seems to be the best possibly in combination with length and angle of the claw.

Participants were encouraged to push introduction of recording systems for claw measurements and, especially, locomotion in their countries.

Table 2. Recording of conformation on linear feet and legs traits (data collected by classifiers) by country (with a delegate participating in the Uppsala workshop).

Country	**Bone/leg quality**	**Rear leg set, side or rear view**	**Claw traits**	**Locomotion**
Germany	x	rear	x	-
France	-	side	x	-
Finland	-	rear/side	x	-
Denmark	x	rear	x	-
Sweden				
Netherlands				
Spain	x	rear	x	(x)[i]
Belgium	-	side	x	-
Italy	x	side	-	-
USA	x	side	x	x
Czech Republic	-	-	-	-
Austria	-	-	-	-
Greece	-	-	-	-
Norway	(x)	rear	x	-
United Kingdom	-	side	x	(x)
Canada	x	side	x	-
Ireland	-	side	x	-

[1] included in overall, subjective feet and legs score

2.2. Initial workshop on fertility and reproduction, Grub, November

42 participants from 18 countries attended the GIFT-workshop from 18. A total of 21 papers was presented; please see INTERBULL bulletin no. 18. The workshop focussed on calving performance and stillbirth, and on female fertility. Main papers included statistical backgrounds on threshold models for categorical traits (Foulley) and physiological aspects of female fertility (Van der Lende). During the workshop, surveys were circulated to get a good overview on the current status of recording calving performance and stillbirth (see Tables 3 and 4).

Calving performance and stillbirth

Calving performance and stillbirth are important traits, not only because of the loss of the calf, but also because of their effects on well being and productive performance of the dam. The significance of stillbirth was heavily discussed; there is evidence of an unfavourable trend in the incidence of stillbirths, especially for first calvings (Philipsson).

It was recommended by the workshop that both calving performance and stillbirth recording schemes should be implemented in dairy cattle breeding programmes, either for routinely (public) evaluation of bull or for (internal) monitoring of genetic trend in the breeding population. Recording of calving performance and stillbirths should be for all parities. An international standard definition of stillbirth was recommended (dead within 24 h after parturition, but

recording fully developed foetus only). More research is recommended on the optimum number of categories for recording categorical traits like calving performance, especially with respect to the effects of misclassification.

The evaluation of calving performance should include both the direct effect (bull as sire of the calf) and the indirect (maternal) effect (bull as sire of the dam), preferably using an animal model. The use of threshold models for evaluation is recommended, especially in situations with heterogeneous variances over fixed effect classes. Evaluation of calving performance should be performed without including gestation length as a (fixed) effect in the model; preferably a multiple trait evaluation of calving performance, gestation length and birth weight is implemented.

Research on the absolute and relative size or maturity of the animal in relation to calving performance was advocated, also because the size of the animal is currently widely discussed in relation to efficiency of production and metabolic stress (negative energy balance).

Female fertility

Trait definition for female fertility should be based on physiological processes. Pulsatory release of GnRH plays an important role in initiation of maturation (puberty) and in the onset of cyclicity in mature cows after parturition. Therefore, the interval from parturition to first ovulation should be routinely evaluated, rather than the currently used interval from parturition to first insemination or interval from parturition to conception (days open). However, routinely, wide-scale measurement of this interval from parturition to first ovulation is still not feasible. Milk progesteron patterns seem to be a promising tool for measuring the interval from parturition to first (Veerkamp *et al.*, Darwash). As the percentage of fertilised oocyts is very high (>90%), important factors determining (apparent) in-fertility of cows are the embryonic development and the maternal recognition of the embryo. The participants recommended that more research on these factors should be encouraged, particularly in relationship to the inbreeding of the dam and the embryo and other non-additive genetic effects. Other identifiable factors for underlying physiological processes are ovarian patterns, silent ovulation, and inter luteal intervals; more research is needed to develop indicators that can be routinely measured on farms. Researchers are now starting to identify specific genes that show multiple alleles, responsible for variation in female fertility.

Many countries still not have a genetic evaluation for female fertility. It was advised, that for female fertility at least to traits should be evaluated: (1) interval from parturition to first insemination or days open, and (2) non-return rate. The first trait is an indicator of observable cyclicity of the cow, and the second trait is an indicator of the probability of becoming pregnant at insemination. Rather than using separate, single trait evaluations for these traits with corrections for other (poor) fertility traits in the model, a bivariate analyses was advocated by the workshop. Over countries different intervals are used for evaluating non-return rate; setting a standard was recommended, with prevalence for 56-days non-return rate. The evaluation of female fertility should include a correction for service sire, preferably with a specification of batch of sperm collection.

Table 3. Calving performance recording and evaluation by country (with a delegate participating in the Grub workshop).

Country	**Recording**		**Genetic Evaluation**				
	yes/no if yes, way	Definition trait	Sire trait	Maternal trait	Heifer-calvings	Cow-calvings	Non-genetic effects considered
Germany	Yes, milk recording	(0/1) Dead or alive after 24 h of birth	Yes	Yes	1 trait		herd*year, season, parity, sex of calf, calving age (1st, 2nd par)
France	not exhaustive yes, but almost, through milk recording	(0/1) Dead or alive after 48 h of birth	Yes	Yes	1 trait		Threshold model, hys, age of dam, sex, month*parity
Finland	Yes, milk recording	(0/1) Dead or alive after 24 h of birth	Yes	Yes	1 trait		herd*year, sex, month, calving age (heifers)
Denmark	Yes, milk recording, compulsary	4 scores converted to dead within 24 h or alive in ealuation	Yes	Yes	Yes	Yes	herd*year, season, sex, age of dam, heterosis
Sweden	Yes, milk recording	(0/1) Dead or alive after 24 h of birth	Yes	Yes	Yes	Yes	herd*year, season , sex parity, calving age
Netherlands	Yes, on calves born from young test bulls	(0/1) Dead or alive after 24 h of birth	Yes	Yes	No	Yes	herd, parity*breed of dam, breed sire, month of calving
Spain	Yes, milk recording, but not exhaustive	Dead or alive	No	No	No	No	No
Belgium	No	-	-	-	-	-	-
Italy	Yes, milk recording	(0/1) Dead or alive after 24 h of birth	No	No	No	No	No
USA	Yes, milk recording+ farm data on sheets	alive dead at birth dead within 48 h	No	No	No	No	No
Czech Rep.	Yes, veterinarian service for test bulls	Born dead Loss within days	simple test young bulls	-	-	-	-
Switzerland	Yes, form filled in by farmers for young bulls	(0/1) dead or alive within 24 h after birth	Yes	No	1 trait >90% cows		parity, sex of calf, region, season
Austria	Yes, milk recording	(0/1) dead or alive within 48 h after birth	starting Feb ‘98	starting Feb ‘98	1 trait		herd*year, season, parity, sex, calving age, perm.env.
Greece	No	-	-	-	-	-	-
Norway	Yes, milk recording	dead/alive	Yes	Yes	Yes	No	year*region, sex, parity
Ireland	Yes, forms filled by AI company personnel	(0/1) dead or alive within 48 h after birth	Yes	No	Yes	Yes	year*region, sex, age of dam, breed dam and sire

Table 4. Still birth recording and evaluation by country (with a delegate participating in the Grub workshop).

Country	**Evaluation yes/no**	**Way of recording**	**Trait definitions**					
			Direct (sire of calf)	Indirect (sire of dam)	Parities	Model	Non-genetic factors in model	
Germany	Yes	Milk recording	x	x	All	A, linear	hys, sex of calf, parity/age of dam perm.env	
France	In preparation '98/'99	Milk recording	x	x	All	S+MGS, threshold	herd*year (random) month, parity/age of dam	
Finland	No	-	-	-	-	-	-	
Denmark	Yes	Milk recording (80% recorded)	x	x	All	S+MGS	hys, sex of calf, parity, breed, heterosis	multitrait with stillbirth and calf size
Sweden	Yes	Milk recording	x	x	All	S+MGS	hys, age of dam	
Netherlands	Yes	Calvings of daughters young bulls Form filled in by farmers	x	x	All, mainly 2nd	S+MGS	hys, parity, breed cow, sex of calf, calving month	
Spain	Yes, north Spain	Milk recording	x	-	All	S	herd*year, month, sex, parity	
Belgium	? in the north	Milk recording	-	-	-	-	-	
Italy	Yes	Milk recording	x	-	All	S	?	in preparation
Czech Rep.	Yes/No	Stillbirth/calving difficulty	x	-	All	S	-	only frequency
Schwitzerland	Yes	Form filled in by farmers for young bulls	x	-	All, >90% cows	S	parity, sex of calf, region, season	multitrait with stillbirth
Austria	Yes	Milk recording	x	x	All	A , linear	herd*year, season,sex of calf, parity, age of dam, perm.env.	
Greece	No	-	-	-	-	-	-	
Norway	Yes	Milk recording	x	x	1st	S	herd, calving month	
Ireland	Yes	AI company personnel	x	-	All	S	year*region, sex of calf, age of dam, breed dam and sire	

2.3 Visits

In 1997, the EU concerted action GIFT financially supported 7 short visits, in which 10 institutes were involved. Three visits focussed at the evaluation of longevity, using survival analysis, and two visits more generally looked at possibilities of co-operation and sharing knowledge and data in the area of genetic improvement of functional traits. Most support was given to young scientist, i.e. PhD students and PostDocs.

- A.R. Vollema (PhD, WAU, Netherlands) to Dr J. Jensen (Foulum, Denmark) - use of Survival Kit for evaluation of longevity
- M.H. Pool (PhD, ID-DLO, Netherlands) to Dr E. Santus (Verona, Italy) - test day models
- Dr N. Vukasinovic (PostDoc, ETH, Switzerland) to Dr V. Ducrocq (INRA, France) - use of Survival Kit for evaluation of longevity
- Dr A.F. Groen and A.R. Vollema (PhD, WAU, Netherlands) to Dr N. Gengler (Gembloux, Belgium), contacts and co-operation on research in the area of functional traits
- Dr G. Greally (Irish Dairy Records Co-operative, Ireland) to several persons in Edinburgh (UK) - exchange of ideas on recording and evaluation of functional traits
- N. Charfeddine (PhD, INIA, Spain) to Dr A.F. Groen (WIAS, Netherlands) - derivation of economic value for somatic cell count
- Dr P. Visscher (Edinburgh, UK) to Dr V. Ducrocq (INRA, France) - future research in the area of evaluation of longevity

2.5. Home page

Directly after the start of the EU concerted action GIFT, an internet home page was established by the Department of Livestock Sciences, University of Agricultural Sciences (BOKU), Vienna. The home page can be assessed at the following address:

http://www.boku.ac.at/nuwi/gift

The home page gives entrance to a lot of information on the EU concerted action GIFT:

- general information (Technical Annex of the EU proposal),
- list of all participating institutes and contact persons,
- possibility of assigning as 'interested person' to receive regular mailings,
- information on forthcoming activities (including registration forms),
- reports on activities.

3. Conclusion

The EU concerted action 'Genetic Improvement of Functional Traits in cattle' (GIFT) has been very successful in its first year. Presentations and discussions during the first two initial workshops have stimulated a further development of accurate genetic evaluations for functional traits. Recommendations were put forward for improving and standardising national and international recording and evaluation of mastitis, somatic cell count, feet and legs problems, female fertility, calving performance and stillbirth. Inclusion of partners from both research and breeding organisations gives a short time lag from development to implementation of breeding value estimation programs. Partnership of INTERBULL facilitates a world-wide distribution of the proceedings and results of the EU concerted action GIFT. We are happy to notice that we are

establishing co-operation with well recognised organisations as the EAAP, BSAS and ICAR, for both the organisation of forthcoming workshops and the presentation of the results of the EU concerted action GIFT.

It is believed, that the EU concerted action GIFT contributes to a sustainable development of cattle production systems, improving animal welfare, improving consumers' acceptance of products and production systems ("healthy food from healthy animals") and facilitating international trade of genetic material.

References

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INTERBULL bulletin no. 12, 1996. Proceedings International Workshop on Genetic Improvement of Functional Traits in cattle, Gembloux, Belgium, January 1996, 245 pp.

INTERBULL bulletin no. 15, 1997. Proceedings International workshop on Genetic Improvement of Functional traits in cattle; Health, Uppsala, Sweden, June 1997, 141 pp.

INTERBULL bulletin no. 18, 1997. Proceedings International workshop on Genetic Improvement of Functional traits in cattle; Fertility and Reproduction, Grub, Germany, November 1997, 116 pp.

APPENDIX 1. PARTICIPANTS TO THE GIFT WORKSHOP ON HEALTH, JUNE 8-10, 1997, UPPSALA

Name	Residence	GIFT Institute
1. Groen, Ab	Wageningen, Netherlands	WAU (1)
2. Banos, Georgios	Uppsala, Sweden	INTERBULL (2)
3. Philipsson, Jan	Uppsala, Sweden	INTERBULL (2)
4. Fikse, Freddy	Uppsala, Sweden	INTERBULL (2)
5. Sölkner, Hans	Vienna, Austria	BOKU (3)
6. Gengler, Nicolas	Gembloux, Belgium	FUSAGx (4)
7. Boettcher, Paul	Guelph, Canada	UoG (5)
8. Kelton, Dave	Guelph, Canada	UoG (5) Invited speaker
9. Pribyl, Josef	Prague, Czech Republic	VUZV (6)
10. Boelling, Dorothee	Tjele, Denmark	DIAS (7)
11. Greally, Gerry	Dublin, Ireland	IDRC (8)
12. Boichard, Didier	Jouy-en-Josas, France	INRA (9)
13. Rupp, Rachel	Jouy-en-Josas, France	INRA (9)
14. Luttinen, Pirkko	Vantaa, Finland	FABA (10)
15. Juga, Jarmo	Vantaa, Finland	FABA (10)
16. Aumann, Hans	Grub, Germany	BLT (11)
17. Chatziplis, Dimitrios	Thessaloniki, Greece	AUTH (13)
18. Heringstad, Björg	Ås, Norway	NLH (15)
19. Klemetsdal, Gunnar	Ås, Norway	NLH (15)
20. Ruane, John	Ås, Norway	NLH (15)
21. Strandberg, Erling	Uppsala, Sweden	SLU (17)
22. Berglund, Britt	Uppsala, Sweden	SLU (17)
23. Ral, Gunilla	Uppsala, Sweden	SLU (17)
24. Rehn, Harriet	Uppsala, Sweden	SLU (17)
25. Roth, Anki	Uppsala, Sweden	SLU (17)
26. Danell, Birgitta	Uppsala, Sweden	SLU (17)
27. Sigurdson, August	Uppsala, Sweden	SLU (17)
28. Bergsten, Christer	Skara, Sweden	SLU (17)
29. Manske, Thomas	Skara, Sweden	SLU (17)
30. De Jong, Gerben	Arnhem, Netherlands	NRS (18)
31. Sander Nielsen, Ulrik	Århus, Denmark	DAAC (22)
32. Pösö, Jukka	Jokioinen, Finland	MTT (24)
33. Reents, Reinhard	Verden, Germany	VIT (25)
34. Pryce, Jennie	Edinburgh, UK	SAC (27)
35. Veerkamp, Roel	Edinburgh, UK	SAC (27)
36. Steine, Torstein	Ås, Norway	NRF (30)
37. Charffedine, Noureddine	Madrid, Spain	INIA (32)
38. Emanuelson, Ulf	Eskilstuna, Sweden	SHS (33)
39. Bratt, Gunilla	Eskilstuna, Sweden	SHS (33)
40. Detilleux, Johann	Liege, Belgium	ULG (35)
41. McDaniel, Ben	Raleigh, USA	Invited speaker
42. Schukken, Ynte	Utrecht, Netherlands	Invited speaker
43. Cassandro, Martino	Cremona, Italy	Paying guest

APPENDIX 2. PARTICIPANTS TO THE GIFT WORKSHOP ON FERTILTIY AND REPRODUCTION, NOVEMBER 23-25, 1997, GRUB

Name	Residence	GIFT Institute
1. Groen, Ab	Wageningen, Netherlands	WAU (1)
2. Van der Lende, Tette	Wageningen, Netherlands	WAU (1) Invited speaker
3. Philipsson, Jan	Uppsala, Sweden	INTERBULL (2)
4. Sölkner, Hans	Vienna, Austria	BOKU (3)
5. Birgit Fuerst-Wahl	Vienna, Austria	BOKU (3)
6. Fuerst, Christian	Vienna, Austria	BOKU (3)
7. Miesenberger, Josef	Vienna, Austria	BOKU (3)
8. Gengler, Nicolas	Gembloux, Belgium	FUSAGx (4)
9. Pribyl, Josef	Prague, Czech Republic	VUZV (6)
10. Barton, Ludek	Prague, Czech Republic	VUZV (6)
11. Czermak, Vaclav	Prague, Czech Republic	VUZV (6)
12. Greally, Gerry	Dublin, Ireland	IDRC (8)
13. Boichard, Didier	Jouy-en-Josas, France	INRA (9)
14. Ducrocq, Vincent	Jouy-en-Josas, France	INRA (9)
15. Foulley, Jean-Louis	Jouy-en-Josas, France	INRA (9) Invited speaker
16. Hyppänen, Kaija	Vantaa, Finland	FABA (10)
17. Aumann, Hans	Grub, Germany	BLT (11)
18. Averdunk, Gottfried	Grub, Germany	BLT (11)
19. Nibler, Thomas	Grub, Germany	BLT (11)
20. Abas, Zaphiris	Thessaloniki, Greece	AUTH (13)
21. Andersen-Randberg, Ina	Ås, Norway	NLH (15)
22. Strandberg, Erling	Uppsala, Sweden	SLU (17)
23. Roth, Anki	Uppsala, Sweden	SLU (17)
24. Steinbock, Lena	Uppsala, Sweden	SLU (17)
25. De Jong, Gerben	Arnhem, Netherlands	NRS (18)
26. Kaal-Lansbergen, Lucia	Arnhem, Netherlands	NRS (18)
27. Veerkamp, Roel	Lelystad, Netherlands	ID-DLO (19)
28. Pedersen, Jorn	Århus, Denmark	DAAC (22)
29. Niskanen, Seppo	Jokioinen, Finland	MTT (24)
30. Pasman, Erik	Verden, Germany	VIT (25)
31. Reinhardt, Fritz	Verden, Germany	VIT (25)
32. Roughsegde, Tom	Edinburgh, UK	SAC (27)
33. Alday, Sofia	Madrid, Spain	Conafe (31)
34. Emanuelson, Ulf	Eskilstuna, Sweden	SHS (33)
35. Moll, Jürg	Zürich, Switzerland	ETH (34)
36. Schleppi, Yves	Zürich, Switzerland	ETH (34)
37. Darwash, Adnan	Nottingham, UK	Invited speaker
38. Thaller, Georg	München, Germany	Invited speaker
39. Carnier, Paolo	Padova, Italy	Paying guest
40. Miglior, Filippo	Cremona, Italy	Paying guest
41. Pizzi, Flavia	Milano, Italy	Paying guest
42. Thompson, John	NewYork, USA	Paying guest