LowInputBreeds

Issue 9 January 2014

NEWSLETTER of the LowInputBreeds project

Development of integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and 'low input' milk, meat and egg production

Editorial

Dear Readers

The 3rd LowInputBreeds Symposium was held in August in conjunction with the 64th Annual Meeting of the European Federation of Animal Science (EAAP, www.eaap2013.org), and it gave the LowInputBreeds project partners the opportunity to present findings and make their work accessible to a much wider audience than in the past. Other FP7 projects were also holding satellite meetings at the conference hence an excellent opportunity to accommodate other findings as we approach the later stages of our project.

The abstracts of the LowInputBreeds papers are reproduced in this newsletter, along with authors' contact information if more details are sought

Partners have also been preparing technical notes; presenting findings from some of our research to give guidance directly to the industry – more can be read about these on page 11 of this newsletter. Again thank you to all contributors.

Veronika Maurer, scientific coordinator and
Gillian Butler, coordinator

Contents

The LowInputBreeds project is co-financed as a Collaborative Project by the European Commission, under the Seventh Framework Programme for Research and Technological Development (Grant agreement No 222623). The contents of this newsletter are the sole responsibility of the authors, and they do not necessarily represent the views of the European Commission or its services. Whilst all reasonable effort is made to ensure the accuracy of information contained in this newsletter, this newsletter is provided without warranty and we accept no responsibility for any use that may be made of the information.

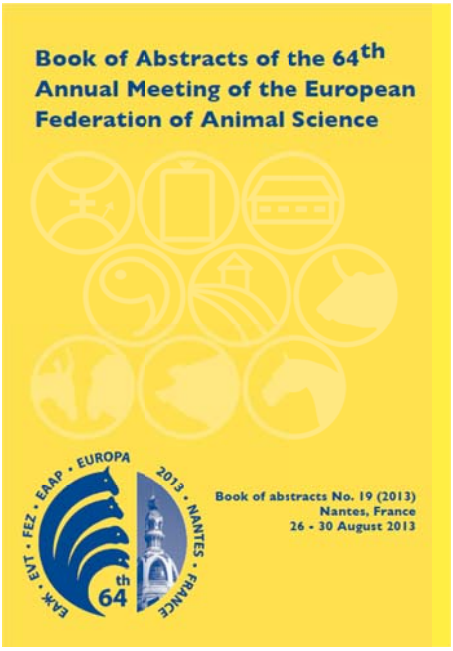
The third symposium of the LowInputBreeds project

The third symposium of the LowInputBreeds project took place in the framework of the 64th Annual Meeting of the European Federation of Animal Science (EAAP) in Nantes, France, August 26 to 30. The LowInputBreeds session "Breeding in Low Input Production Systems" (session no 42) was held in the afternoon of August 28 and was followed by the General Assembly of the LowInputBreeds project.

On the following pages you will find the abstracts of the papers from the LowInputBreeds project presented at the EAAP meeting and of the papers that were presented in the LowInputBreeds session.

The book of abstracts of the 64th Annual Meeting of the European Federation of Animal Science (EAAP), to which the LowInputBreeds project contributed the session "Breeding and Management in Low Input Production Systems", is available online on the EAAP website.

European Federation of Animal Science (2013) Book of Abstracts of the 64th Annual Meeting of the European Federation of Animal Science. Wageningen Academic Publishers, The Netherlands, 2013 DOI: 10.3920/978-90-8686-782-0. Available at http://www.eaap.org/Previous_Annual_Meetings/2013Nantes/Nantes_2013_Abstracts.pdf



Papers from the LowInputBreeds project and papers presented at the Session "Breeding in low input production system at the 64th Annual Meeting of EAAP

Session 14. Genetic control of adaptation

Heat tolerance and reproductive performance in two sow lines

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Pig breeding companies face the challenge to produce animals for a range of environments. One of the environmental challenges is elevated temperatures. Main research questions were: (1) does genetic variation for heat tolerance exist; (2) what is the correlation with reproductive performance; and (3) what could be underlying mechanisms for these correlations. Data was routinely collected for the TOPIGS breeding program in Spain and Portugal (high temperature zone), on Yorkshire (D-line) and Large White (ILW-line) pigs. Temperature recordings of local weather stations were used as approximation of the on-farm temperatures. Heat load was defined as the deviation upwards from the max temperature on the day of insemination from 19.20C. Farrowing rate (FR) was more affected by high temperatures in the D-line than in the ILW-line. The heritability for heat tolerance (HT) at 29.30C was higher in the D-line (0.04) than in the ILW line (0.02). The genetic correlation between FR and HT was 0.16 in the D-line and -0.36 in the ILW-line, and between litter size and HT -0.76 in the D-line and -0.10 in the ILW-line. Pearson rank correlations in the D-line in time reveal that heat stress during days 21 to 14 before insemination had the largest negative association with farrowing rate (-0.08), possibly related to oocyte quality. Heat stress between 7 days before to 12 days after insemination had the largest negative association with total number born (-0.05), possibly related to fertility and implantation. In conclusion, heat tolerance is heritable and of importance for reproduction in high temperature environments. Selection under temperate conditions results in higher reproductive performance and decreased heat tolerance. Taking day of insemination as point of reference is ok as the correlation with the most sensitive period is high (0.9).

Session 16. Advances in genomic analysis and prediction: 1

HD genotype imputation in 54k genotyped and ungenotyped Original Braunvieh and Brown Swiss cattle

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In silico genotyping by imputation of unknown genotypes can be used to reduce the implementation costs of genomic selection. We evaluated the accuracy of genotype imputation from Illumina 54k to High Density (HD) in Original Braunvieh and Brown Swiss cattle in Switzerland. Genotype data consisted of 6,106 54k and 880 HD genotyped bulls and cows. Genotype data was checked for parentage conflicts and SNP were excluded if MAF was below 0.5% and SNP call rate was lower than 90%. The final data set included 39,004 SNP for the 54k and 627,306 SNP for the HD chip. HD genotypes of animals born between 2004 and 2008 (n=365) were set to unknown to mimic animals genotyped with the 54k chip. Population and pedigree (family) imputation methods were used as implemented in FImpute and Findhap V2. The accuracy of imputation was assessed by the squared correlation between true and imputed genotypes (R2). Both programs resulted in high imputation accuracy. R2 increased with increasing relationship between the HD genotyped reference population and 54k genotyped imputation candidates. Average R2 for FImpute and Findhap were 0.98 and 0.97 when both parents of the 54k genotyped candidate were HD genotyped, respectively. R2 was lower when no direct relatives were HD genotyped. FImpute and Findhap provide in silico genotypes for completely ungenotyped animals. Incorporating these genotypes in the reference population could be specifically beneficial

for small breeds with low numbers of genotyped animals such as Original Braunvieh cattle in Switzerland. Therefore, next steps include the evaluation of accuracy of ungenotyped animals in Original Braunvieh and Brown Swiss cattle.

Session 21b. Use of knowledge in animal nutrition in specifications for 'label' and other higher quality production systems

Improving winter milk fatty acid profile by linseed supplementation to conventional and organic cows

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Many studies show considerable changes in milk fatty acid (FA) profile between summer and winter. This study investigated the impact of linseed supplementation of winter diets on milk FA profiles in both organic and conventional herds. Two herds (conventional, organic) were divided into two groups of 20 animals, receiving two different diets (control, linseed-2 kg/cow per day) over a 6-weeks period, with milk sampled on three occasions. Analysis of variance was performed by linear mixed effects models in R, using 'management', 'diet' and 'sampling date' as fixed factors and individual cow as random factor. Milk FA profiling was carried out by gas chromatography. Cows in the (1) organic herd and (2) linseed group produced milk with higher ($P<0.001$) concentrations of nutritionally beneficial individual FA (vaccenic; 47.0% and +85.1%, -linolenic; +72.1% and +67.4%, and rumenic; +39.7% and 55.9%) and FA groups (monounsaturated FA; +15.9% and +27.7%, polyunsaturated FA; +41.5% and +41.1%, and omega-3 FA +53.1% and +85.4%) and lower concentrations of saturated FA (-8.6% and -12.3%) when compared with conventional system and control diets respectively. Beneficial eicosapentaenoic was higher under organic than conventional management (+24.9%) but decreased when cows ate linseed rather than control diets (-36.1%). Although both herds responded to supplementation, those fed organic diets (with grass clover silage and slightly higher forage content) showed a greater response ($P<0.05$). The consequences of linseed on milk fat quality appear dependant on the basal diets and in this study the beneficial impact of the organic feeding and linseed were complimentary.

Session 37. Ethic aspects of breeding

Is genomic selection compatible with organic values?

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In a subproject within the EU project LowInputBreeds, it is planned to examine the potential for using genomic selection in breeding of organic dairy cows. This plan has been subject of some controversy within the organic movement. Taking these discussions as its point of departure, this paper aims at analyzing the question whether or not genomic selection, when used to promote organic production, still must be considered incompatible with basic organic values. Applying the IFOAM principles on breeding lead me to the following statements: Breeding should ensure that animals are well adapted to their conditions in the ecosystem made up by the farm. Organic agriculture should maintain local breeds continually over time. It is wrong to breed animals to live in conditions not in accord with their 'physiology, natural behavior and well-being', and breeding should not involve serious risk of adverse effects on future health and well-being of humans and/or animals. How should one assess the use of genomic selection from this perspective? The problem is that the continuous adaptation has been broken. Many years breeding for higher productivity have made many breeds less well adapted to organic conditions. Genomic selection could have a potential in breeding for

functional traits to make animals better adapted to organic conditions. Would this violate organic values? Perhaps the most important concerns is that genomic selection leads to use of unacceptable reproduction techniques. Concerning the first, I suggest that organic values are already violated in terms of many cases of poorly adapted animals. In this situation, a strict interpretation could imply that production must be stopped. But a more pragmatic view would imply, I argue, that better adapted animals should have more weight than using organically acceptable reproduction techniques. So if genomic selection serves this goal better than traditional breeding (and if certain other concerns are met), it should be favored.

Killing new born animals for efficiency reasons; genetic selection as a cause for a dilemma

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In commercial egg production, male chicks are killed immediately after hatch as they are not profitable for meat production. Some of them are utilised as feed for zoo or pet animals, or snack for humans, but they do not have a life of significance. In many countries people have objections against this practice. The origin of this problem is the development and use of specialised breeds for specific purposes, to obtain increased production efficiency and low-priced animal products. Specialization can overcome the opposite requirements for high efficiency in the production of meat and eggs (milk), respectively. For efficient meat production, a high growth rate is essential. In contrast, for efficient production of eggs or milk, low animal maintenance costs, i.e. a high production rate per kg body mass, is most important. This dichotomy is most clearly seen in modern industrialized poultry production. Egg type males require 3 times more time and 2-4 times more feed than meat type birds to reach an acceptable slaughter weight, while meat type hens require much feed for growth and maintenance which makes them inefficient for egg production. Selection of layer type birds for improved growth rate could make it more attractive to rear the males for meat production, but would strongly compromise efficiency of egg production by the females. A similar situation, albeit less extreme (for now?) can be found in dairy goats and cattle. Male offspring of dairy goat and some typical dairy cattle breeds do not have an economic value for meat production and may be killed at birth. In terms of economics, resource efficiency, or animal welfare (provided killing is carried out in a humane way), this may not be a problem but ethically it is. We discuss this ethical dilemma and explore technological and niche market alternatives as possible solutions.

Session 42. Breeding in low input production systems

Organic and free range egg production systems: effects of genotype and management

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Within the EC FP7 project LowInputBreeds, researchers from the Netherlands (NL), France (F) and Switzerland (CH) search for the ideal combination of genotype and management for free range egg production systems. In total 257 farmers with free range layers (organic and conventional) with 273 flocks were interviewed to determine the relationships between genotype of the hens, management and performance. Almost 20 different genotypes (brands) were present on the farms. In F, all birds were brown feathered. In CH and NL, there were brown, white, and silver hens. In CH, mixed flocks (brown/white) were also present. Overall performance in organic and conventional systems differed significantly (higher mortality and lower egg production among organic hens). The difference was highly significant in NL, and showed a non-significant tendency in the same direction in CH and F. White hens tended to perform better than brown hens. Silver hens appeared to have a higher mortality and

lower production. There were no significant relationships between production, mortality, feather condition and use of outside run or with flock size. There was more variation in mortality and egg production among small than among large flocks. As a second step, 40 farms each were visited in NL and CH to find possible reasons for these differences and to look at management as well as animal health and welfare into more detail. First results indicate that in NL free range hens scored better on plumage condition and wounds than organic hens, while in Switzerland organic hens scored better on plumage condition and keel bones than free range hens. Effects of management and genotype are currently analysed. Furthermore we examine egg quality and application of prolonged laying periods or moulting in the visited farms.

Evaluating the need for organic breeding programmes and assessing possible implementation strategies

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This paper outlines motivations for implementing independent dairy cattle breeding programs for low input or organic production systems. Subsequently, we suggest and evaluate possible breeding strategies. From a scientific perspective, motivations for implementing organic breeding programs are based on additional or new breeding goals with a focus on animal health and welfare, possible genotype by environment interactions, and limitations in the use of biotechnologies. Hence, we will give a general overview of existing organic breeding programs along with their breeding goals, we will present results from own studies related to genotype by environment interactions and from gene expressions in harsh environments (genetic studies on heat stress), and we discuss the potential and limitations of reproductive and molecular technologies. A special focus is on aspects of genomic selection for new phenotypes using calibration groups of cows, and including imputing strategies in a designed experiment. A stochastic simulation was conducted to evaluate different breeding program designs by including aspects of genotype by environment interactions, accuracies of genomic breeding values, and various mating designs (e.g. natural service sires versus artificial insemination). Overall evaluation criteria were true breeding values of selected sires and their offspring, and the development of inbreeding and relationships in the low input population.

Genetic basis of functional traits in low input dairy cattle

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Phenotypic data of Brown Swiss cows collected from 40 Swiss dairy farms within the EU-funded project LowInputBreeds were analyzed with two aims: (1) testing methods to describe functional traits; and (2) estimating genetic parameters and accuracies of breeding values for novel functional and conformation traits. (1) A data set of 1112 cows was analyzed to evaluate a commonly used Body Condition Scoring (BCS) system regarding its ability to assess the back fat thickness (BFT) and to generate a more objective scoring method. The results of multiple regression models showed that the BCS system, which takes the overall condition of the animal into account when scoring, was not only able to explain the BFT best, but also did outperform other apparently more objective scoring systems. (2) Estimation of genetic parameters and prediction of EBVs on 1799 Brown Swiss cows with ASReml revealed heritabilities for milking speed, udder depth, position of labia, rank order in herd, general temperament, aggressiveness, milking temperament and days to first heat in similar ranges as reported in literature. Values on some traits (e.g. udder depth $h2=0.42\pm0.06$) were at the high end, whereas estimates for others (e.g. days to first heat $h2=0.04\pm0.05$) showed low heritability. Position of labia, genetically analyzed for the first time, showed a moderate heritability. Moreover, genetic parameters and accuracies of breeding values for milk content traits of individual udder quarters revealed significant systematic differences in fat,

protein and lactose content between front and rear udder quarters, while content of urea, SCS and hyperkeratosis did not. Our findings suggest that the front and the rear udder could be considered as partly genetically different organs.

Effect of season and management system on 'Sfakion' sheep milk fatty acid profile

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Recent research has demonstrated possible beneficial effects of several milk fatty acids (FA) on human health. However, in contrast to cows, little is known about factors affecting the milk FA profile of small ruminants. Our study investigates seasonal variation of FA profile of sheep milk from two management systems. Ten extensive and 10 semi-intensive 'Sfakion' sheep flocks on Crete, Greece, were monitored for two consecutive lactations, collecting monthly bulk milk samples and managerial records. Milk FA profiling was carried out by gas chromatography. Analysis of variance was performed by linear mixed effects models in R, using 'management', 'month' and 'year' as fixed factors and 'flock' as a random factor. Significant variations of the FA profile were found between sampling months, especially comparing January with July; saturated FA were 6.8% lower and monounsaturated and omega-3 FA were 17.4% and 31.7% higher ($P<0.001$) respectively in the later. Differences were greater in extensive flocks, which had higher concentrations ($P<0.001$) of monounsaturated (+6.4%) and omega-3 FA (+21.7%) and lower concentration of saturated FA (-2.8%) compared to semi-intensive flocks. Differences were also identified between the years of this study; milk in year 2 had higher ($P<0,001$) concentration of monounsaturated (+18.2%), polyunsaturated (+28.8%) and omega-3 FA (73.1%) and lower concentration of saturated FA (-8.3%). Sheep milk FA profile highly varies within and between lactations, but these changes can be modified by managerial practices.

Effects of different proportions of sainfoin pellets combined with hazel nut peels on infected lambs

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Tannin-rich plants are nutraceuticals helping to control GIN infections in ruminants. The aim of the study was to evaluate the anthelmintic activity of pellets of sainfoin completed by agro industrial by-products in H. contortus infected lambs. The study lasted for 7 weeks (D0 to D42). On D0, 24 lambs were individually infected with 4000 L3 and composed 4 groups (G1, G2, G3, G4), fed first ad libitum on hay plus 500 g lucerne pellets. On D21 post infection (PI), the G2, G3, G4 groups were offered sainfoin dehydrated pellets (i.e. 33; 66, 100% of the concentrate diet). G1 remained fed on lucerne pellets (control group). Moreover, from D35 to D42PI, G2, G3 and G4 received a daily individual supplementation of 500 g of hazelnut peels (HZP). The mean overall refusals of concentrate and HZP were measured from D21 to D34PI; and from D35 to D41PI. Packed cell volume (PCV) and faecal egg counts (FEC) were measured weekly. Last, worm counts were measured after necropsy (D42PI). There were no refusals of concentrate for the 2 experimental periods. The mean refusals of HZP from D35-D41 PI ranged from 68 to 82%. A constant decrease in PCV values was found but without any differences between groups. The reductions in FEC in the treated groups reached a maximum value of 60%. The differences between treated and control groups showed a trend ($P<0,09$) after HZP addition. The worm counts showed establishment rates ranging from 30 to 44% but with no differences between groups.

Improving low input pig production systems

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In comparison with conventional pig production systems, low input systems are characterised by smaller herd size, more space per animal, lower capital investment, often outdoor management, greater labour requirements and focus on animal welfare. In order to improve production efficiency in low input pig production systems, an extensive research program was set up, aiming at developments in the areas of breeding, management and product quality. The program included research on breeding infrastructures and strategies in order to design dedicated breeding solutions for the low input sector. Key breeding goal traits, such as pig survival, sow longevity and heat stress resistance of sows, were evaluated for optimal inclusion in specifically designed breeding programmes. Breed choice for low input systems was investigated by experimental studies and surveys to compare reproductive performance and carcass and meat quality of modern versus traditional pig breeds. Various gilt rearing and lactation environments were compared for their effects on mothering ability and piglet health and welfare. So far, research highlights and key results of the project include the implementation of an economically viable replacement breeding strategy for organic pig production in The Netherlands. This concept is designed in such a way that it easily can be adapted and transferred to other low input systems across Europe. Another highlight is the definition and design of a sow robustness concept that will be implemented in the breeding goal of a newly developed genetically robust sow line. In conclusion, results from this project contribute to improvements in production efficiency, animal health and welfare and product quality in low input pig production systems. This will underpin consumer perceptions about added value quality characteristics of pork products from these systems and thus may help to maintain economic sustainability of such systems.

Can pig breeding contribute to the sustainability of low input production systems?

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Low input systems (LIS) are often based on specific values such as cultural traditions or principles for organic production. Low amounts of external inputs imply a closed nutrient cycle. Climate change, growing world population and loss of biodiversity put high demands on all systems; conventional as well as LIS have to be efficient. A LIS breeding goal typically includes pigs' ability to efficiently use local feed (preferably waste and by-products), thrive in their climate (heating and cooling are energy consuming), stay healthy (limited use of chemotherapy), and maternal ability (piglet mortality decreases efficiency and sow milk alternatives are external inputs). With grazing, strong legs are needed. Systems based on internal inputs are exposed to larger variation in feed quality than conventional systems where inputs come from a global market. Thus, low environmental sensitivity is an additional goal trait. Traits listed above are relevant also for conventional production, but economic weights differ between systems. Socio-economic impact and acceptance of goal traits must be considered for each LIS. Organic producers in Sweden want higher weight on disease and parasite resistance. In a EU project, 15 production systems were studied. Many alternative systems used animals bred for conventional production. The claimed added values of the products were therefor not reflected in the breeding. Some systems with local breeds were studied. Pig population size and human and technical resources were limiting factors for their breeding work. This illustrates that the small scale of LIS (related to their local nature) is problematic, since breeding is more efficient for large populations. Choosing animals suitable for LIS from a conventional breeding programme can be a more realistic strategy than specific LIS breeding.

The LowInputBreeds Technical Notes[1]

Partners of the LowInputBreeds project are currently preparing a number of technical notes, which give an introduction to the key themes of the LowInputBreeds project and which summarize key results of the project.

The first notes were published during 2013. They are available at the LowInputBreeds website (www.lowinputbreeds.org) under "Publications".

Technical note 2.3: Impact of grazing management on lamb meat quality

In low-input farming systems, particularly in the Mediterranean area, reducing the exploitation of pastures is of interest to farmers. But limiting access to grazing may have a negative impact on the production performance and meat quality of ruminants. Research conducted within the LowInputBreeds project with lambs aimed at determining the impact of pasture management on quality and shelf life of meat, and on lamb performances.

› Giuseppe Luciano (2014): Impact of grazing management on lamb meat quality. LowInputBreeds Technical Note 2.3

Technical note 3.1 Breeding for organic and low input pig production systems

Breeds and breeding strategies for organic and low input pig production systems need to be adapted to the specific characteristics and regulations of this type of production. This technical note presents an overview of research results on this topic, as obtained in the LowInputBreeds project.

› Jascha Leenhouwers (2013) Breeding for organic and low input pig production systems. LowInputBreeds Technical Note 3.1.

Technical note 3.4 Adaptation of sows to rising temperatures

Pork is the world's most consumed meat. With further growing demand pig production tends to move from moderate to somewhat harsher climates. Heat stress is expected to have negative effects on sow production. But as a result of genetic improvement, sensitivity of pigs to high temperatures has increased. This technical note presents an overview of research results on the genetics of heat stress sensitivity of sows, as obtained in the LowInputBreeds project.

› Saskia Bloemhof and Egbert Knol (2013) Adaptation of sows to rising temperatures. LowInputBreeds. LowInputBreeds Technical Note 3.4

Technical note 4.6 Raising cockerels from free range egg production

Worldwide most males from layer type poultry are currently killed at hatch. Yet farmers with laying hens, consulted in the LowInputBreeds project, revealed they despised this practice and look for possibilities to raise cockerels possibly working with dual purpose chickens.

This technical note explains the best option with regard to resource use efficiency and what production costs might be to raise and market cockerels of specialized layer strains.

Leenstra, Ferry (2013) Raising cockerels from free range egg production. LowInputBreeds Technical Note 4.6

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First announcement for free workshops "Improving sustainability in crop and livestock production systems"

8 & 9 April 2014, Newcastle University, Newcastle Upon Tyne, UK

The NUE-CROPS (www.nuecrops.eu) and LowInputBreeds (www.lowinputbreeds.org), EU funded research projects, are hosting two workshops for researchers and advisers on recent advances in sustainability in agricultural systems. NUE-CROPS focusses on genetic and agronomic approaches for improving nutrient use efficiency in crops while the LowInputBreeds project focusses on integrated breeding and management strategies to improve health, product quality and performance in European organic and 'low input' milk, meat and egg production. These workshops provide an opportunity for advisers and early-stage researchers to learn from some of the practical outcomes from these projects.

The first day will focus on **"Tools and techniques for assessing nutrient sustainability at the field and farm scale"** while the second workshop will highlight **"Improving sustainability: lessons from low-input and organic livestock production"**. The workshops will feature hands-on sessions with some of the software tools available for sustainability assessment as well as presentations from leading researchers in the field.

Programme highlights

Workshop 1: Tools and techniques for assessing nutrient sustainability at field and farm scale

- NPK budgeting at the farm scale – comparison of software tools available
- Calculating farm scale carbon budgets and use of on-line tools
- Advances in simulation models for field scale N dynamics

Workshop 2: Improving sustainability: lessons from low-input and organic livestock production

- Linking grazing and profitability in dairying
- The role of clover in soil fertility and animal nutrition
- Extending the life of anthelmintics
- Mastitis control without antibiotics?

There is no registration fee for the workshops and we can subsidise travel for researchers and advisers. Please register your interest with teresa.jordon@newcastle.ac.uk for either or both workshops and information on travel bursaries.

More information http://www.nefg-organic.org/improving-sustainability-in-crop-and-livestock-production-systems-workshop-8th-and-9th-april-2014/

LowInputBreeds workshops in Switzerland

Early 2014, a number of workshops will take place in Switzerland. These are organized by the Research Institute of Organic Agriculture (FiBL) in collaboration with the LowInputBreeds project.

› January 22, 2014: Bio Weide-Beef (in German)
› January 29, 2014: Bio Weide-Beef (in German)
› January 23, 2014: Biolegehennentagung - (in German)
› February 5, 2014: Bio Weide-Beef (in German)
› February 12, 2014: Boeuf de pâturage bio - (in French)
› February 19, 2014: Laufställe für Kühe mit Hörnern (in German)

More information:
http://www.lowinputbreeds.org/events-lib.html

Publications of the LowInputBreeds project

Publications of the LowInputBreeds project can be downloaded at the project website www.lowinputbreeds.org > Publications.

Partner list of the LowInputBreeds project

- Partner 1: Newcastle University UNEW, UK, Coordinator
- Partner 2: Research Institute of Organic Agriculture FiBL, Switzerland, Scientific coordinator
- Partner 3: Institut National de la Recherche Agronomique INRA, France
- Partner 4: Wageningen UR, Livestock Research, The Netherlands
- Partner 5: University of Göttingen / Georg-August-University Göttingen UGöt, Animal Breeding and Genetics Group, Germany
- Partner 6: University of Catania UCat, Department of Animal Sciences, Italy
- Partner 7: National Agricultural Research Foundation NAGREF, Greece
- Partner 8: Federal Research Institute for Rural Areas, Forestry and Fisheries vTI, Institute of Organic Farming, Germany
- Partner 9: Danish Centre for Bioethics and Risk Assessment, University of Copenhagen, UCPH-CeBRA, Denmark
- Partner 10: University of Ljubljana ULju, Animal Science Department, Slovenia
- Partner 11: University of Louvain UCLou, Centre for Philosophy of Law, Belgium
- Partner 12: Swissgenetics, Switzerland
- Partner 13: Swiss Brown Cattle Breeders' Federation SBZV, Switzerland
- Partner 14: Applied Genetics Network an, Switzerland
- Partner 15: Institute for Pig Genetics IPG, The Netherlands
- Partner 16: TOPIGS Iberica / Pigture Ibérica, Spain
- Partner 17: Institut de Sélection Animale BV ISA, a Hendrix Genetics company, The Netherlands
- Partner 18: Institut National de la Recherche Agronomique de Tunisie INRAT, Tunisia
- Partner 19: Lincoln University UL-NZ, Faculty of Agriculture and Life Sciences, New Zealand
- Partner 20: University of Guelph UG-CAN, Centre for Genetic Improvement of Livestock, Canada
- Partner 21: Federal University of Vicosa UVF, Animal Science Department, Brazil
- Partner 22: Louis Bolk Institute, Driebergen, The Netherlands

Additional partners

- Partner 24: The Department of Veterinary Science and Public Health (DIVET) of the Faculty of Veterinary Medicine at Milan University, Italy
- Partner 25: Department of Animal Breeding and Product Quality, Animal Production Research Centre, Nitra, Slovakia
- Partner 26: Irish Agriculture and Food Development Authority – Teagasc

Imprint

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