

Edited by

Claudia Luksch
TU München
Hans Eisenmann-Zentrum für Agrarwissenschaften

© 2015 for the individual papers by the papers' authors.
Re-publication of material requires permission by the copyright owners.

Page Content

- 3 **Index of contents**
- 5 **Foreword**
- 7 **Program**

Abstracts Talks

- 11 **Baumgartner M.**, *Feasible indicators for assessing equine welfare*
- 15 **Buffler M.**, *Re-evaluation of iron supplementation in newborn piglets*
- 19 **Dandikas V.**, *Development of an empirical model to estimate the biogas yield of energy crops*
- 21 **Hofer K.**, *Influence of nitrogen fertilization on the Fusarium complex of barley*
- 23 **Koehler B.**, *Ascertainment of nutrient flows on dairy farms.*
- 25 **Luebke K.**, *Animal welfare in aquaculture – non-invasive stress measurement in fish holding water*
- 27 **Mair S.**, *Succession in Horticultural Family Businesses – Determining Factors*
- 29 **Plieschke L.**, *Stratification of the Brown Swiss and Fleckvieh population*
- 31 **Renner A.-C.**, *Molecular assay for rapid quantification of Rhizictonia solani AG2-2IIIB in soil*
- 33 **Schönleben M.**, *Genomic selection across breeding cycles in rye*
- 35 **Strobl M.**, *How raw data become an indicator system – a useful way for benchmarking, modelling and compiling statistics*

Abstracts Posters

- 39 **Abriel M.**, *Influence of tail docking, housing conditions and stocking density on the appearance of cannibalism in weaning piglets*
- 41 **Alpmann J.**, *Dairy Conflict and resulting association structures: Economic and emotional effects of market liberalization*
- 43 **Bauer R.**, *Studies on the decrease of spore potential of common bunt (Tilletia caries) and dwarf bunt (T. controversa) spores of wheat in soil considering different crop rotation systems in ecological farming*
- 45 **Brugger D.**, *Short term experimental modelling of zinc status in weaned piglets*
- 47 **Deml M.**, *Enzymes as enhancers for digestion in ruminants*
- 49 **Forster F.**, *Nitrogen fluxes and potential nitrogen leaching of agricultural farming systems in an area with high livestock density*
- 51 **Gabriel A.**, *Heuristical approach for a system description of SMEs in hortibusiness*
- 53 **Gnädinger F.**, *Challenges in future phenotyping methods for maize breeding*
- 55 **Gräff A.**, *Animal behavior in a fully automatically controlled dairy farm*

- 57 **Grundler M.**, *Development of quantitative and qualitative test methods for detection of wheat and barley bunt diseases (*Tilletia* spp., *Ustilago nuda*) by means of Real-Time PCR assays*
- 59 **Habtemariam L.H.**, *Climate change and its impact on Thiopian Agriculture*
- 61 **Hailer B.**, *Effective vole control in the grassland of Bavaria*
- 63 **Hanauer M.**, *Copper supplementation – Is there an influence on the ruminal microbiome?*
- 65 **Höld M.**, *Elaborate the basics for implementation of an on-farm energy management system in a dairy barn*
- 67 **Köhler A.S.**, *Indicators of functional diversity for biodiversity management in value chains of organic food stuff*
- 69 **Kokovic N.**, *Cooperatives in the German Horticultural Sector: Internal Governance Structure*
- 71 **Loibl P.**, *Influence of stressful situations on feed intake behavior in fattening pigs*
- 73 **Mederle M.**, *Analysis of Influencing Factors on Infield-Logistic*
- 75 **Nachtmann K.**, *Development of a laboratory plant to produce liquefied biomethane and dry ice from biogas*
- 77 **Oliveira V.C.**, *Soil functionality indicators and multifunction assessment of Cerrado – Brazil*
- 81 **Rombach M.**, *A typology of online flower shops on the German market*
- 83 **Seiferth B.**, *Development of a system for selective machining on pasture to automate pasture care by an autonomous mobile robot*
- 85 **Sghyer H.**, *Investigating the genetic structure and diversity of the barley pathogen *Ramularia collo-cygni**
- 87 **Singh A.**, *Biocontrol of *Aphis gossypii* on okra in Cameroon*
- 89 **Zißler E.**, *Characterization of the rumen microbiome with DNA-classification by qPCR at a different structure supply of beef bulls*

Foreword by Prof. W. Windisch

Director Hans Eisenmann-Center for Agricultural Sciences, TUM

Agricultural science is going to become an essential field of expertise being highly relevant to numerous challenges of the 21st century, such as e.g. food security, climate change, and sustainability of natural resources of food production (e.g. water, soil, and genetic diversity). These challenges require integration of various working tools from the applied to the fundamental level to a systemic cutting-edge approach of research.

It is a fortunate coincidence to find three institutions dedicated to agricultural sciences from the fundamental to the applied level in close neighborhood around Munich: the chairs of the TUM School of Life Sciences Weihenstephan (WZW) forming the Hans Eisenmann Center for Agriculture Sciences (HEZ), the Bavarian State Research Center for Agriculture (LfL) and the Weihenstephan-Triesdorf University of Applied Sciences (HSWT). Integrating the specific potential of each of these institutions opens a great chance to achieve the critical mass of joined cutting-edge research to step into a highly innovative level of systemic agricultural research.

The 1st HEZagrar PhD Symposium was initiated to start that process of integration. As a first step, the research groups of the HEZ members and the LfL were invited to present mutually their current projects with special emphasis on already existing collaborations and future fields of synergy waiting for straight forward realization. It is a great pleasure to realize the overwhelming feedback from both institutions. This demonstrates a strong motivation to step jointly into novel directions of agricultural research. Indeed, the plenty of contributions covers a colorful bunch of scientific expertise and provides a fertile matrix for cutting-edge synergy. But most important of all, the 1st HEZagrar PhD Symposium brings together our young scientists. It hopefully helps the creation of a common spirit about agricultural sciences, the future challenges, and the great feeling to contribute to their solutions.

Weihenstephan im April 2015

A handwritten signature in blue ink, appearing to read 'W. Windisch', is centered below the text.

Foreword by J. Opperer

President of the Bavarian State Research Center for Agriculture (LfL), Freising

The Bavarian State Research Center of Agriculture focuses on the fields of researching, supporting and training. Regarding this, the cooperation with the Technical University Munich (TUM) and the Weihenstephan-Triesdorf University of Applied Sciences (HSWT) is considered as an important approach. It comprises the scientific exchange and the execution of joint projects.

The joint mentoring of PhD students is of particular importance. Such cooperation is highly likely to result in a so called “win-win” situation for everyone involved. The key aspects of the process are the scientific results as well as the generation of excellent junior academics. It allows the LfL an important access to improved methodical approaches and the university benefits from a strong link to the real concerns of a sustainable agriculture.

The improvement of the actual process of training the PhD students is a concern of all participants. In reference to the PhD students this event arises the chance to establish contacts and to find scientific exchange with other colleagues. After completion of the dissertation the graduates and their knowledge are available for everyone involved. The LfL is therefore happy to actively participate in the **1st HEZagrar PhD symposium**. We wish this event every success and hope this is the beginning of a promising future.

Weihenstephan im April 2015

A handwritten signature in blue ink, appearing to read 'J. Opperer', with a stylized flourish extending to the right.

Program

8:30 Welcome: W. Windisch, J. Opperer

8:45 Manfred Schönleben
Genomic selection across breeding cycles in rye

9:05 Anne-Catherine Renner
Molecular assay for rapid quantification of *Rhizictonia solani* AG2-2IIIB in soil

9:25 Katharina Hofer
Influence of nitrogen fertilization on the *Fusarium* complex of barley

9:45 Stefan Mair
Succession in Horticulture Family Business – Determining Factors

10:00 Coffee Break (- 10:20)

10:25 Martin Strobl
How raw data become an indicator system –
a useful way for benchmarking, modelling and compiling statistics

10:45 Vasilis Dandikas
Development of an empirical model to estimate the biogas yield of energy crops

11:05 Brigitte Koehler
Ascertainment of nutrient flows on dairy farms

11:25 Laura Plieschke
Stratification of the Brown Swiss and Fleckvieh population

11:45 Lunch Break (- 13:00)

13:00 Postersessions
[Session A: 13:00 – 14:00, Session B: 14:10 – 15:10]

15:15 Marzell Buffler
Re-evaluation of iron supplementation in newborn piglets

15:40 Kay Luebke
Animal welfare in aquaculture – non-invasive stress measurement in fish holding water

16:00 Miriam Baumgartner
Feasible indicators for assessing equine welfare

16:20 Conclusions: W. Windisch/ J. Opperer

16:30 Awards for best poster & best talk, “**Wrap up**” with Beer & Brezn (- ca. 18:00)

Abstracts Talks

Feasible animal-based indicators for assessing equine welfare

Current status of the development of an animal welfare assessment system for horse husbandries as a part of a sustainability management system

Miriam Baumgartner, Verena Frank, Johanna Gandorfer, Anna Ramoser, Sarah Seiler, Margit H. Zeitler-Feicht
TUM, Chair of Organic Farming, Workgroup „Ethology, Animal Husbandries and Animal Welfare“

Introduction

Are horses doing well in their husbandries? For the first time the answer shall be given objectively by an integral on-farm welfare assessment system for horse husbandries. A current research project at the Technical University Munich evaluates indicators for well-being, pain and suffering in horses in order to develop a welfare assessment system (BAUMGARTNER AND ZEITLER-FEICHT 2013, 2014A, 2014B, 2015, ZEITLER-FEICHT ET AL. 2015). The research project is professionally supported by horse husbandry experts from academics, industries as well as leading organizations for horse owners and veterinarians.

The aim of the project is to develop a welfare assessment system for all horse husbandry systems which can be applied both for sport horses and for leisure horses. It is based on national animal welfare standards (BMELV 2009) and does take sustainability into consideration. Animal-based indicators are completed with resource-based indicators if necessary. It is stipulated that indicators are valid, reliable and feasible. Welfare criteria were formulated for the two principles „good health“ and „behavioural demands“ (see figure 1 and 2). Each has to be represented by at least one indicator.

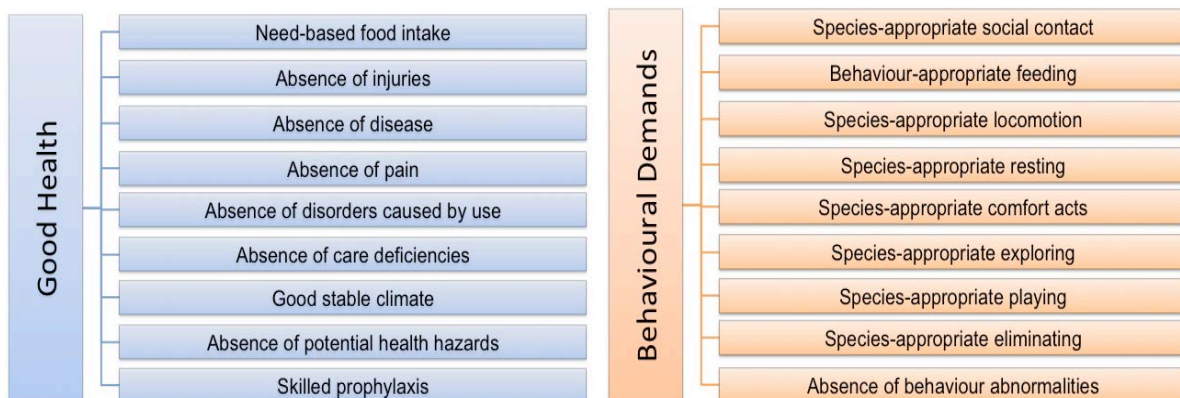


Fig. 1: Welfare Criteria for „good health“ and for „behavioural demands“

The principle „behavioural demands“ aims at the possibility for horses to practise species-specific behaviour. It is gathered to what extent the housing conditions allow the horses to live out and show species-specific behaviour. Furthermore in the present studies the frequency of selected behaviours including abnormal behaviour was collected in precise timeframes.

Material and Methods

Potential indicators for assessing equine welfare on-farm were selected by study of literature and field tests. The field tests included direct observations (continuous behaviour sampling) on free-ranged horses (48 hours; group size 34 horses), horses in group-housing systems (2 studies each 36 hours; n= 15 different groups; group size \varnothing 11,2 and \varnothing 20,4 horses; range 8 - 31 horses) and single-stabled horses (24 hours; 36 horses). The following section presents selected indicators that are feasible for assessing equine behaviour on-farm.

Results and Discussion

1. Feasible behavioural indicators for well-being

The literature research revealed that „**being together**“ is linked with affiliative behaviour. It includes „resting together“, „foraging together“ and additionally „walking together“. Horses do have a strong need for social bonds. „Being-together“ amongst horses must be voluntary and not caused by bad weather conditions or lack of space. Therefore the context must be considered. For temporary direct observations the frequency in group-housing systems is sufficient (0.57 ± 0.67 per horse per 20 minutes). That's why in our study „being-together“ is considered as a feasible indicator for well-being for horses in permanent or temporary groups. It is intended to conduct further studies on its validity.

Other behaviours such as „**social play**“ is not only linked with positive emotional states in adult horses. Several studies showed that horses use „social play“ as a stress relief. However, it is too seldom to collect in an on-farm assessment system. Because of the lack of feasibility and validity we excluded „social play“ as an indicator for well-being.

2. Feasible behavioural indicators for suffering

Horses show „**abnormal behaviour**“ in distress, frustration, deprivation or conflict situations. The present studies showed a relatively high frequency in single-stabled horses (3.3 ± 6.45 per horse per 20 minutes). Hence „abnormal behaviour“ is a feasible and valid indicator for suffering. However, established stereotypes need to be excluded, because they may indicate a previous welfare status rather than the current welfare status.

Horses use „**agonistic behaviour**“ to regulate social relations, to defend themselves or to defend resources. If husbandry or management is inadequate, „agonistic behaviour“ increases and thereby the frequency of injuries caused by social conflicts. A high frequency of „agonistic behaviour“ indicates a high aggression level in group-housed horses and therefore distress and suffering. The mean frequency of group-housed horses is sufficient for temporary observations (2.6 ± 2.26 per horse per 20 minutes). As a result „agonistic behaviour“ is a feasible and valid indicator for suffering. Further studies need to be done on the scoring and severity.

References

BAUMGARTNER M. & M. H. ZEITLER-FEICHT (2013): Entwicklung eines Bewertungssystems zur Beurteilung der Tiergerechtigkeit von Pferdehaltungen als Bestandteil eines Nachhaltigkeitsmanagementsystems. KTBL Schrift: Aktuelle Arbeiten zur artgemäßen Tierhaltung 503, 226 – 227.

BAUMGARTNER M. & M. H. ZEITLER-FEICHT (2014A): Indikatoren für Tierwohl beim Pferd. 7. Pferde-Workshop Uelzen 2014. DGfZ-Schriftreihe Heft 64, 161 – 166.

BAUMGARTNER M. & M. H. ZEITLER-FEICHT (2014B): Entwicklung eines Bewertungssystems zur Beurteilung der Tiergerechtigkeit von Pferdehaltungen als Bestandteil eines Nachhaltigkeitsmanagementsystems. 9. Niedersächsisches Tierschutzsymposium in Oldenburg, Hrsg. Nds. Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz, 37 – 42.

BAUMGARTNER M. & M.H. ZEITLER-FEICHT (2015): Eignung ausgewählter tierbezogener Indikatoren zur Beurteilung der Tiergerechtigkeit von Pferdehaltungen hinsichtlich Praktikabilität. In: Tagungsband der Deutschen Veterinärmedizinischen Gesellschaft e.V. (DVG), Fachgruppen „Ethologie und Tierhaltung“ sowie „Tierschutz“, Verlag der DVG Service GmbH, Gießen, S. 182 - 192.

BMELV (2009): Leitlinien zur Beurteilung von Pferdehaltungen unter Tierschutzgesichtspunkten. Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz. Sachverständigengruppe tierschutzgerechte Pferdehaltung.

ZEITLER-FEICHT M.H., FRANK V., RAMOSER A., SEILER S., GIRISCH C., BAUMGARTNER M. (2015): Anhand welcher Verhaltensweisen lassen sich Rückschlüsse auf das Wohlbefinden von Pferden ziehen? In: Tagungsband der Deutschen Veterinärmedizinischen Gesellschaft e.V. (DVG), Fachgruppen „Ethologie und Tierhaltung“ sowie „Tierschutz“, Verlag der DVG Service GmbH, Gießen, S. 148 - 156.

Corresponding Author

Dr. Miriam Baumgartner
Technical University Munich - Life Science Center Weihenstephan – Hans-Eisenmann-Zentrum
Liesel-Beckmann-Str. 2
85354 Freising
m.baumgartner@tum.de

Re-evaluation of iron supplementation strategies in newborn piglets

Marzell Buffler

TUM, Chair of Animal Nutrition

Introduction

Iron deficiency in newborn piglets is a common problem in pig production. Low body iron stores at birth (50mg) and insufficient iron content in sows' milk (~1.03 mg/l) failing to fulfill the needs for high growth rates during the suckling phase lead to anemia. Therefore, parenteral iron supplementation as soon as possible after birth is standard practice to maintain animal health and reduce pre-weaning mortality.

The objective of the research project is to investigate the application of oral iron supplements in suckling piglets as an alternative to injection with regard to animal health and efficiency. Furthermore, the influence of iron sustenance in pregnant sows on the iron metabolism of the piglets was to be studied.

Methods

8 sows (DL) were fed with low (100 ppm) or high (230 ppm) iron diets during pregnancy. 3 untreated piglets (DL x Pie) from each litter were euthanized at day 1, 5 or 21 p.p., serving as *negative control* animals. 5 piglets from each litter were treated with different iron applications: *positive control*: intramuscular injection at day 5 (200mg iron dextran), *1/0*: oral application (100mg iron fumarat) at day 1, *5/0*: oral application at day 5, *1/14*: repeated oral application (100 mg iron fumarat each) at day 1 and 14 and *5/14*: repeated oral application day 5 and 14. All treated piglets were sacrificed at day 21 p.p. During the experimental phase, blood samples were taken from all piglets at days 1, 5, 9, 14 and 21 p.p..

Haemoglobin content was measured photometrically using the cyanhaemoglobinmethod. For haematocrit determination a microcapillary system was used. Serum iron and total iron binding capacity were measured photometrically using specific test kits. Liver iron analysis was performed with atomic absorption spectrometry. Gene expression and protein abundance were determined using qPCR and Western blot analysis, respectively.

Results and Discussion

The study showed that the absence of iron supplementation led to acute anemia with a complete depletion of iron stores within the first three weeks of life in suckling piglets. Parenteral iron supplementation can ensure an adequate supply to avoid iron deficiency as characterized by Rudolphi & Peacock (1977). However, the enormous influx of free iron in the body after parenteral administration represented by the increase of the iron content in the liver and in the serum, suggested oxidative stress. To clarify, further investigations in relation to oxidative stress in the corresponding tissues are necessary.

None of the studied oral supplementation strategies at different times and frequencies achieved the efficiency of the iron injection. Oral administration of iron shortly after birth as it is currently

recommended in practice didn't lead to a noteworthy improvement of iron status compared to the negative control. This is consistent with studies by Lipinski et al (2010) showing an inappropriate transport of iron across the intestinal epithelium in the first days of life. In conclusion, neither single oral supplementation at day 1 nor at day 5 could provide satisfactory results.

In 5/0 a limited improvement can be achieved in the iron status. It is therefore assumed that successful iron absorption from the gut has taken place, but the intake for demand coverage up to day 21 was not sufficient (Pallauf & Kirchgessner, 1974).

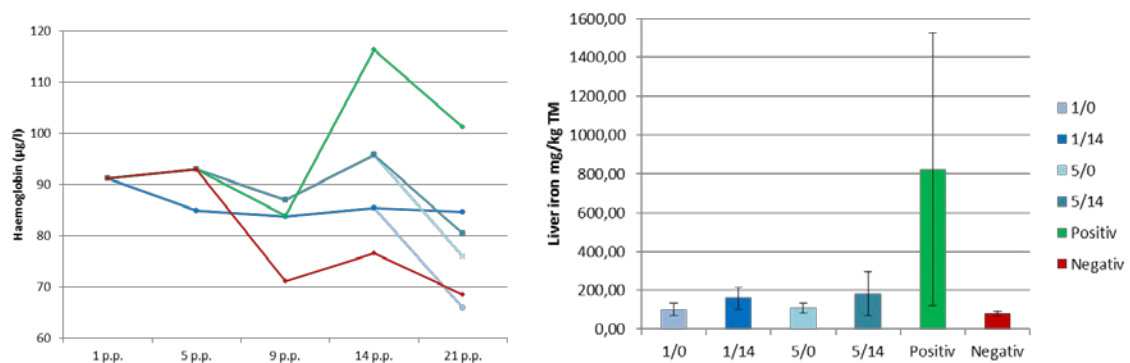


Figure 1a and b: Iron state parameters after different supplementation strategies a) haemoglobin concentration in blood samples during the first three weeks *post partum*. b) Liver iron content 21 days p.p.

Repeated doses on day 14 lead to improved blood parameters during the first three weeks of life.

To further clarify the issue of the earliest possible and meaningful oral iron supplementation the molecular transport processes are currently under investigation on transcriptomic and proteomic levels. Furthermore, oxidative stress parameters are in the focus of the analysis.

Finally, possible epigenetic effects of different iron supply from the sow, on the absorption capacity of the piglets will be investigated.

Conclusion

Absence of iron supplementation in piglets leads to iron deficiency anemia. Parenteral iron application can solve this problem, but poses risks to health. The lack of effect of single oral supplementation of iron could also be clearly demonstrated in this study. However, the results of repeated oral application show positive effects on the iron status of piglets. However, complete elimination of a deficiency state as in the parenteral administration possible, could not be achieved here. Nevertheless, an optimization of this supplementation strategy should be pursued on a more convenient use to the organism without bypassing the natural regulatory mechanisms. This requires further investigation at the molecular level, which can deliver the information about the effects of free iron on the metabolism of the piglet.

Literature

Lipinski P., Starzynski R. R., Canonne-Hergaux F., Tudek B., Olinski R. (2010) Benefits and risks of iron supplementation in anemic neonatal pigs. *Am. J. Pathol.*, 177, 1233–43.

Pallauf J., Kirchgessner M. (1974) Zur Prüfung von Eisenpräparaten in der Anämieprophylaxe bei Saugferkeln. *Züchtungskde.*, 45, 119-132.

Rudolphi K., Pfau A. (1977) ^{59}Fe - Ganzkörperretentionsmessungen zur Beurteilung des Eisenstoffwechsels von Saugferkeln. *Dtsch. Tierärztl. Wschr.*, 84, 434-437.

Corresponding Author

Marzell Buffler

Chair of Animal Nutrition, Technische Universität München

Liesel-Beckmann-Straße 2, 85354 Freising

eMail: marzell.buffler@wzw.tum.de

Phone: 08161/713551

Development of an empirical model to estimate the biogas yield of energy crops

Vasilis Dandikas

Bayerische Landesanstalt für Landwirtschaft, Institut für Landtechnik und Tierhaltung, Am Staudengarten 3, 85354 Freising

Technische Universität München, Lehrstuhl für Siedlungswasserwirtschaft, Am Coulombwall 8, 85748 Garching

Introduction

Energy generation from biogas is an environmentally and economically attractive alternative to fossil fuels. Therefore, the number of agricultural biogas plants increased in recent years. In Germany, most of the agricultural biogas plants are running with maize silage as sole substrate or in a mixture with other energy crops or manure (FNR, 2014). In future, a flexible operation regarding the use of different substrates is needed, in order to sustain or increase the efficiency of biogas plants. Determine the biogas potential is crucial for assessing the feedstock's quality. However the tests are very expensive and time consuming. The aim of this study was to develop a model based on the chemical composition of different energy plants in order to predict the biogas yield quickly and reliably.

Material and Methods

Diverse energy crops, typically feedstock of agricultural biogas plants, were analyzed in order to assess the influence of the chemical composition on the biogas yield. Moreover, two field experiments were carried out. Four grass species and two clover species were grown in field plots and harvested systematically with advancing harvest date in order to investigate the changes in chemical composition of the plants and their effect on the biogas yield. Standardized batch anaerobic digestion test and forage analysis for all samples were carried out. Principal component analysis and regression analysis were conducted, in order to explain mathematical the interconnection between the chemical compounds and the biogas yield of the samples.

Results and Discussion

Based on the unsystematic collected dataset from different energy crops, it was observed that biogas yield (Y_B) and lignin content (ADL) are highly negatively correlated with a correlation coefficient (r) of -0.90. Moreover, it has been shown that the lignin content and the hemicellulose (HC) content can be used for biogas yield prediction across energy crops species (Fig. 1), with an estimation accuracy of 8 % for the calibration and of 10 % for the validation of the model with an independent data set. For the

systematic collected grassland samples values of biogas yield in a range of 500 to 768 L_N/kg_{VS} were recorded, representing a wide spectrum of content of the chemical compounds. The across energy crops model can predict the biogas yield range of the grassland samples, however with low accuracy (12%).

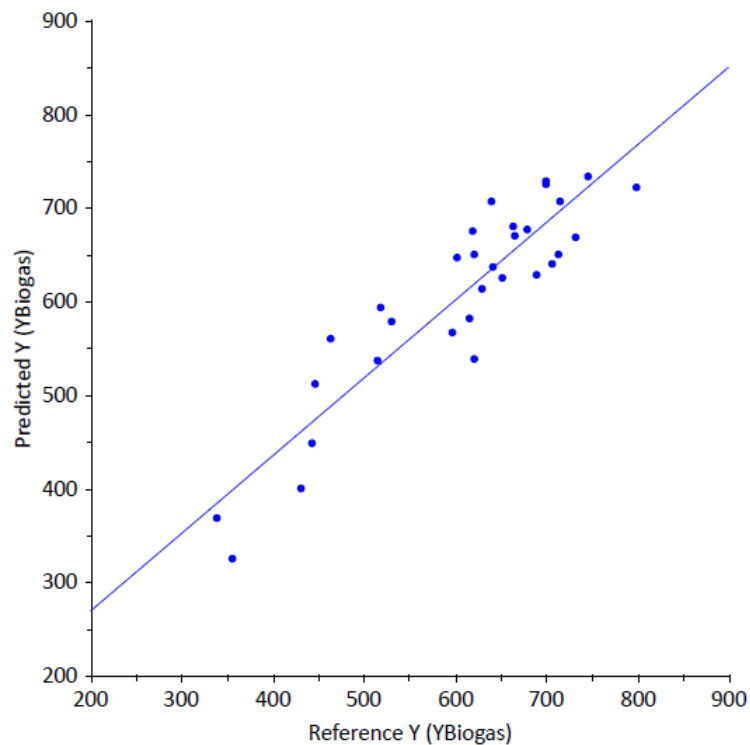


Figure 1: Calibration of the across energy crops model. Observed (reference) versus predicted values of biogas yield of diverse energy crops, expressed in L per kg volatile solids. (Dandikas et al., 2014).

Conclusions

For the estimation of biogas and methane yields across plant species, the following equations are proposed (Dandikas et al., 2014):

$$Y_B \text{ (L}_N\text{/kg}_{VS}) = 727 + 0.25 \text{ HC (g/Kg}_{VS}) - 3.93 \text{ ADL (g/kg}_{VS})$$

In future work, a model calibration with samples of a specific plant group and specific plant species will be carried out in order to improve the estimation accuracy.

Literature

- (1) Dandikas, V., Heuwinkel, H., Lichti, F., Drewes, J.E., Koch, K., 2014. Correlation between biogas yield and chemical composition of energy crops. *Bioresour. Technol.* 174, 316–320.
- (2) FNR, 2014. Bioenergy in Germany: Facts and Figures. Available at: <<http://mediathek.fnr.de/broschuren/fremdsprachige-publikationen/english-books/bioenergy-in-germany-facts-and-figures.html>> (accessed: 31.03.2015)

Corresponding Author

Vasilis Dandikas

Bayerische Landesanstalt für Landwirtschaft, Institut für Landtechnik und Tierhaltung,

Am Staudengarten 3, 85354 Freising, eMail: vasilis.dandikas@lfl.bayern.de, Telefon: 08161 71-3792

Influence of nitrogen fertilization on the *Fusarium* complex of barley

Katharina Hofer

Technische Universität München, Wissenschaftszentrum Weihenstephan, LS für Phytopathologie

Introduction

As in wheat, *Fusarium* head blight (FHB) of barley is known as a destructive disease. The infection results in yield loss, quality reduction and mycotoxin contamination of grain. FHB is caused by a complex of several *Fusarium* species, including *F. culmorum*, *F. graminearum*, *F. avenaceum*, *F. tricinctum*, *F. langsethiae* and *F. sporotrichioides*. Beside toxin spectra, those species vary in their epidemiology and respond differently to environmental and agronomic factors. In addition to soil cultivation methods, crop rotation and barley variety selection, other agronomical tools are necessary to prevent *Fusarium* infection and infestation, especially due to existing persistent lack of barley adapted and licensed fungicide strategies. Therefore, nitrogen application as feasible preventative measure, including potential incalculable risks, is in the focus of the present study.

Nitrogen fertilization acts indirectly by changing canopy parameters like micro climate conditions on the host-parasite-interaction as well as directly by influencing plant physiology.

Material and Methods

Field trials, including various barley varieties and inoculation treatments were carried out to compare selected *Fusarium* species in response to different nitrogen fertilization levels. Quantitative PCR measurements detecting *Fusarium* contamination on barley leaves, spikes and grain material were combined with collecting detailed information of canopy parameters recorded with the assistance of a phenotyping platform.

Results and Discussion

Distinct differences between single *Fusarium* species became apparent. Nitrogen fertilization yielded in supportive and reductive effects for specific *Fusarium* species at which parameters like canopy density, microclimate, degree of soil coverage, plant height and greenness might have played important roles. More detailed information about the influence of single factors will be revealed by correlation analysis.

Conclusions

The present study detected differences in the epidemiology of single *Fusarium* species and their response to nitrogen fertilization. First of all, generated information could support the choice of agronomical tools like nitrogen fertilization to prevent *Fusarium* infestation. Above all, a more detailed knowledge about *Fusarium* epidemiology and *Fusarium*-barley-interactions will contribute to future improvements and developments towards effective fungicide control strategies.

Corresponding Author

Katharina Hofer, Technische Universität München, LS für Phytopathologie,
Emil-Ramann-Straße 2
85350 Freising-Weihenstephan
eMail : katharina.hofer@mytum.de
Phone : 08161/71-3737

Ascertainment of nutrient flows on dairy farms – farm scale analysis under Bavarian site conditions

Brigitte Köhler

Bavarian State Research Center of Agriculture, Department of Animal Nutrition and Feed Management, Poing-Grub, Christian-Albrechts-University, Institute of Crop Science and Plant Breeding, Grass and Forage Science/Organic Agriculture, Kiel.

Introduction

Dairy farms face challenges due to increasing production, loss of agricultural land and land use change, while being obliged to reduce environmental impacts at the same time (1). Therefore, the efficiency optimization in feed management is highly relevant for a sustainable and economical feed production (2). In Europe grassland – which covers 35 percent of the utilized agriculture area (3) – is an important feed and protein source in dairy farming systems. A major approach to improve the nutrient use efficiency is to reduce feed losses from “field to trough”. An efficient silage system for feed production should ensure a low level of losses and a high silage quality. A better control of the feed management requires a permanent measuring of the mass and nutrient flows on farm scale (4). The aim of this thesis is to investigate these flows in feed management in an overall analysis. Its results will bring new findings concerning nutrient flows for the use in balance and system evaluation models on dairy farming systems.

Material and Methods

The mass and nutrient flows were examined on five farms in Bavaria which belong to the Bavarian State Research Center for Agriculture. The feed sources of the farms involved permanent grassland, maize and further forage crops such as grass-clover mixture or lucerne. Data were collected over a period of four years from 2009 to 2012. Figure 1 shows the principle of measurements from harvesting to feeding. The analyses were focused on yields of permanent grassland as well as dry matter (DM) and nutrient losses of silages of all fodder crops. The grassland was examined on field scale to investigate variation of DM yields. The total-in versus total-out procedure was defined as the method to determine the DM losses in the farm scale bunker silos, executed by selected farms. Samples were taken to determine the fodder

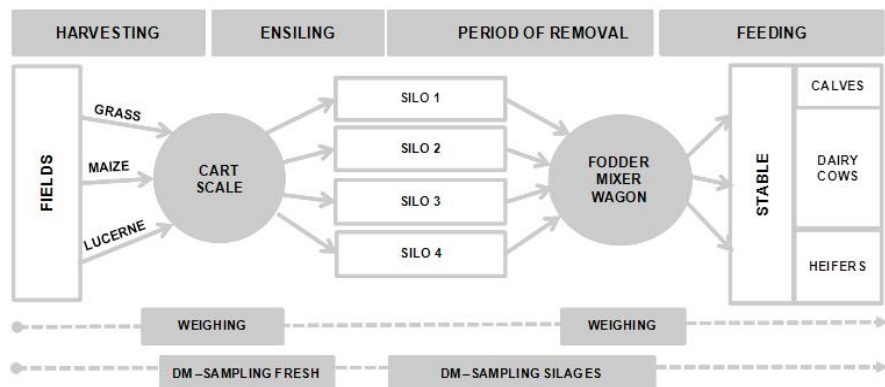


Figure 1 Principle of measurements based on farm scale

quality and further parameters according to the “Silo Controlling” method (5). Evaluation of all data was carried out by statistical analysis.

Results and Discussion

The results of DM yields from grassland on a four-year average ranged from 60 to 97 dt ha⁻¹ per farm under intensive cutting regimes (three to five) with high (> 200 kg N ha⁻¹) and low (< 200 kg N ha⁻¹) level of nitrogen fertilization per year. Several site conditions like sward type, temperature of vegetation period (sum > 5°C), annual precipitation and management factors such as cutting regime and nitrogen level influenced the DM yields. Noticeably, there were high variations between the fields on every farm. Further results concerning the protein yields and the nutrient balances from the grassland of the farms are in progress. The measurement of grassland yields can help to adjust the fertilization according to the nutrient removal.

During further evaluations data of silages from the whole period were examined to determine DM and nutrient losses. In the first step of these investigations the DM losses of grass, lucerne and maize silages in farm scaled bunker silos were analyzed. The results from 48 silos revealed an average DM loss of 9 – 12 percent for all investigated crops. Density and feed out rate showed a negative correlation to DM losses in maize silages (6). Further investigations will include the changes of the nutrient contents and of the feed quality. Data evaluation concerning these aspects is in progress.

Conclusions

The thesis describes a method to determinate mass and nutrient flows on farm scale. This method provides the basis to optimize the feed management. A systematic control enables farmers to reduce nutrient and feed losses in dairy farming systems. In daily practice automatic collection systems should be used more widely, as these systems could pave the way to precision farming.

Literature

- (1) Taube, F., Gierus, M., Hermann, A., Loges, R., Schönbach, P. (2013). Grassland and globalization – challenges for northwest European grass and forage research. *Grass and Forage Science* 69, 2–16.
- (2) Humphreys, J., Aarts, H.F.M., Watson, C.J., Wachendorf, M., Le Gall, A., Taube, F., Pflimlin, A. (2009). Sustainable options for grassland-based dairy production in the northwest of Europe. *Tearmann: Irish Journal of Agri-Environmental Research* 7, 175–194.
- (3) Smit, H.J., Metzger, M.J., Ewert, F. (2008). Spatial distribution of grassland productivity and land use in Europe. *Agric. Sys.* 98, 208–219.
- (4) Köhler, B., Südekum, K.-H., Spiekens, H., Taube, F. (2014). Quantitative Erfassung von Masse- und Nährstoffströmen im Futterbaubetrieb. *VDLUFA Schriftenreihe* 70, 406–410, *in press*.
- (5) Spiekens, H., Ostertag, J., Meyer, K., Bauer, J., Richter, W. (2009) Managing and controlling silos to avoid losses by reheating of grass silages. In: Broderick, G.A. et al (eds). *Proceedings of the 15th International Silage Conference 27-29 July, Madison, USA*, 317–318.
- (6) Köhler, B., Diepolder, M., Ostertag, J., Thurner, S., Spiekens, H. (2013). Dry matter losses of grass, lucerne and maize silages in bunker silos. *Agricultural and Food Science, Special Issue of the XVI. International Silage Conference in Hämeenlinna, Finland, Vol. 22 No.1*, 145–150.

Corresponding Author

Brigitte Köhler
LfL Bayern, Prof.-Dürrwaechter-Platz 3, D-85586 Poing-Grub
eMail: Brigitte.koehler@lfl.bayern.de, Phone: 089-99141417

Animal welfare in aquaculture – non-invasive stress measurement in fish holding water

Kay Lübke

Bayerische Landesanstalt für Landwirtschaft, Institut für Fischerei
LMU, Tierärztlichen Fakultät, Lehrstuhl für Fischkrankheiten und Fischereibiologie

Introduction

Today the issue of animal welfare is of increasing importance, especially in farmed fish. Both, consumers and producers, are highly interested in a good welfare status of the fish for ethical, as well as product quality reasons (1). In this context some methods used in aquaculture, e. g. high stocking densities or raising fish in artificial habitats, came under criticism. To evaluate common husbandry actions in aquaculture a novel, non-invasive method for measuring (the most important stress parameter (2)) cortisol in fish holding water is used in this project.

Material and Methods

In a first pretest the time course of an acute stress reaction was determined in different local aquaculture species (rainbow trout, common carp and african catfish). Therefore, a management action was accompanied by a series of samplings. For each species the stock of one tank was caught by net, weighted and stocked to another similar tank. Daily cortisol release and the reaction on potentially stress initiating factors such as noise (single sound 113 dB, one hour noise with max 90 dB) and disturbance through the night were studied in two different size classes of rainbow trout under controlled conditions.

For all procedures water samples were taken at the outflow of the tank directly before and during a subsequent period after the conducted action. The water samples were immediately frozen (-20°C) in glass bottles. For the analysis of cortisol the samples were processed in a solid phase extraction to concentrate the hormone. After the elution of cortisol with ethyl acetate the amount of cortisol in the samples was determined by ELISA (3,4). To compare different situations the cortisol release rate, which corrects for the water volume, flow rate and fish biomass was calculated (5).

Results and Discussion

The course of cortisol release after an acute stress was very similar in trout and carp. The highest release rate was detected in the first 30 minutes after transferring the fish (Fig. 1a). Afterwards, the cortisol release quickly decreased and reached basic values under 1 ng/(g*h) within one to two hours. This was observed in other studies, too (4). For african catfish the highest release rate was measured during the first 30 minutes, too but the value was much smaller than in carp or trout (Fig. 1b). Furthermore, release rates were elevated for a longer period and reached species specific basic values within three to four hours post stress. Altogether, the cortisol reaction on acute stress was clearly species specific. In general, basic values are re-reached within a short time frame.

Under the experimental conditions especially the small rainbow trout showed a daily cycle with maximum cortisol release rate after midnight and during the morning time. This finding agrees with other studies (6). The applied acoustic stimuli did not result in a clear cortisol response. So, the used

noise levels were found to be too low to evoke a stress reaction in trout (7). Likewise, the disturbance at night by suddenly switching on the light, led to no significant change in cortisol release. However an intense, undirected swimming activity was observed in this case. This shows that behavioral changes can occur, which are not necessarily reflected in a change of the cortisol release.

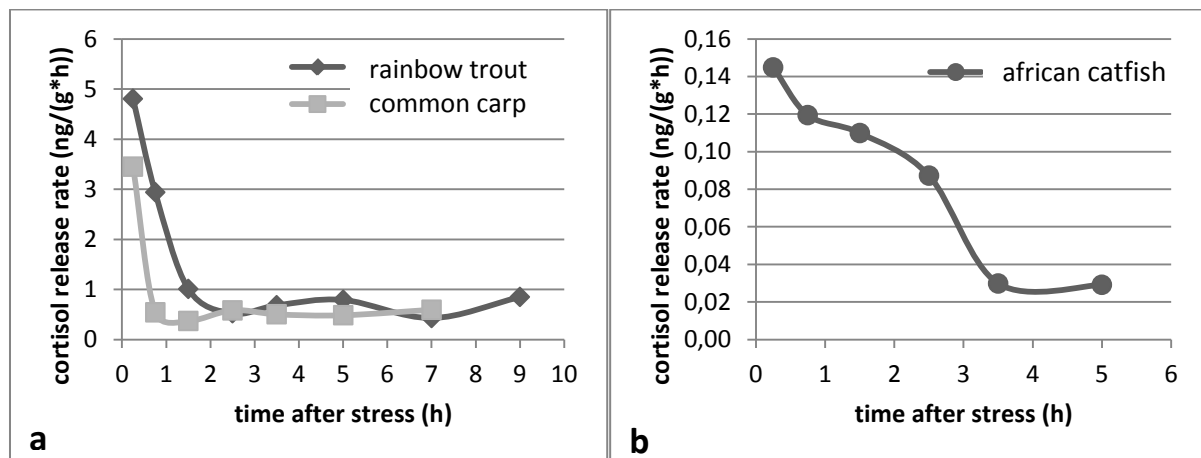


Fig. 1 a+b: Course of cortisol release after transfer of fish. a: Rainbow trout and common carp. b: African catfish. The values are plotted in the middle of the respective time interval (0-0.5-1-2-3-4-6-8-10h). Note the different scaling of x and y-axis.

Conclusion

The measurement of cortisol in fish holding water is an implemental method for evaluation of stress in fish. This method can contribute to the assessment of animal welfare in aquaculture. However, specific reference release values have to be established for the different species, age classes and sexes. Furthermore, the cortisol release can only be one part in the evaluation of animal welfare in aquaculture systems next to, for example behavioral observations, monitoring of environmental quality and measuring other physiological traits.

Literature

- (1) North, B. P., Turnbull, J. F., Ellis, T., Porter, M. J., Migaud, H., Bron, J., & Bromage, N. R. (2006). The impact of stocking density on the welfare of rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 255(1), 466-479.
- (2) Wedekind, H. und Schreckenbach, K. (2004). Grundlagen und Wirkmechanismen von Stress bei Fischen. Tagungsband Seminar „Tierschutz in der Fischerei“, 31. Januar 2004, Schriftenreihe des Landesfischereiverbandes Baden-Württemberg, Heft 2: 43-48.
- (3) Ruane, N. M. & Komen, H. (2003). Measuring cortisol in the water as an indicator of stress caused by increased loading density in common carp (*Cyprinus carpio*). *Aquaculture* 218, 685–693.
- (4) Ellis, T., James, J. D., Stewart, C. & Scott, A. P. (2004). A non-invasive stress assay based upon measurement of free cortisol released into the water by rainbow trout. *Journal of Fish Biology* 65, 1233–1252.
- (5) Adams, S. M. & Breck, J. E. (1990). Bioenergetics. In *Methods for Fish Biology* (Schreck, C. B. & Moyle, P. B., eds.), pp. 389–415. Bethesda, MD: American Fisheries Society.
- (6) Reddy, P. K., & Leatherland, J. F. (1995). Influence of the combination of time of feeding and ration level on the diurnal hormone rhythms in rainbow trout. *Fish physiology and biochemistry*, 14(1), 25-36.
- (7) Wysocki, L. E., Davidson, J. W., Smith, M. E., Frankel, A. S., Ellison, W. T., Mazik, P. M., Popper, A. N. & Bebak, J. (2007). Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout *Oncorhynchus mykiss*. *Aquaculture*, 272(1), 687-697.

Corresponding Author

Kay Lübke, LfL, Inst. für Fischerei, Weilheimer Straße 8, 82319 Starnberg,
eMail: Kay.Luebke@lfl.bayern.de, Tel: 08151/2692154

Succession in Horticultural Family Businesses – Determining Factors

Stefan Mair

TUM, Chair Economics of Horticulture and Landscaping

Introduction

According to the Institut für Mittelstandsforschung (IfM)¹ within the five year period from 2014 to 2018 approximately 135.000 small and medium-sized businesses will have to find a way to master the process of succession. 3.400 of these belong under the agricultural sector and in 54% of these enterprises succession within the family is favored (IfM, 2013). Consequently during the five year period specified above, about 1.840 transitions from Generation to Generation have to be managed. A preliminary explorative study, composed of expert interviews with employees of horticultural consultancies and representatives of associations and public administration affirmed the actuality of the issue of Succession in Horticultural Family Businesses and the prospectively growing importance.

Material and Methods

To identify relevant determining factors in the decision process of intra family successions, a qualitative approach was chosen. Strübing² describes the fundamental characteristic of qualitative research as “[...] the idea not to >Measure<, but to gain and interpret process bound knowledge.” Applying Grounded Theory Methodology, the source data for analysis and reflection was built from digital recordings of interviews conducted in 12 horticultural enterprises located in different regions in Germany. 8 predecessors and 8 successors (1 female) were interviewed and to get different views on one and the same succession process it was attempted to talk to persons of both generations within the same company. Using f4 software the recordings were transcribed and excluding preliminary talk the transcribed contents concerning succession comprised 23 minutes to 68 minutes. The qualitative analysis was supported by the use of the specialized software ATLAS.ti.

Preliminary Results

So far Socialization and choice of identity of the potential successors were identified as important determining factors. Further analysis focuses on categories as communication between the involved persons, explicitly or implicitly perceived obligations and also on the interdependency of the different categories. Likewise considered is the influence of the spouses and life partners on the development of the succession. To increase the density of both, the analysis and the emerging theory as well as to meet the requirements of theoretical saturation, further interviews especially with female successor are projected.

Literature

- (1) Kay, R.; Suprinovič, O. (2013): Unternehmensnachfolgen in Deutschland 2014 bis 2018, in: Institut für Mittelstandsforschung Bonn (Hrsg.): Daten und Fakten Nr. 11, Bonn
- (2) Strübing J. (2014): Grounded Theory. Zur sozialtheoretischen und epistemologischen Fundierung des Verfahrens der empirisch begründeten Theoriebildung. (p. 83) 3. Aufl. Wiesbaden: Springer

Corresponding Author

Stefan Mair
TUM Chair Economics of Horticulture and Landscaping
Alte Akademie 16, 85354 Freising
eMail: stefan.mair@tum.de
Telefon: 08161-71-2541

Stratification of the Brown Swiss and Fleckvieh population

Laura Plieschke

Bavarian State Research Center for Agriculture, Institute of Animal Breeding
Institute of Animal Husbandry and Breeding, University Hohenheim

Introduction

Genomic selection [1] is a new method to estimate breeding values for the selection of livestock. It uses a large number of DNA markers, evenly spread over the entire genome, to derive - amongst other things - improved estimates of the true genetic relationship between the animals of a breeding population. These improved estimates are typically summarized in a single matrix called the genomic relationship matrix. This matrix also allows to characterize the genetic structure of a population and to study population stratification even in the absence of pedigree information. Since population subdivision can have a negative impact on the prediction of breeding values, it is important to measure the magnitude of the subdivision in order to decide whether special methodological adoptions are necessary. For the two breeds Brown Swiss (BS) and Fleckvieh (FV) genomic selection was implemented in 2011. The breeding populations of both breeds are spread across several countries and this was the motivation to analyze the population structure of both breeds in detail. We therefore derived and analyzed genomic relationship matrices for both breeds.

Material and Methods

The datasets consisted of genotypes from the common genotype pools of the transnational breeding value estimation. The current results are based on 7,965 FV and 4,400 BV animals that were genotyped with the Illumina 50k-Chip which contains approximately 50,000 SNP markers. These genotypes are also used for the routine prediction of genomic breeding values. Various methods to visualize population structures were used. These included, among others, principal component analysis (PCA) [2] and F_{st} statistics [3]. Both methods use the genomic relationship matrix to detect population subdivision. In addition, a new method was developed to separate the overall genetic distance between subpopulations to a distance already existent in the base population and into the distance which is caused by the actual breeding process of the recent past.

Results and Discussion

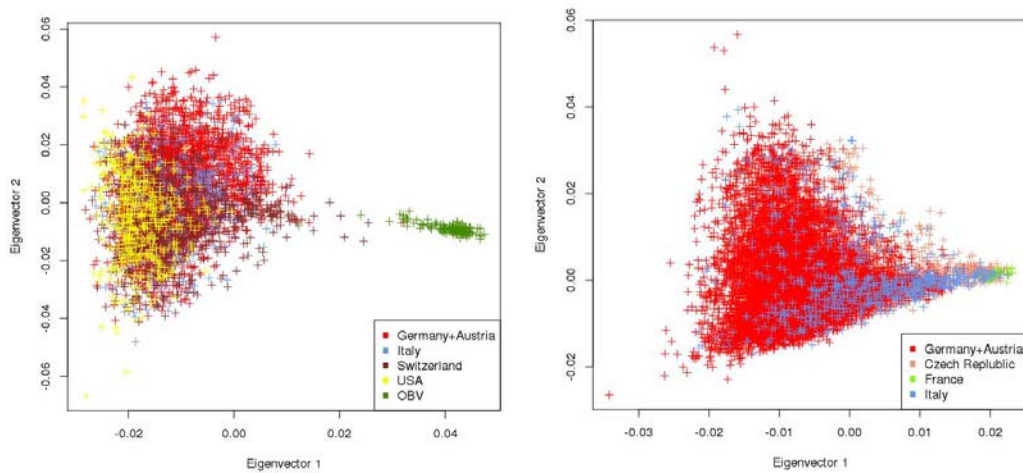


Figure 2: PCA-Plot of both breeds. Left hand side: PCA-Plot of Brown Swiss; right hand side: PCA-Plot of Fleckvieh. Different colors mark different countries.

The two figures show that in both breeds some degree of stratification can be found. In the case of FV we found no clear separation into individual "population-clouds", but it can be seen from the coloration that there are some genetic distances between countries. For BS, we found two distinct subpopulations, with the smaller cloud representing the animals of the Original Braunvieh (OBV) and the larger cloud representing the main population of BS. Also within the main population, we found some degree of separation. Additionally we can show that the greater proportion (up to 76%) of the genetic distance between OBV and BS can be assigned to a distance already present within the genetic base population. The base population was defined with the help of the known pedigrees, which can be traced back in most cases to the 50/60's of the last century.

Conclusions

With this investigation we could demonstrate that there is some genetic differentiation between the animals of the different countries in both breeds. For BS the greater part of the differences found between OBV and the main population of BS can be traced back to a distance already existent in the genetic base fifty to sixty years ago. Besides the difference found between OBV and BS all other stratifications within breeds are not very pronounced, so it can be concluded that a specific adjustment of the established methods to estimate genomic breeding values is currently not necessary.

References

- (1) Meuwissen THE, Hayes BJ, Goddard ME. *Genetics* 2001; 157:1819–1829.
- (2) Patterson N, Price AL, Reich D. *PLoS Genetics* 2006; 2:2074-2093.
- (3) Weir BS, Cockerham CC. *Evolution* 1984; 38:1358-1370.

Corresponding Author

Laura Plieschke
 Bayerische Landesanstalt für Landwirtschaft, Institut für Tierzucht, Prof.-Dürrwachter-Platz 1,
 85586 Poing-Grub, Laura.Plieschke@lfl.bayern.de, Telefon: 089/99141-149

Molecular assay for rapid quantification of *Rhizoctonia solani* AG2-2IIIB in soil

Anne-Catherine Renner

Bavarian State Research Center (LfL), Institute for Plant Protection (IPS3c), Freising

Introduction

Rhizoctonia solani AG2-2IIIB is the causal agent of late crown and root rot in sugar beet (*Beta vulgaris* subsp. *vulgaris*) and causes considerable yield losses worldwide. Besides the broad host range of the soilborne fungus, its occurrence in patches and the absence of authorized chemical control products are the main reasons for the difficulties in controlling *R. solani*. It is known that *R. solani* occurs ubiquitously and the onset of the disease is strongly influenced by external factors like crop rotation, soil structure, soil moisture and temperature. In order to study the impact of different agricultural practices and the influence of environmental factors on the inoculum potential of *R. solani* AG2-2IIIB, a specific molecular quantification assay was established at the Institute for Plant Protection of the Bavarian State Research Center ⁽¹⁾.

Material and Methods

The molecular assay is based on a seed baiting technique combined with quantitative real time-PCR and was called quinoa-qPCR-assay. First, up to six soil samples were randomly taken from each plot, which were then pooled, homogenized and passed through a 4-mm mesh sieve to remove plant debris. Two subsamples of the pooled soil sample were then filled into two petri dishes with 150 g soil each. On top of the soil of each petri dish 32 autoclaved quinoa seed (*Chenopodium quinoa*) baits, as described by Thornton et al. ⁽³⁾, were evenly distributed. The baits were used to extract the actively growing mycelia from the soil. After an incubation period of 6 d at 25°C, the *R. solani* infested quinoa seeds were used for total DNA extraction. Then the *R. solani* AG2-2IIIB DNA was quantified using a SYBR green based qPCR system (primer sequences by Budge et al. ⁽²⁾). In order to convert Ct values to sclerotia numbers per gram soil, a standard curve was set up by using *Rhizoctonia*-infested poppy seeds, which were comparable in size of typical sclerotia formed by *R. solani* AG2-2IIIB. One infested poppy seed was set equal to one sclerotium (or 1 CFU).

Results and Discussion

The *R. solani* AG2-2IIIB specific molecular quantification method (quinoa-qPCR assay) is used in a wide range of applications to monitor changes in the inoculum potential of *R. solani* in soil. In a three year field test, the impact of energy and protein crops (like maize, sorghum, soybean and wheat) as part of crop rotation sequence patterns with sugar beet on the soil inoculum density of *R. solani* AG2-2IIIB are investigated. Results to date have shown that maize and sorghum produced highest *R. solani* inoculum levels in soil (up to 7 CFU/300 g soil) whereas very low *R. solani* amounts (2 CFU/ 300 g soil) were detected in wheat plots. The results of the quinoa-qPCR assay were similar to those achieved by plant ratings. The specific and fast detection (only 7 days) of *R. solani* AG2-2IIIB with the quinoa-qPCR assay is

advantageous compared to non-molecular methods. Moreover the quinoa-qPCR-assay is very sensitive (detecting 1 sclerotium in 1 kg soil). For routine soil testing pooled samples of 300 g are most cost and time efficient. Depending on available equipment and staff up to 100 samples can be processed simultaneously.

Conclusions

The results imply that the quinoa-qPCR assay is a valuable method for researching the interaction of agricultural practices and environmental factors triggering *Rhizoctonia* root rots. In future the quinoa-qPCR assay will be used for investigations of *R. solani* risk areas identified by geo-referenced data analysis. Furthermore, the routine use of the method for prediction of *R. solani* disease outbreak followed by practical advice to farmers on matters such as choice of variety is examined.

Literature

- (1) Boine B., Renner A., Zellner M., Nechwatal J. (2014) Quantitative methods for assessment of the impact of different crops on the inoculum density of *Rhizoctonia solani* in soil, *European Journal of Plant Pathology* 140, 745-756
- (2) Budge G. E., Shaw M. W., Colyer A., Pietravalle S. & Boonham N. (2009) Molecular tools to investigate *Rhizoctonia solani* distribution in soil, *Plant Pathology* 58, 1071–1080
- (3) Thornton C. R., O'Neill T. M., Hilton G. & Gilligan C. A. (1999) Detection and recovery of *Rhizoctonia solani* in naturally infested glasshouse soils using a combined baiting, double monoclonal antibody ELISA, *Plant Pathology* 48, 627–634

Corresponding Author

Anne-Catherine Renner
LfL Institut für Pflanzenschutz
Lange Point 10, 85354 Freising
eMail: anne-catherine.renner@lfl.bayern.de
Telefon: 08161-71 5658

Genomic selection across breeding cycles in rye (*Secale cereale* L.)

Manfred Schönleben¹, Eva Bauer¹, Malthe Schmidt², Andres Gordillo², Peer Wilde², Viktor Korzun², and Chris-Carolin Schön¹

¹Technische Universität München, Plant Breeding; ²KWS LOCHOW GmbH

Introduction

Advances in molecular and statistical genetics encouraged the application of genomic selection (GS) as a tool for plant variety improvement (1-2). The key feature of GS is the accurate prediction of the breeding value of unphenotyped individuals based on their DNA profile. In plant breeding applications, within and across breeding cycle prediction scenarios arise (Figure 1 **A**). While the prediction accuracy within cycles can be seen as initial indicator for a successful incorporation of GS into breeding programs, the key interest of the breeder lies in the prediction of selection candidates from future breeding cycles. Our objectives were to i) investigate and contrast genomic and pedigree-based prediction within and across four interconnected cycles of a hybrid rye breeding program, and ii) evaluate the importance and effect of genotype by year interactions on the prediction performance of three economically important traits.

Material and Methods

The study comprised data of 1,040 S₂ inbred lines from the rye pollen parent pool, genotyped with 10,416 single nucleotide polymorphism (SNP) markers. Selection candidates were phenotyped as testcrosses for the traits grain dry matter yield (GDY), plant height (PHT) and thousand kernel weight (TKW) at multiple locations in Germany over four years. We applied pedigree (PBLUP) and genomic best linear unbiased prediction (GBLUP), combined with five-fold cross validation.

Results and Discussion

Within breeding cycles, GBLUP yielded intermediate to high prediction accuracies for the traits GDY, PHT and TKW and outperformed PBLUP in all instances. In across cycle prediction scenarios, we observed for all traits promising prediction accuracies of GBLUP. Here, the superiority of GBLUP over PBLUP became even more evident (Figure 1 **B**). Prediction performance of GBLUP could be improved when data from multiple cycles were combined in the calibration set.

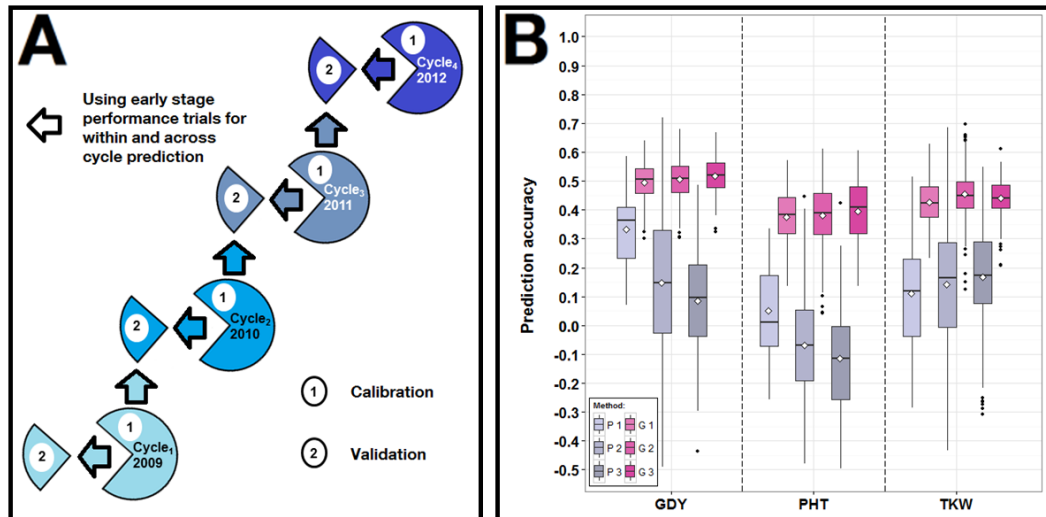


Figure 3: (A) Succession of four breeding cycles in time, displaying two distinct cross-validation schemes for predicting within (horizontal arrows) and across breeding cycles (vertical arrows). Numbers indicate the fraction of S_2 lines used for model calibration (1) and validation (2). (B) Colour coded across cycle prediction accuracies using ten times replicated five-fold cross validation for traits grain dry matter yield (GDY), plant height (PHT) and thousand kernel weight (TKW) from PBLUP (light blue) and GBLUP (violet), with number of cycles (P1, P2, P3, or G1, G2 and G3) forming the calibration set.

Conclusions

Our results show GBLUP prediction accuracies at high levels, suited for a successful implementation of GS in within and across cycle prediction scenarios. In conclusion, GBLUP takes advantage of an increasing number of phenotypes available from multiple cycles and successfully handles possible genotype by year interactions.

Literature

- (1) Meuwissen, T.H.E., Hayes, B.J., Goddard, M.E. (2001) Prediction of total genetic value using genome-wide dense marker maps. *Genetics* 157, pp 1819–1829
- (2) Wimmer, V., Albrecht, T., Auinger, H.-J., Schön, C.-C. (2012) Synbreed: a framework for the analysis of genomic prediction data using R. *Bioinformatics* 28, pp 2086–2087

Corresponding Author

Manfred Schönleben
 Technische Universität München, Lehrstuhl für Pflanzenzüchtung,
 Liesel-Beckmann-Str. 2, D-85354 Freising
 eMail: manfred.schoenleben@tum.de
 Telefon: +49.8161.71.5141

How raw data become an indicator system – a useful way for benchmarking, modelling and compiling statistics

Martin Strobl

Bayerische Landesanstalt für Landwirtschaft, Institut für Betriebswirtschaft und Agrarstruktur, München, TUM, Produktions- und Ressourcenökonomie landwirtschaftlicher Betriebe

*Bavarian State Research Centre for Agriculture, Institute for Agricultural Economics and Rural Structural Development, Munich
TUM, Chair of Agricultural Production and Resource Economics*

Introduction

Compiling annual statistics on the situation of the Bavarian biogas production, to evaluate and benchmark the efficiency of a single biogas plant or to discuss the sustainability of its power input in the national grid in context to the national power mix, each of these objectives requires a catalogue of technical, economic and ecological indicators. To ensure the validity and reliability of each indicator, it needs a unique key and definition. Calculating an indicator for an individual plant, the definition describes how its value is directly or indirectly based on raw data of the real production process.

Methods

The definition of a single indicator is based on a concept with five steps.

- 1) Definition of terms
- 2) Scope of accounting
- 3) Areas of accounting
- 4) Stock flows
- 5) Definition of indicator

The concept is discussed using the example of the agricultural biogas production. To establish a basis for abstracting and modelling agricultural biogas plants, biogas specific terms were defined (step 1). The definitions gather objects of a similar type under a similar term. This is like a first pre-modelling. For example labels the term “digester” every vat that has the function of pre-digestion, the main-digestion or after-digestion of the fermenting mixture.

These definitions enable to determine a border of accounting (step 2). The border of accounting explicitly marks off the biogasspecific things of a farm (i.e. investments, labour-input) to other non-biogasspecific things of the farm.

Next, defined areas of accounting divide the border of accounting into several zones (step 3). Such sections are e.g. the substrate production, the substrate harvesting as well as the substrate transportation. This higher level of detail makes the handling of special problems, regarding to the biogas production and biogas utilization, possible. Analyzing the biogas plant, it is possible to group several areas of accounting individually.

Furthermore, stock flows were defined between the single areas of accounting (step 4). The term stock flow labels every flow of goods, services and rights into or out an area of accounting. On this note, stock flows are the labelled mapping of actually occurring flows of materials, money or other resources. Stock flows define what type of material is considered, what area of accounting is affected and whether it is either in inflow or an outflow.

It is important to distinguish between absolute (measurable) and derivative indicators [1] (step 5). The definition of measurable indicators is based in information associated to the stock flows or the objects. In that context, stock flows have a multitude of attributes. E.g. imaginable attributes of the stock flow substrate input are the attribute fresh mass or the dry matter contents. In that way, every single combination of an attribute and a stock flow or an object determines an absolute (measurable) indicator. In the mentioned example these are the absolute indicator fresh mass input and dry matter content at the substrate input.

Derivative indicators result from the mathematical accounting of several absolute indicators. For example, the product of the two absolute indicators fresh mass input and dry matter content at the substrate input is equal to the derivative indicator dry mass input.

Results

The concept has been applied in several projects since 2005. Each project both benefits and complements the catalogue of indicators. Besides providing an insight into an individual plant, they allow vertical ratings, horizontal ratings and statistics as well. For that purpose the indicator must be coordinated with colleagues and throughout the whole branch (e.g. "DLG-Standard BZA Biogas" [2], VDI 4631 [3]).

Conclusions

The discussed concept to define indicators proved itself as a valid and reliable way to describe, generate and transmit in indicator compacted raw data information for any purpose. The unique key and definition decreases the risk of misunderstandings in form and content. It allows its efficient data processing in computer-based models and therefore ensures a high multiplier effect.

Literature

- (1) Vollmuth, H. (2005): Kennzahlen. 3. Auflage, Rudolf Haufe Verlag, München, 2005, ISBN 3-448-06323-1, p 9
- (2) Strobl, M. (2011): Handbuch Betriebszweigabrechnung für Biogasanlagen – Einzelbetriebliches Controlling für Praxis und Beratung. 1. Auflage, HLBS Verlag, Sankt Augustin, 2011, ISBN 978-3-89187-063-3, p 9
- (3) Strobl, M.; Bachmaier, H.; Effenberger, M.; Keymer, U.: Bilanzierung von landwirtschaftlichen Biogasanlagen – Energiegestehung aus Biogas: Modellierung und verfahrenstechnische Kennzahlen, Arbeitspapier als Vorlage für die VDI 4631. Bayerische Landesanstalt für Landwirtschaft, München: September 2006 (unveröffentlicht)

Corresponding Author

Martin Strobl

Bayerische Landesanstalt für Landwirtschaft, Institut für Betriebswirtschaft und Agrarstruktur

Menzinger Str. 54, 80638 München

eMail: martin.strobl@lfl.bayern.de

Telefon: 0049 89 17800 -474

Abstracts Poster

Influence of tail docking, housing conditions and stocking density on the appearance of cannibalism in weaning piglets

Miriam Abriel, Christina Jais and Klaus Reiter, Institute for Agricultural Engineering and Animal Husbandry, Bavarian State Research Center for Agriculture, DE-85586 Poing – Grub

Heinz Bernhardt, Chair of Agricultural System Technology, Technische Universität München, DE- 85354 Freising – Weihenstephan

The major part of the weaner and finishing pigs in Germany are kept in housing systems with slatted floors without litter, because of procedural, hygienic and economic reasons. These housing systems are characterized by a low-stimulus environment and few possibilities to explore or manipulate. Many publications mention the low-stimulus environment to be the primary cause for tail biting [1, 2, 3, 4, 5, 6]. Tail docking is the most effective method to reduce tail biting [1, 7], but in the EU it is not allowed to be carried out routinely [8]. Nevertheless, it is the common practice in Germany and so almost all of the conventional pigs are tail-docked [3,9].

The first aim of the study was to estimate the risk of tail biting in conventional housing systems arising from leaving the tails undocked. Another aim was to find practices to prevent tail biting and stop it in case of an outbreak.

In four trial runs with a total of about 830 piglets, the influence of tail docking as well as housing conditions on the appearance of tail biting in weaners was examined. In addition the effect of counteractions in case of the appearance of cannibalism should be tested.

In the first two trial runs 50% of the piglets were docked and the other 50% were left undocked. They were housed in conventional pens with only one enrichment object (ball), four pens with docked piglets, four pens with undocked piglets.

In the next two trial runs, all piglets were left undocked and half of the pens were highly enriched and the stocking density was reduced.

Docking the tails was the most secure way to suppress tail biting. This was the only trial version in which no cannibalism appeared. In the conventional pens with undocked piglets, tail biting was strongly pronounced. In the trial versions with enriched pens, tail biting was reduced significantly, but could not have been suppressed completely. Counteractions in case of tail biting proved to be effective.

(1) EFSA (2007): Scientific Report on the risks associated with tail biting in pigs and possible means to reduce the need for tail docking considering the different housing and husbandry systems. The EFSA Journal, 611, 1-98.

(2) Knoop, Dr. Stephanie (2010): Literaturlauswertung zum Thema Schwanzbeißen / Schwänze kupieren, Landesanstalt für Schweinezeit – LSZ, Boxberg

(3) Knoop, Dr. Stephanie, Schrade, Hansjoerg (2010): Problematik Schwanzbeißen/Schwänze kupieren bei Schweinen, Landesanstalt für Schweinezeit – LSZ, Boxberg

(4) Moinard, C., et al. (2000): Investigations into risk factors for tail-biting in pigs on commercial farms in England, UK; Proceedings of the 9th International Symposium on Veterinary Epidemiology and Economic

- (5) Taylor, N., Edwards, S., Main, D., Mendl, M., Armstrong, D., Parkes, K., Parker, R. (2010): Management tool for predicting tail biting, British Pig Executive (BPEX)
- (6) Taylor, N. R. et al. (2012): Prevalence of risk factors for tail biting on commercial farms and intervention strategies. The Veterinary Journal (194), 77-83
- (7) McGlone, J.J.; Sells, J.; Harris, S.; Hurst, R.J.(1990): Cannibalism In Growing Pigs: Effects Of Tail Docking And Housing System On Behavior, Performance And Immune Function; Texas Tech Univ. Agric. Sci. Tech. Rep. No. T-5-283. pp 69-71.
- (8) Richtlinie 2001/93/EG der Kommission vom 9. November 2001 zur Änderung der Richtlinie 91/630/EWG über Mindestanforderungen für den Schutz von Schweinen
- (9) Compassion in World Farming (2008): Schweinehaltung in Europa: Ein Zustandsbericht
http://www.provieh.de/downloads_provieh/ciwf_zustandsbericht_schweinehaltung_eu.pdf

Corresponding Author

Miriam Abriel

TU München, Center of Life and Food Sciences, Agricultural Systems Engineering,
Am Staudengarten2, D-85354 Freising-Weihenstephan, Germany

Miriam.Abriel@lfl.bayern.de

Dairy Conflict and resulting association structure – Economic and emotional effects of market liberalization

Jan Alpmann

TUM, WZW, Freising, Chair Economics of Horticulture and Landscaping

Introduction

The dairy sector has to meet the challenges of markets in the process of liberalization resulting in increasing fluctuations in prices. The competitive pressure in dairy farming in Europe is growing due to the political decision to abolish the dairy milk quota. Many German farmers reacted with protests and demonstrations, milk delivery strikes, blockades of streets and dairies, and public milk obliteration. Furthermore, while many farms are struggling with financial distress, emotionalized conflicts between farmers and within farm families ensued. In the course of these developments a remarkable number of farmers lost confidence in the German Farmers Association as well as in the European and Federal agricultural policy.

There are different studies regarding the development of milk prices and the impact of the reform of the Common Agricultural Policy (CAP). This project explores the conflict between the German Farmers' Association (DBV) and the Federal Dairy Farmers Association (BDM) based on the two milk delivery strikes as culmination points in the so called dairy conflict. The analysis focusses on the main causes of the conflict and the different stages of escalation in the dairy industry. The objectives are to outline the process of change in Germany's farmers associations, and the opportunities and risks regarding a long-term institutional differentiation. The conceptual frameworks are change management, conflict management, and organizational development.

Material and Methods

Within the qualitative research umbrella, the main data collection methods are personal interviews (in total 34). The data collection included individual in-depth interviews with farmers, policy makers, agricultural experts, as well as, experts regarding conflict and change management and organizational development. Regionally, the study focusses on southern Germany with its small-scale dairy cattle regions, where the pressure for adaption is especially high.

Results and Discussion

The dairy conflict was emotionally charged, with the two milk delivery strikes in 2008 and 2009. Important key drivers identified were the abolishment of the dairy milk quota, low milk prices and the proceeding structural change, closely related with the fear of change. The fear of change underlines the argument of many farmers regarding their insecurity about what will happen after the abolishment of

the dairy milk quota in 2015 on the market and their own prospect. Furthermore, a decreasing communal feeling of farmers and the growing pressure to expand were driving factors. Overall emotional backgrounds were playing a paramount role in the conflict as is becoming evident when exploring the pressure on non-striking farmers even within families and between different generations. Preliminary results show that this conflict also had an impact on the German agricultural associations' structure in general and the political discussion, as well as, representation of farm interests. The German Farmers' Association (DBV) is losing its influence and role as major single representative of German farmers, including dairy farmers. A consortium of more than twenty organizations has evolved including the Federal Dairy Farmers Association (BDM) and the Friends of the Earth Germany (BUND) as important players. These institutions are now increasingly included in political discussions, opinion formation and decision-making processes regarding agricultural policy at the federal level and particularly in Bavaria at the state level.

Corresponding Author

Jan Alpmann, Technische Universität München,
Alte Akademie 16, 75354 Freising
eMail: Jan.Alpmann@tum.de
Telefon: 08161/712540

Studies on the decrease of spore potential of common bunt (*Tilletia caries*) and dwarf bunt (*T. controversa*) spores of wheat in soil considering different crop rotation systems in ecological farming

Robert Bauer

Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding, Freising; TUM, chair of Organic Farming and Crop Production Systems, Freising

Introduction

Common bunt and dwarf bunt of wheat play an increasingly important role as dangerous plant diseases in ecological farming (Voit et al. 2012 & 2014, Bauer et al. 2014). High infection levels lead to an increase of the spore potential in soil. Based on the fact that spores of dwarf bunt and, to a certain degree common bunt, infest their host plants from soil, affected farmers put forward the question if they have to pause wheat cultivation temporarily and furthermore how many years wheat should not be grown on these fields. In order to determine whether it is possible to decrease the spore potential in soil, 3-years randomized field trials are performed at three sites with crop rotation links commonly used in ecological farming. Brassica species setting free isothiocyanate after mulching are cultivated to examine a possible reduction of the spore potential. Additionally, the influence of stable manure on bunt spores is tested.

Material and Methods

The field trials were performed at three sites in Bavaria (Obbach, Oberndorf, Wolfersdorf) with four replications (10 m² per plot) on freshly infested fields with a high bunt spore potential in soil. The experimental design was a split block with the three factors crop rotation, fertilization with stable manure, and cultivation of a side crop (mustard). Eight different crop rotation variations commonly used in ecological farming were tested (Tab. 1).

Soil samples were taken yearly from each plot and common and dwarf bunt spore potential in 10 g soil was determined by extracting the spores from soil by wet sieving and sedimentation steps, followed by filtration and counting the spores under the microscope.

Results and Discussion

Regarding the factor crop rotation, the three test sites yielded a varied picture: significant effects were observed in Obbach where the crop rotation variations three-years grass-clover and fallow (both variations without soil tillage) exhibited less decrease of spore reduction after three years, whereas the situation was different in Oberndorf and Wolfersdorf. Test site factors like soil type and weather conditions have to be considered.

Over all three test sites a significantly higher decrease of the spore potential in soil after application of stable manure was observed for the period 2012 to 2014. The plots treated with stable manure showed a significantly higher decline of spore potential at the Wolfersdorf site during the same period.

The plots cultivated with mustard did not exhibit a significantly greater reduction of bunt spore numbers in soil within three years at any site, although possibly a tendency towards a stronger reduction with mustard cultivation was observed in Wolfersdorf.

Tab. 2: crop rotations tested in the three years crop rotation field trials

previous crop	2011/12	2012/13	2013/14
winter wheat	fallow	fallow	fallow
	grass-clover	grass-clover	grass-clover
	grass-clover	grass-clover	winter wheat
	grass-clover	winter wheat	winter rye
	winter rye	peas	winter wheat
	triticale	peas	winter wheat
	oats	winter rye	peas
	peas	winter wheat	winter rye

Conclusions

The options to reduce bunt spore potential in soil by different crop rotation variations, application of stable manure, and biofumigation are very limited. It is therefore more effective to cultivate wheat varieties less susceptible to common bunt and dwarf bunt of wheat on fields contaminated by bunt spores. Thus, a new infection of soil with bunt spores is reduced. A less susceptible wheat variety does not necessarily take the first place regarding the economic factors yield and quality, but it is economically more efficient than not to grow wheat at all.

Literature

- (1) Voit, B., Dressler, M., Killermann, B. (2012) Warum ist Zwergsteinbrand derzeit nicht nur im ökologischen Getreidebau ein Problem? Tagungsband der ALVA Jahrestagung 2012, Wien, ISSN 1606-612X, 291-293.
- (2) Voit, B., Bauer, R., Killermann, B. (2014) Zwergsteinbrand: Saatgut prüfen. Bioland, Fachmagazin für den ökologischen Landbau, 08/2014, 11, ISSN 0173-9832
- (3) Bauer, R., Voit, B., Killermann, B., Hülsbergen, K.-J. (2014) Veränderung des Bransporenpotenzials von Steinbrand- (*Tilletia caries*) und Zwergsteinbrandsporen (*T. controversa*) im Boden unter Berücksichtigung verschiedener Fruchtfolgen des ökologischen Landbaues. VDLUFA Kongressband 70/2014, 536-539.

Corresponding Author

Robert Bauer

Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding, Working Group Seed Testing & Seed Research, Lange Point 6, Labor 2, 85354 Freising

eMail: Robert.Bauer@lfl.Bayern.de

Telefon: 08161-714306

Short-term experimental modelling of zinc status in weaned piglets

Daniel Brugger

TUM, Chair of Animal Nutrition

Introduction

Classic experimental approaches which aim to model the zinc (Zn) status of mammals start with a Zn depletion period over several weeks with a subsequent Zn repletion phase during which the metabolic response to varying dietary zinc supply is monitored. Indeed, such experimental designs promote severe zinc deficiency. But this is accompanied also by various secondary metabolic imbalances, which impair differentiating between truly zinc depend measures and indirect metabolic countermeasures. Furthermore, feed Zn bioavailability is often overestimated under such conditions as the organism maximises Zn absorption at the gut barrier above the basal level in order to satisfy its maintenance requirements as well as to replenish its depleted Zn stores. Furthermore, Zn deficiency disease represents an endpoint of metabolic imbalance which is quite uncommon in nature especially under the terms of modern animal husbandry. The more likely scenario is a latent reduction in zinc status without visible signs of malnutrition but presumably significant metabolic consequences, as it might occur i.e. under the terms of weaning or changes in feed supply. Therefore, the aim of the present doctoral project was to develop a novel experimental approach to induce fine-graded differences in zinc status of weaned piglets under short-term conditions without promotion of Zn deficiency disease.

Material and Methods

48 newly weaned piglets (50% male-castrated, 50% female) received a corn-soybean based diet ad libitum within a 2 week acclimatization phase (13.0MJ ME/kg; 24% CP; native Zn: 28mg/kg; added Zn as ZnSO₄: 60mg/kg; analysed total Zn: 88 mg/kg). Subsequently, all animals were assigned to 8 dietary treatment groups (n=6) in a complete randomized block design. Dietary composition remained unchanged except for Zn supplementation which was gradually reduced from initial level (control) to zero (analysed dietary Zn, mg/kg: 88 (control), 68, 58, 48, 43, 39, 34, 28). Animals were fed these 8 diets at restricted amounts (450g/d) for 8 days and were then sacrificed in order to derive blood plasma, liver and bone (femur) samples. Faecal samples were collected to derive apparent Zn absorption on base of dietary TiO₂ as indicator. Analyses included plasma Zn content, plasma Zn binding capacity (ZBC), plasma alkaline phosphatase activity (AP), hepatic Zn content, hepatic metallothionein (1a and 2b) gene expression, hepatic metallothionein protein expression and femoral Zn content.

Results and Discussion

During the entire study, no symptoms of severe Zn deficiency (growth depression, feed refusal, skin lesions etc.) were evident. Bone and plasma parameters acted in a straight linear fashion in response to varying dietary Zn supply. On the contrary, faecal and hepatic parameters exhibited a change in behaviour around ~60mg Zn/kg feed. The response of bone and plasma parameters was surprising as earlier published data hints towards a change in behaviour at the point of satisfied gross zinc

requirement (60mg Zn/kg feed; [1]). Whole-body zinc deficiency needs about 3d to fully adapt to changing dietary conditions [2]. The present data indicates that short-term fluctuations in dietary zinc supply have the potential to induce latent zinc deficiency, even if the dietary Zn contents fluctuate between levels that would be satisfying on a long-term scale. This highlights the necessity to avoid even short periods of significant fluctuations of dietary Zn contents. The response of faecal and hepatic parameters is in good context to the literature. As the point of behavioural change around ~60mg Zn/kg seems to mark the transition from sufficient to deficient whole-body Zn status, this set of parameters might be suitable to serve as status parameters in future investigations. Moreover, the slope in response over the range of deficient dietary Zn supply might be used as indicator of differences in feed Zn bioavailability under various dietary conditions.

Conclusions

We were able to successfully induce fine-graded differences in whole-body zinc status through dietary intervention in weaned piglets without promotion of severe zinc deficiency. The experimental model was published in all details by Brugger et al. (2014) [3]. Subsequently, the approach was used to study early metabolic adaptations to latent zinc deficiency. Especially the effects on digestive function and anti-oxidative capacity were monitored. The results point towards significant loss of digestive function via down-regulation of pancreatic enzyme synthesis as well as metabolic shifts towards increased oxidative stress and associated pro-apoptotic signalling in the heart muscle. Furthermore, comparative screening of zinc transport proteins in the small and large intestine point towards a shift of the main absorptive site from the upper to the lower intestinal parts under the terms of early latent zinc deficiency. Currently, several manuscripts are written for peer-reviewed publication of this data [4; 5; 6].

Literature

- (1) NRC. 2012. Nutrient requirements of swine. Washington, D.C., USA: Nat. Acad. Press.
- (2) Windisch W, Kirchgessner M. 1994. Verteilung und Austausch von Zink in verschiedenen Gewebefractionen bei defizitärer und hoher Zinkversorgung. 3. Zum Effekt einer unterschiedlichen Zinkversorgung auf den quantitativen Zinkumsatz im Stoffwechsel adulter Ratten. *J Anim. Physiol. Anim. Nutr.* 71:131 - 139.
- (3) Brugger D, Buffler M, Windisch W. 2014. Development of an experimental model to assess the bioavailability of zinc in practical piglet diets. *Archives of Animal Nutrition.* 68:73-92.
- (4) Brugger D, Weiss K, Windisch W. 2015. The effects of short-term latent zinc deficiency on faecal crude nutrient digestibility and pancreatic digestive enzyme synthesis in weaned piglets. (in preparation)
- (5) Brugger D, Neubarth J, Donaubaue S, Windisch W. 2015. Early latent zinc deficiency promotes pro-apoptotic signalling through reduced anti-oxidative capacity in the heart muscle of weaned piglets. (in preparation)
- (6) Brugger D, Hanauer M, Windisch W. 2015. Comparative screening of known zinc transporters in the small and large intestine indicates a shift of the main absorptive sight under the terms of early latent zinc deficiency in weaned piglets. (in preparation)

Corresponding Author

Daniel Brugger

TUM, Lehrstuhl für Tierernährung, Liesel-Beckmann-Strasse 2, 85354 Freising

eMail: daniel.brugger@wzw.tum.de

Telefon: +49 8161 71 4009

Enzymes as enhancers for digestion in ruminants

Mirko Deml

TUM, Chair of Animal Nutrition

Introduction

The efficiency of rumen fermentation is dependent on and limited by the chemical properties of the feed (e. g. plant cell wall digestibility, chemical composition of the grain). Feed additives may improve feed utilization in ruminants. For example, exogenous enzymes are administered to ruminant diets trusting that the supplementation increases ruminal catalytic capacity.

Material and Methods

Eight non-lactating rumen-fistulated cows were used to study rumen dry matter degradability according to the *in situ*-method (1) with the aid of exogenous enzymes (amylase, protease) with following treatments: Control (Con): no enzyme addition; addition of amylase (A); addition of protease (P); combination of both enzymes (AP). Cows were used as a Latin square for four periods (double 4×4). During each period two cows received the same treatment. 7.0 kg dry matter (DM) of the total mixed ration (TMR) were fed in two equal portions per animal and day consisting of 49% maize silage, 20% grain maize, 15% grass silage, 10% hay, and 6% soybean meal. Samples of the TMR and the single ingredients were weighed into nylon bags. The enzymes were admixed to the content of the nylon bags in the same proportion as it was presented in the TMR to guarantee homogenous presence in all tested material. The nylon bags (4 replicates) were incubated in the rumen just before the morning feeding for 1, 2, 3, 4, 5, 6, 9, 12, 24, and 48 hours to determine *in situ* dry matter disappearance (ISDMD) and effective dry matter degradability (EDMD). Additionally, samples of ruminal fluid were taken to determine pH and volatile fatty acids and samples of feces were collected to calculate total tract digestibility.

Results and Discussion

Preliminary findings showed that supplementation of the combination of both enzymes (AP) resulted in accelerated ruminal degradation and in an increased EDMD of maize silage and grain maize. The remaining components of the TMR (grass silage, hay, and soybean meal) were not affected by one of the enzyme treatments. This enhanced ISDMD results neither in changes of volatile fatty acid production in the rumen nor in an increase of total tract nutrient digestibility. Further investigations should resolve the following question: the degradation of what kind of nutrients (crude protein, starch, fiber fractions) is responsible for the enhanced ISDMD of maize silage and grain maize.

Literature

- (1) ØRSKOV, E. R., McDONALD, I., (1979): The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agric. Sci., Camb. 92: 499-503

Corresponding Author

Mirko Deml
Liesel-Beckmann-Str. 2, 85354 Freising
eMail: mirko.deml@wzw.tum.de
Phone: 08161/713551

Nitrogen fluxes and potential nitrogen leaching of agricultural farming systems in an area with high livestock density

Felix Forster

Technische Universität München, Lehrstuhl für Ökologischen Landbau und Pflanzenbausysteme

Introduction

Conditions in the Hohenthann, Pfeffenhausen and Rottenburg a.d. Laaber districts are favourable for arable farming. However, there has been a big increase in livestock density in these areas, in particular pig farming, accompanied by an increase in the nitrogen content in groundwater. Therefore a research project was started to analyse nitrogen fluxes and potential nitrogen leaching from farms in this region. As a second step, mitigation strategies will be developed and evaluated.

Material and Methods

Nitrogen fluxes and nitrogen balances were calculated with the model REPRO (1), using detailed information about farm management collected from farms in the region surveyed. At present, data has been collected from 5 farms: two pig farms, one dairy farm and two arable farms, one with and one without slurry application. Stocking densities range from 0 to 6 livestock units per hectare. Data was collected for one to three years for each farm.

The calculated nitrogen balances are complete balances, and include N-inputs via N-deposition, seeds, N₂-fixation as well as organic and mineral fertilizers, but don't include gaseous N-losses.

Results and Discussion

Nitrogen surpluses on the farms studied ranged from 71 to 163 kg N/ha. Thus, there is a risk that the critical value of 50 mg nitrate/l percolate water will be exceeded. In this region this corresponds to leaching of 23-34 kg N/ha. All farm types had high surpluses, but they were lowest in the farm without slurry application. Grain maize, winter barley and oilseed rape have particularly high surpluses as their N-removal is low, and these crops are widely grown in the region. In addition, the amount of fertilizer applied often exceeds official recommendations if actual yield levels and slurry nitrogen content are taken into account.

For livestock farms, the most important mitigation strategy is to apply less slurry in summer and more in spring, when crop requirements are highest. As a result, mineral fertilization can be reduced and thus nitrogen surpluses and leaching losses lowered. Moreover, application techniques such as trail hoses can lower ammonia losses and can therefore also reduce the need for mineral fertilization.

Conclusions

In order to reach the target of 0-50 kg N surplus (2), all of the farms studied need to reduce their fertilization levels. This implies more efficient use of slurry nitrogen, as well as a reduction in mineral

fertilization. Lower N-balances can then be achieved without any or with only a minor reduction in yields.

Literature

- (1) Küstermann, B., Christen, O., Hülsbergen, K.-J. (2010) Modelling nitrogen cycles of farming systems as basis of site- and farm-specific nitrogen management. *Agriculture, Ecosystems & Environment* 135; pp 70-80
- (2) DLG (2013) Nachhaltiger Ackerbau – DLG Merkblatt 369.

Corresponding Author

Felix Forster
TUM, Liesel-Beckmann-Straße 2, 85354 Freising
eMail: felix.forster@mytum.de
Telefon: 08161-716139

Heuristical approach for system modelling of SMEs in hortibusiness

Andreas Gabriel

TUM, Chair Economics of Horticulture and Landscaping, University of Applied Sciences Weihenstephan-Triesdorf

Introduction

The number of small horticultural retail companies selling ornamental plants and trees in Germany is declining within the last two decades due to several external (e.g., growing competition) or internal challenges (e.g., lack of successor or of specialized workforce). In many cases, the impact of upcoming threats on these companies - regarded in terms of “complex organizational systems” with a number of involved elements and managerial disciplines - can hardly be overlooked in order to counteract with appropriate managerial interventions. Based on the principles of system theory and cybernetics we show the process of an integrated system modelling of such enterprises. For that purpose, we use a methodology of system analysis that deal with complexity and interdisciplinarity. The methodology is able to combine qualitative heuristics and quantitative techniques to describe and evaluate the system and its interactions with its surrounding.

Material and Methods

The semi-qualitative methodology of Vester’s sensitivity model (VSM) is used to identify the structure and relevant elements of the system, and expose non-linear interactions (feedback-loops) and coherencies. With the assistance of an interdisciplinary expert panel (e.g., owner-managers, employees, consultants, suppliers), the computer-assisted methodology tool of VSM allows in successive interlocked steps the description and interpretation of system patterns and key factors. The poster illustrates the working process of VSM to generate and interpret the system model and the role of certain key elements of the system. Our presentation is restricted to the first six workings steps that are necessary to establish the effect system of the modelling for later scenario analysis and simulation tasks (Figure 1).

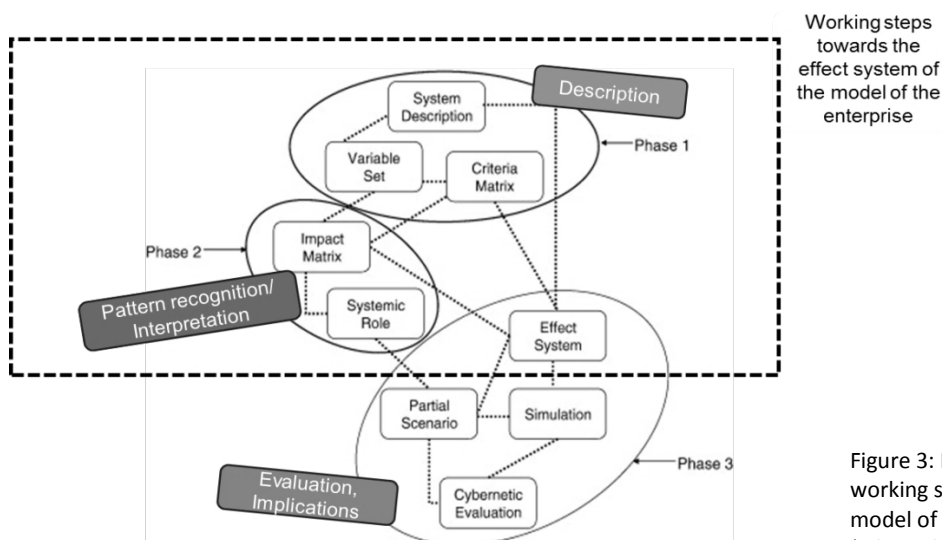


Figure 3: Illustrated procedure of working steps to generate a system model of hortibusiness SMEs (adapted from Huang et al., 2009)

Results and Discussion

The poster highlights the first workings steps of the VSM up to the finalized effects system and the systemic role of the determined key factors. We illustrate the successive procedures and outcomes of the experts input at the different steps and show first results of the descriptive and interpretative phases of the analysis. For instance, the examination of the systemic relevance of the identified set of variables (criteria matrix) reveals that the analyzed hortibusiness SMEs are strongly affected by the involved human resources, their sentiments and the companies' tasks. Furthermore, the system itself is primarily controllable from inside (management, employees) and opens itself more from its output than from the input of surrounding factors. The buildup of the effect system and the interpretation of the role of the system variables permits us now to concentrate on special problems in partial scenarios (e.g. the situation of lack of workforce) and simulate long-term effects on the enterprise.

Conclusions

The fundamental ideas of the methodology of VSM – which make it different from other modelling approaches - enable the use of both qualitative assessments of the experts and quantitative data. With the help of the methodological approach, it is possible to visualize and understand complex and interdisciplinary coherencies within the special kind of enterprises and determine key elements that are significant for their development. The results of system analysis help practitioners and scholars to understand the managing of hortibusiness SMEs and their special problems and challenges.

Literature

- (1) Brexendorf, J. (2012) Komplexität in Kooperationen – eine empirisch basierte Analyse unter der Anwendung des Sensitivitätsmodells. PhD-Thesis. University of St. Gallen (CH).
- (2) Huang, S.-L., Yeh, C.-T., Budd, W.W., Chen, L.-L. (2009) A Sensitivity Model approach to analyze urban development in Taiwan based on sustainability indicators. *Environm. Imp. Assess. Rev.* 29 (2009); pp. 116-125.
- (3) Vester, F. (1988) The bio-cybernetic approach as a basis for planning our environment. *Syst. Pract.* 1(4); pp. 399-413
- (4) Vester F., Hesler, A. (1982) The Sensitivity Model. Frankfurt/Main: Umland-Verband.

Corresponding Author

Andreas Gabriel
Alte Akademie 16, 85354 Freising-Weihenstephan.
eMail: andreas.gabriel@tum.de
Telefon: +49 (0) 8161-712586

Challenges in future phenotyping methods for maize breeding

Friederike Gnädinger

TU München, Department of Plant Sciences, Chair of Plant Nutrition, Emil-Raman-Straße 2, 85350 Freising

Maize grain yield has steadily risen over the last years. The biomass productivity of maize per hectare is 1.7 times higher in comparison to wheat and yielded in 2014 988 million tonnes worldwide. The German maize production was in average around 75-89dt/ha from 2003-2013 (DMK, 2014). It would be a great improvement for maize breeders to implement high throughput phenotyping techniques in field trials to replace tedious and time consuming scoring methods for detecting various plant traits being relevant in the breeding process. Phenotypic traits like yield potential, abiotic stress adaptation, disease resistance, plant architecture and quality parameters can be detected with sensor measurements and digital imaging. To gain deeper knowledge and understanding of important maize physiological traits phenotyping methods such as spectral reflectance and light interception measurements as well as digital imaging will be performed. Additionally N- and C-content will be measured to analyze their translocation and distribution at different growth stages.

The aim of this work is to find close relationships between high throughput phenotyping measurements and physiological traits (e.g. starch, sugar, water, carbon and nitrogen content, biomass production, phosphorous deficiency) and to distinguish the differences between various maize cultivars. Therefore 12 different cultivars were planted in plots with the size of 71,28m² in 6 rows. Maize plants were harvested at 3 different growth stages: flowering, lactic and seed ripeness. Therefore 7 m of every second row alternately from the front and the back were harvested manually to avoid boundary effects. Plants were separated into leaves, stem, bulb, husk, corn and cob. The nitrogen contents of all plant components were measured with the mass spectrometer. Additionally spectral reflectance measurements with active and passive spectral sensors and digital imaging have been applied at each harvest date. The resulting data were analyzed to distinguish biomass production and nitrogen content of the different maize cultivars.

Due to the optimal climate conditions in 2014 all cultivars showed proper plant growth and those cultivars being resistant against unsuitable environmental conditions (e.g. drought/heat/hail) couldn't differ significantly in terms of biomass yield. The average biomass yield was approximately similar for all cultivars and no significant differences could be shown. Cultivar differences for biomass accumulation and N content at certain growth stages could be detected. Different strategies of the cultivars regarding the stay-green ability and maturity groups became apparent. Based on the yield homogeneity the spectral measurements and digital images could not be successfully compared to pot-experiments conducted during winter in the vegetation hall. These pot experiments showed significant differences in the growth rate and phosphorous deficiency, which could be detected with spectral sensing and digital imaging especially on young cultivars.

Consequently all phenotyping approaches which have been tested successfully under greenhouse conditions during winter will be applied under field conditions in 2015, considering different N-levels

and a diverse set of maize cultivars. Target traits, which will be detected using high-throughput phenotyping, are important maize breeding traits such as early vigor (growth rates), leave architecture, and stress adaption (phosphorus and nitrogen).

Literature

- (1) Behmann J., 2014: Detection of early plant stress responses in hyperspectral images. *ISPRS Journal of Photogrammetry and Remote Sensing* 93, 98-111
- (2) Ciampitti, 2012: Physiological Perspectives of changes over time in maize yield dependency on nitrogen uptake and associated nitrogen efficiencies: A review. *Purdue University, United States, Field Crops Research* 133, 48-67
- (3) Ciampitti, 2013: Grain Nitrogen Source Changes over Time in Maize: A Review. *Crop Science*, VOL.53
- (4) Deutsches Maiskomitee e.V. (DMK): Bedeutung des Maisanbaues weltweit (März 2015), <http://www.maiskomitee.de/web/public/Fakten.aspx/Statistik/Welt> (zuletzt aufgerufen 08.04.2015)
- (5) Winterhalter L., 2011: High-Throughput Sensing of Aerial Biomass and Above-Ground Nitrogen Uptake in the Vegetative Stage of Well-Watered and Drought Stressed Tropical Maize Hybrids. *Crop Science* 51, 479-489

Corresponding Author

Friederike Gnädinger
Department of Plant Sciences, Chair of Plant Nutrition,
Emil-Raman-Straße 2, 85350 Freising
Email: friederike.gnaedinger@wzw.tum.de
Phone: +49 8161/71-5948

Animal behavior in a fully automatically controlled dairy farm

Anja Gräff¹, Renate Luise Dörfler¹, Manfred Höld², Jörn Stumpfenhausen², Heinz Bernhardt¹

1: TUM, Chair Agricultural Systems Engineering, Freising

2: HSWT, Faculty of Agricultural and Nutritional Sciences, Freising

Introduction

Agricultural holdings are all constrained by rationalizations and by improvements of efficiencies. This applies in particular to German dairy farming. Especially in Bavaria, smaller, family-run farms grow in numbers [1]. In order to keep up with the high work demands it's indispensable to enhance the degree of mechanization and automation. This is shown in practice, for example, in the increasing use of automatic feeding and milking systems [2]. For cost and environmental reasons the required energy (400 – 600 kWh per cow and year) should be provided by renewable energy (wind, solar, biomass) [3]. Despite innate fluctuations in supplies from wind or photovoltaic energy facilities a full-day electricity supply has to be granted. Therefore, functional safety and product quality requires energy-storage systems and efficient control units even though energy self-sufficiency can be implemented mathematically. Objective of the overall project is the development of a central monitoring and controller module for an "on-farm-energy-management-system", which combines different renewable energy producers with smart-grid capable load currents and optional energy storages. Important as these energetic-technical capabilities and features in a modern dairy farm are, the final decision when using automatic machinery depends on the animal itself and its behavior. As a result, all animal-physiological criteria, animal protection and animal welfare have to be taken into consideration. The tests done are used to investigate dairy cattle behavior (positive and negative stress) on suddenly occurring energy failures, fluctuations or postponements due to a load management.

Material and Methods

The experiments have been taken in four different stables with up to 120 cows. In each stable twelve so-called "focus cows" have been selected at random-one. In order to measure their daily stress response, they wore a heart rate belt and a heart rate monitor (POLAR RS800CX Science Equine). By video observation, modifications in behavior, escape or avoidance reactions have been recorded and now will be analyzed by using the statistics programme "R". The cows have not been limited in movement; they have been able to walk around freely in the stable. A pedometer recorded the movement activity (number of steps), how long and how often the cow lies down or stays in its box. In order to determine cortisol metabolites faecal samples have been taken [4].

Results and Discussion

For a comprehensive On-farm-energy-management system the scientific foundations have to be developed, transformed into prototypes and be tested in practice. Concrete solutions should be developed by the inclusion of regenerative energy sources, including intelligent network access and by intensive investigation of the animal-machine-interactions for "Integrated Dairy Farming". Upon the termination of the evaluation of all test results in this sub-project, possible stress reactions should be shown by dairy cattle with a possible energy-conditioned failure of milking robots. The test results

should give explanation whether variations or failures in the energy supply have effects on the cow behavior or whether postponements in the usual daily routine e.g. in the milking routine cause stress reactions to the milk cows. Therefore, ethological criteria can be validated to a quantitative and qualitative analysis. Moreover, the behavior patterns - appropriate for animal species in an increasingly automated process of engineering in a dairy farm - can be evaluated while taking autonomous control options within the scope of a comprehensive On-farm-energy-management system into account. The study investigates in particular how energy failures, energy fluctuations and postponements might influence cattle's daily routine. Expected results: No statistically significant effects on the usual daily routine should occur.

Conclusions

For an exact analysis of the consumption-technical characteristic features of the installed aggregates and system elements of a modern dairy production the bases for their Smart-Grid binding and the development of a central monitoring and control module must be compiled first. After a next simulation phase with simultaneous externally supported hard- and software development, the installation and extensive series of experiments on an everyday farm intended for it are planned. Nevertheless, it is not to be calculated on the fact that few manufacturers of automatic milking and feeding technology will agree in close future on a Bus-System on dairy farms. Hence, it cannot be intervened directly in the machine control, but for every device available in the market a data sheet must be provided which contains the relevant system data, like power consumption, application time and above all the importance with which the device must be supplied with stream. Then on account of these data sheets all manufacturers can be integrated into the On-farm-energy-management system. Afterwards the bases should play an important role onto a prototype of an energy-management system which could be developed by an industrial partner who considers the priorities and the temporal flexibility of the consumers. The prototype will be installed on an everyday farm and its function will be tested by experiments.

Literature

- (1) Bayerisches Landesamt für Statistik und Datenverarbeitung (2013): Jeder dritte landwirtschaftliche Betrieb Deutschlands liegt in Bayern. In: Bayerisches Landesamt für Statistik und Datenverarbeitung. Pressemitteilung 18/2014/33/C vom 23.01.2014
- (2) AgriDirect Deutschland GmbH (2013): Milchviehhalter investieren hauptsächlich in Melkroboter. In: AgriDirect Pressespiegel 2013. Pressemitteilung vom 25.04.2013
- (3) Kämper, Hartmut (2010): Energie- und Leistungsbedarf in der Milchviehhaltung. In: BauBriefe Landwirtschaft 2010, 29.11.2010 (Baubrief 47 Energieeinsatz in der Tierhaltung), S. 16–19
- (4) Palme, Rupert; Möstl, Erich (2001): Bestimmung von Kortisolmetaboliten im Kot von Nutztieren zur nichtinvasiven Erfassung von Belastungen. In: Aktuelle Arbeiten zur artgemäßen Tierhaltung 2000, KTBL-Schrift: S. 9-17

Corresponding Author

Anja Gräff,
TU München, Center of Life and Food Sciences, Agricultural Systems Engineering,
Am Staudengarten2, D-85354 Freising-Weihenstephan, Germany
eMail: anja.graeff@wzw.tum.de
Telefon: 08161-71-3444

Development of quantitative and qualitative test methods for detection of wheat and barley bunt diseases (*Tilletia* spp., *Ustilago nuda*) by means of Real-Time PCR assays

Monika Grundler

Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding, Freising

TUM, Chair of 'Technische Mikrobiologie', Freising

Introduction

Smut and bunt diseases of wheat and barley cause considerable yield loss and have a negative influence on quality right up to infestations crop can't be used for food production or animal feeding stuff. In conventional farming, chemical seed treatment prior to sowing is sufficient to control seed borne infections. Since chemical treatment is prohibited, the use of healthy seed is the only option in ecological farming to circumvent infection (Voit and Killermann, 2013). Knowledge about infection levels of bunt diseases is very important, especially in ecological seed multiplication and for official seed certification. Only with a maximum infestation of 20 spores per kernel untreated seed is permitted for trade in Germany (Dressler et al., 2011; AG-AKST, 2014). Different species and races of the pathogens appear in different regions around the world. In Europe the major bunt pathogens are *Tilletia caries* (DC) Tul. (Common bunt) and *T. controversa* Kühn (Dwarf bunt) (Goates, 1996). Seed is traded internationally and a variety of quarantine regulations exist in the different countries. Therefore it is very important to have effective methods for detection of the particular pathogens available to make up quick decisions for the export and import of seed. *T. controversa* e.g. is a quarantine pest in China and Russia and *T. indica* Mitra (Karnal bunt) has been classified for whole Europe (Hoffmann, 1982).

At present detection and quantification of teliospores on seeds as well as the differentiation between *Tilletia caries* and *T. controversa* depend on a very time consuming and cost-intensive microscopy method performance of which requires many years of experience. To make this part of seed health testing during official seed certification more effective our approach is to develop a selective, sensitive, robust and reproducible PCR-based method which shall be internationally validated and accepted by ISTA (International Seed Testing Association) as an official Seed Health Testing Method.

Material and Methods

For quantitative Real-Time PCR, specific DNA fragments are necessary for the design of species specific primers and probes. By means of ISSR (Inter-Simple Sequence Repeat) based primers species specific marker fragments will be amplified from reference DNA using standard PCR and agarose gel electrophoresis. Species specific DNA will be sequenced and used for specific primer design.

Several *Tilletia* species, various races as well as collections from different national and international regions will be used for the method development and validation.

Teliospores prepared from sori are used for initial DNA isolation using commercially available extraction kits. Monosporidial cultures generated from teliospores are planned to provide alternative source of purified DNA. Teliospores washed from kernels will be used in the next step to test specificity and sensitivity of primers and probes. Primer testing by q-PCR will be performed with intercalating dyes and with fluorescently labelled probes. The aim of this research project is to develop a multiplex q-PCR based assay to detect, identify and quantify the most important *Tilletia* species in sample materials using a single assay.

Results and Discussion

As the project started in January this year up to date first experiments are running.

Literature

- (1) AG-AKST (2014) Erforderliche Gesundheitsprüfungen im Rahmen der amtlichen Anerkennung von Saatgut. Arbeitsgemeinschaft der Anerkennungsstellen für landwirtschaftliches Saat- und Pflanzgut in Deutschland, Anlage 5 Gesundheitsprüfung, pp. 1-5
- (2) Dressler, M., Sedlmeier, M., Voit, B., Büttner, P., Killermann, B. (2011) Schwellenwerte und weitere Entscheidungshilfen bei Befall mit Zwergsteinbrand (*Tilletia controversa*) und Steinbrand (*Tilletia caries*), Beiträge zur 11. Wissenschaftstagung Ökologischer Landbau 16.-18. März 2011, Gießen, Band 1, pp. 270-273
- (3) Goates, B. J. (1996). Common bunt and dwarf bunt. Bunt and smut diseases of wheat: concepts and methods of disease management. pp. 12–25
- (4) Hoffmann, J. A. (1982). Bunt of Wheat. Plant Disease. 66, pp. 979-986
- (5) Voit, B., und Killermann, B. (2013) Welche Rolle spielen die samen- und bodenbürtigen Krankheitserreger Fusarium (*Fusarium* spp.), Steinbrand (*Tilletia caries*) und Zwergsteinbrand (*Tilletia controversa*) für das Saatgut heute noch? Mitteilungen der Gesellschaft für Pflanzenbauwissenschaften, Band 25, pp. 172-173

Corresponding Author

Monika Grundler

Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding, Working Group Seed Testing & Seed research, Lange Point 6, Labor 2, 85354 Freising

eMail: Monika.Grundler@lfl.bayern.de

Telefon: 08161-714306

Climate change and its impact on Ethiopian Farm Population

Lemlem Habtemariam

TUM, Chair of Agricultural Production and Resource Economics

Introduction

Climate change is anticipated to decrease global agricultural production with impact unevenly distributed across regions (Calzadilla et al. 2013). Sub-Saharan African countries are particularly concerning due to already warm climates and their existing socio-economic conditions which limit their adaptive capacity (Brown and Funk 2008). The majority of Ethiopian population depends on agriculture, a sector very sensitive to climate change and variability. Considering two different agro ecologies in major agricultural production regions, this study provides insights on the expected impacts of climate change on Ethiopian smallholder farm population.

Material and Methods

The tradeoff analysis method for multi-dimensional impact assessment (TOA-MD) model is used to assess the impact of climate change on the economic performances of the farm population in the two study areas. The model compares the expected returns of production systems under current- and future climate and socio-economic conditions, and simulates impact on a farm population. Production and socio-economic data for the current production system was gained from recently collected farm level survey data. To characterize future production systems, the model is parameterized with data from crop yield simulations under climate change, and socio-economic scenarios. For this, yields of the major crops under climate change are simulated using the AquaCrop yield simulation model. The future socio-economic changes used in this analysis are derived from scenarios developed for a region of similar settings.

Preliminary Result and Discussion

The output of the model shows the percentage of farm population who would be negatively affected by climate and socio-economic changes, and net loss as percentage of mean agricultural income relative to the current production system. In addition, it also shows the percentage of farm population who would fall below poverty line in the future production system. Not all farms are affected in the same way because of variation in farm size, land quality and farm characteristics which affects the net returns associated with production systems (Antle 2011). Variation in impact is also observed between study sites and when adaptation measures are considered.

Literature

- Antle JM (2011) Parsimonious Multi-dimensional Impact Assessment. *American Journal of Agricultural Economics* 93(5):1292–1311. doi: 10.1093/ajae/aar052
- Brown ME, Funk CC (2008) CLIMATE: Food Security Under Climate Change. *Science* 319(5863):580–581. doi: 10.1126/science.1154102

Calzadilla A, Rehdanz K, Betts R, Falloon P, Wiltshire A, Tol, Richard S. J. (2013) Climate change impacts on global agriculture. Climatic Change 120(1-2):357–374. doi: 10.1007/s10584-013-0822-4

Corresponding Author

Lemlem Teklegiorgis Habtemariam
TU München
Chair of Agricultural Production and Resource Economics
Alte Akademie 14, 85354 Freising
lemlem.teklegiorgis-habtemariam@tum.de
Tel. 08161/ 71-4046

Effective vole control in the grassland of Bavaria

Barbara Hailer

Bavarian State Research Center for Agriculture, IPS 2d

Introduction

Pest rodents are a threat to crops in some parts of Germany. ^{(1) (2)} Especially voles inflict severe damage in agro-ecosystems. If their high reproductive potential is combined with enough food being available for a long time, vole "plagues" can take place. Common voles (*Microtus arvalis*) and water voles (*Arvicola terrestris*) are the mainly found vole species in agricultural grassland. The dominant species in European arable land is the common vole. Its relative abundance in the small mammal fauna is about 60–90%. ⁽³⁾ They live in burrows, which are approximately 50 cm deep and feed of aerial parts of plants, seeds and sometimes roots. The feeding of plants is the main damage which causes up to 50% losses of the yield. ⁽⁴⁾ In comparison to common voles water voles feed mainly on roots. Hence they burrow an underground tunnel system up to 1 m deep. The displaced earth is pushed to the surface and results in heaps of earth related to molehills. As a consequence of this the harvest is contaminated with soil which leads to wrong fermentation processes in the silage and the milk yield of cows decreases. Furthermore the machine abrasion is higher. The mentioned damages both species make it necessary to control the populations of the water vole as well as the common vole using poisoning, trapping and predatory birds.

There are many possible control methods on the market but yet a suitable, effective solution for the farmers is not available. Because of that one aim of this project is to identify an applicable method with a reduction of rodenticides. Due to the fact that there are no available data of the occurrence of voles in Bavaria and the knowledge of the infestation core areas is necessary for effective control also a monitoring of both species in all parts of Bavaria is carried out. Besides this the co-housing with the European mole (*Talpa europaea*) should be studied.

Material and Methods

A questionnaire was sent to Bavarian farmers with the objective of gaining farmers in all parts of Bavaria which provide grassland fields for experiments. Using the questionnaire as a basis different plot are selected for either monitoring or control experiments. Monitoring will take place in spring and autumn 2015 and 2016. The distribution of common voles is measured by means of activity studies. ⁽⁵⁾ For this purpose all burrows are closed on 2 x 250 m² and re-opened burrows are counted after 24 hours. Water vole and European mole monitoring is done with a method by Stutz C. (personal correspondence) estimating burrows of the individuals on 5000 m².

After monitoring the different options for control of the pest rodents will be compared with each other using plot trials.

Results and Discussion

According to the questionnaire in each administrative district five to ten plots were selected for monitoring (Table 1).

Table 1: Returned questionnaire for each administrative district and number of selected monitoring plots

Administrative district	Questionnaires	Selected monitoring plots
Upper Bavaria	85	10
Upper Palatinate	32	7
Middle Franconia	21	6
Lower Bavaria	17	6
Swabia	12	6
Lower Franconia	12	6
Upper Franconia	5	5
Total	184	46

As the monitoring and the control experiments are taking place at the moment these data are right now not evaluated.

Conclusions

The high number of returned forms of the questionnaire does not only constitute a good source for selecting suitable plots, it also shows the importance and the need of an effective solution for the control of voles.

Literature

- (1) Im Osten Deutschlands droht eine Feldmaus-Plage (24.03.2015). Retrieved from: <http://www.agrarheute.com/im-osten-deutschlands-droht-eine-feldmaus-plage>
- (2) Thüringen: Mäuseköder auf Antrag erlaubt (2013). Top agrar (6/2013); p 46
- (3) Jacob, J., Hempel, N. (2003). Effects of farming practices on spatial behaviour of common voles. J. Ethol. 21, pp 45–50
- (4) Barten, R. (2008). Feldmäuse. Die Zuckerrübe (1/2008), p 18
- (5) Lauenstein G., Barten R. (2011) Management von Feldmäusen in der Landwirtschaft. frunol delicia GmbH; Unna, pp 90-93

Corresponding Author

Barbara Hailer
 IPS 2d, LfL, Lange Point 10, 85354 Freising
 eMail: barbara.hailer@lfl.bayern.de
 Telefon: 08161/715718

Copper supplementation – Is there an influence on the ruminal microbiome?

Martin Hanauer

TUM School of Life Sciences Weihenstephan, Chair of Animal Nutrition

Introduction

A suitable supply with copper proves more difficult at ruminants than at monogastric animals. During the passage of feed through the rumen insoluble complexes are formed with other trace elements (e.g. Cu-thiomolybdates). Therefore, Cu is bound irreversibly and cannot be absorbed in the small intestine any more [1]. Moreover, divalent trace elements (e.g. Fe, Mn, Zn) use identical transport systems leading to an antagonistic effect on Cu absorption. These negative impacts on the capacity of Cu absorption lead to an absorption <10 % [2]. High concentrations of antagonists or complexing agents even can cause an acute undersupply (→ growth depression, bone deformation, infertility, diarrhea, loss of coat and coat color). Hence, supplementation of Cu is necessary. The current supply recommendation for cattle is 10 ppm [3]. Next to its importance as essential trace element Cu has toxic effects. Particularly the antimicrobial effect on the intestinal flora along with growth promotion at fattening pigs has to be mattered. This effect appears in a range (20 ppm) which is situated in a legal range of cattle (permitted maximum amount: 35 ppm) [4]. Until now there have been no investigations performed regarding the effect of such Cu doses on the ruminal microbiome. Thus, this possibly relation is the focus of this investigation.

Following issues should be treated:

- Does supplementation with Cu affect speed and extent of microbial fermentation of crude nutrients?
- How does the pattern of ruminal microbiome change concerning different Cu doses and sources?
- In what form “utilizable” Cu reaches the duodenum?

Material and Methods

In this experiment 8 non-lactating rumen fistulated dairy cattle will be fed restrictively a total mixed ration mainly consisting of 50 % grass silage, 40 % maize silage, 5 % soybean meal and 5 % wheat. Cu from two sources (sulfate vs. TBCC) will be added to the diet at three levels (according to requirement [10 ppm] vs. maximum permitted dietary level [35 ppm] vs. excessive dose [50 ppm]). Each of the 8 animals will receive every of the 6 treatments throughout 6 experimental periods of each 21 days (14 days pre-experimental phase [adaptation] and 7 days experimental phase). The in situ dry matter degradability of TMR (total mixed ration) and its individual components will be studied using the nylon bag technique [5]. Samples from ruminal fluid and ruminal solid part will be collected for measurements of Cu concentration and time course of rumen fermentation endpoints (pH, volatile fatty acids, NH₃) as

well as for characterization of the ruminal microorganisms. Additionally, samples of duodenal juice will be taken to determine the form of available Cu.

Expectations

It is to be expected that the supplementation of Cu within the permitted range of 35 ppm compared to the recommendation of 10 ppm affects the quantitative composition of the ruminal microbiome. Thus, digestive processes and the provision of nutrients for the host can be negatively influenced. Moreover, the application of different Cu compounds is assumed to cause either more or less negative impacts on ruminal microflora due to varying solubility. Besides, the provision of “utilizable” Cu in the duodenum will change as well.

Literature

- (1) Suttle NF (2012) Copper imbalances in ruminants and humans: unexpected common ground. *Adv Nutr*, 3, 666-74
- (2) Dias RS, Lopez S, Montanholi YR, Smith B, Haas LS, Miller SP, France J (2013) A metaanalysis of the effects of dietary copper, molybdenum, and sulfur on plasma and liver copper, weight gain, and feed conversion in growing-finishing cattle. *J Anim Sci*
- (3) GfE (2001) Empfehlungen zur Energie- und Nährstoffversorgung der Milchkühe und Aufzuchtrinder. In: (ed) Ausschuss für Bedarfsnormen der Gesellschaft für Ernährungsphysiologie, Energie- und Nährstoffbedarf landwirtschaftlicher Nutztiere, Nr. 8, DLG-Verlag Frankfurt/M
- (4) Armstrong TA, Cook DR, Ward MM, Williams CM, Spears JW (2004) Effect of dietary copper source (cupric citrate and cupric sulfate) and concentration on growth performance and fecal copper excretion in weanling pigs. *J Anim Sci*, 82, 1234-40
- (5) Orksov, E. R. and McDonald, J. (1979) The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage, *J. Agric. Sci*, 92, 499-503

Corresponding Author

Martin Hanauer

TUM School of Life Sciences Weihenstephan, Chair of Animal Nutrition, Liesel-Beckmann Straße 2, 85354 Freising

eMail: martin.hanauer@wzw.tum.de

Phone: 08161 – 71 3551

Elaborate the basics for implementation of an on-farm management system in a dairy barn

Manfred Höld

University of applied science: Hochschule Weihenstephan-Triesdorf, faculty of land- and food economy, Technical university of Munich, Munich School of Engineering (MSE)

Introduction

Dairy Farmers often produce in addition to milk also electrical energy by using the sun or the wind. Since the year 2012, it is cheaper for the farmers using their own produced energy by photovoltaic before they buy electrical energy from the energy supplier ⁽¹⁾. Therefore, it must be the highest aim to use much as possible of the own produced energy in the dairy barn. The machines in the high automated dairy barn, like the automatic milking system or the automatic feeding system, are often produced by several manufacturers. In cause of this, it is difficult to establish a communication between the machines. Find a way, how to distribute the energy to the right place at the right time within the dairy barn is the primary task. But the welfare of the cows must be guaranteed at the whole time, when we manage the energy distribution in the dairy barn.

Material and Methods

First of all, a model dairy barn must be defined. The model dairy barn must provide space for round about 120 dairy cows. Daily load profiles of all electrically operated machines will be created by measurements on different dairy barns. For the measurements, power meter "econ sense+" from the company "econ solutions" will be used. Time intervals of one minute while the recording are necessary, because some machines in the dairy barn only work for a few minutes. By overlapping the load profiles of the individual machines, a daily load profile for the whole dairy barn arise.

The PV-plant on the roof of the dairy barn will supply the dairy barn with electrical energy only when the sun is shining. On the other side, the biogas plant can supply electrical energy, when it will be used in the dairy barn because the biogas can be stored. The amount of energy and the load profiles of these plants will be calculated with theoretical values.

A „central control unit“ realize the distribution of the electrical energy in the dairy barn. This unit must be in contact with all energy consumers and with all energy supplying systems. Furthermore, the unit must be in contact with the weather forecast due to the PV-plant.

The unit must work based on algorithms, which must be given to the systems. First of all, the dairy barn must be supplied with energy, and then the residual energy can be delivered to the energy supplier. If an energy storage system should be integrated, algorithms must be determined, how the charging process should be done. These algorithms must guarantee the welfare of the dairy cows.

Results and Discussion

First calculations shows, that the PV-plant on the roof of the dairy barn produces more energy than the machines in the dairy barn use. When a dairy barn with an asymmetric shed roof was built, a PV-plant with round about 185 kW_{peak} of electrical power can be installed. The energy produced from one installed kW_{peak} in a year is round about 1100 kWh, when the dairy barn was built in Freising. For each cow an amount of energy of round about 1700 kWh will be produced.

Additional, the energy from the biogas plant can be used in the dairy barn. The illustration 1 shows, that a biogas motor with 75 kW of power can be used, when the biogas over 16 hours will be stored. The power of 67 kW can be used over a time of eight hours. The slurry of each cow provides an amount of energy of round about 1500 kWh.

Amount of slurry ⁽¹⁾	TS-content	TS	org. TS-content	org. TS	Biogas ⁽²⁾	Biogas volume	Methan content ⁽²⁾	Methan
m ³ / cow and year	%	kg / cow and year	% of TS	kg org. TS / cow and year	l/kg org. TS	m ³ / cow and year	%	m ³ / cow and year
20,0	10,0	2.000,0	82,5	1.650,0	418,0	689,7	56,9	392,4

1 m ³ Methan ~ 3,3 - 4,3 kWh _{el} ==> 3,8 kWh ⁽³⁾	
elektr. energy in kWh / cow and year	1.491,3
for 120 dairy cows	
elektr. energy in kWh / year	178.952
work hours per day	8
electrical power of the biogas plant in kW	67

Illustration 1: Calculation of the energy production from biogas

The PV- and biogas-plant produces round about 3200 kWh each cow and year. It is estimated that an energy consumption of round about 700 kWh each cow and year in the dairy barn will be used.

Last, but not least, the dairy barn produces a lot of energy, which can be sold to the local energy provider.

Conclusions

The next steps after calculating the amount of energy, in a dairy barn can be produced, is to define the algorithms for the distribution of the energy to the consumers. When the “central control unit” works, the energy management system should be connected with the public grid.

Literature

- (1) Pfeifroth, Ph.; Schmid, Th.; Samweber, F. (2012) Netzparität und Eigenverbrauch bei steigenden Strompreisen, <https://www.ffe.de/publikationen/fachartikel/403-netzparitaet-und-eigenverbrauch>, Aufruf 10.04.2015, 11:05 Uhr
- (2) Wendland, M. (2012) Leitfaden für die Düngung von Acker- und Grünland
- (3) Strauss, G. (2012) Keimreduktion in Biogasfermentern und Biogaserträge von Rindergülle unterschiedlicher Provenienz

Corresponding Author

Manfred Höld, Hochschule Weihenstephan-Triesdorf, Am Hofgarten 1, 85354 Freising
 eMail: manfred.hoeld@hswt.de, Telefon: 0 81 61 - 71 53 11

Indicators of functional diversity for biodiversity management in value chains of organic food stuff

Anna-Sophie Köhler

Technische Universität München, Chair for Organic Agriculture and Agronomy

Introduction

Public awareness of biodiversity loss forces food business to think about integrating this topic into their environmental management and marketing. Although there are approaches to mitigate biodiversity impacts, these don't account for the problems of extensive raw material production. Specifically agriculture is the main driver impacting biodiversity within the value chains of food production (Figure 1). Farmers practice an active biodiversity management both in a positive and in a negative way. However, in sustainable systems they can benefit from the provision of ecosystem services linked to biodiversity like pollination or natural pest control (Zhang et al. 2007, Power 2010). Therefore indicators for functional biodiversity on agricultural fields are recorded. Afterwards they will be integrated in the biodiversity management in value chains of organic food stuff.

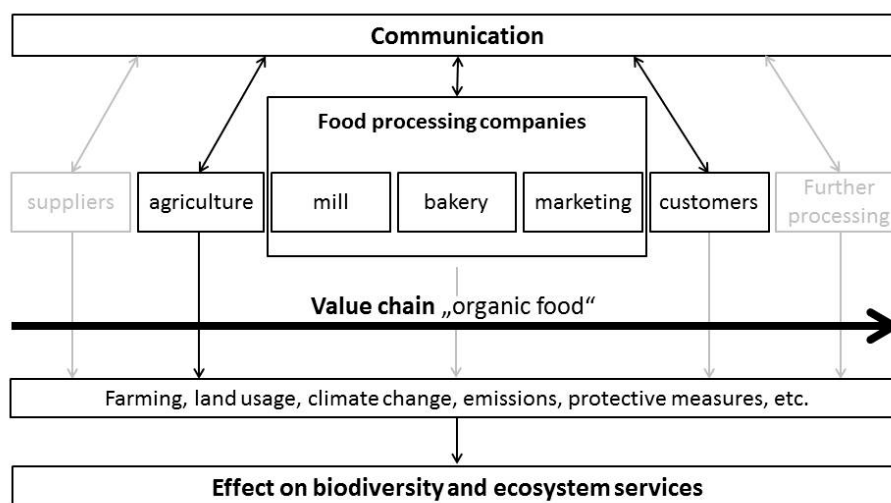


Figure 4: Diagram of the value chain of organic food stuff

Research approach

Figure 2 shows the schematic diagram of the research approach. With direct biodiversity indicators values like abundance and species diversity of chosen organisms (e.g. earthworm population), who are relevant for different ecosystem services (e.g. water infiltration, nutrient turnover) are collected. With this indicators, biodiversity is recorded immediately, but direct conclusions on farming practice can't be drawn. Indirect indicators provide statements about biodiversity based on management data, because intensity of agricultural practice influences species, ecosystems and their functions. Cause-effect

relationships will be characterized and universally valid models will be developed. To generate the link to the ecosystem services, chosen ecosystem services will be quantified. The participation of relevant actors of the value chain in the development process enables a target group oriented development of instruments for the biodiversity management.

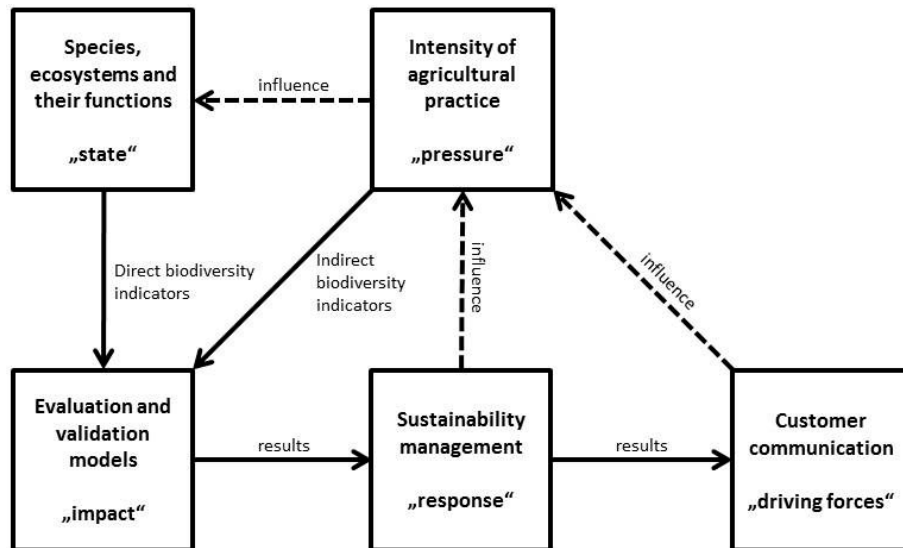


Figure 5: Schematic diagram of the research approach, based on the “Drivers-Pressure-State-Impact-Response” (DPSIR)-model

Objectives

The aim of the project is to develop simple and valid sets of methods and models to assess the effects of agriculture on functional biodiversity. These methods are to be integrated in the biodiversity management of organic food production. For the use of the results by the actors of the value chain interfaces for efficient data exchange will be defined.

Acknowledgement

The project “Entwicklung von Instrumenten für das Biodiversitätsmanagement in Wertschöpfungsketten ökologisch erzeugter Lebensmittel“ is financed by Deutsche Bundesstiftung Umwelt (DBU).

Literature

- (1) Power, A.G. (2010): Ecosystem services and agriculture: tradeoffs and synergies. *Phil. Trans. R. Soc. B* 365, pp 2959–2971
- (2) Zhang, W.; Ricketts, T.H.; Kremen, C.; Carney, K.; Swinton, S.M. (2007): Ecosystem services and dis-services to agriculture. *Ecological Economics* 64, pp 253-260

Corresponding Author

Anna Köhler, Lehrstuhl für ökologischen Landbau und Pflanzenbausysteme, Liesel-Beckmann Str. 2, 85354 Freising, eMail: anna.koehler@tum.de, Telefon: 08161-71 6141

Cooperatives in the German Horticultural Sector: Internal Governance Structure

Nevena Kokovic and Vera Bitsch

TUM, Chair Economics in Horticulture and Landscaping

Introduction

Traditional cooperatives have been criticized for failing to respond to rapid market changes. Critique also addresses governance (i.e., inefficient leadership), and capital acquisition of traditional cooperatives (Bijman et al., 2013; Cook, 1993; Iliopoulos, 2013). In response to competitive pressure, many cooperatives have become more market oriented, diversified and innovative. At the same time, these cooperatives have changed their governance by allocating decision-making to non-farmer, expert management (Bijman et al., 2013).

Cooperatives represent an important legal and organizational form in the German horticultural sector. About 80 cooperatives are active within the sector, with 23,300 members and 5,120 employees (German Raiffeisen Federation, GRF). Based on the critique directed toward traditional cooperatives, this study analyzes the extent to which farmer-members engage in decision-making functions in the German horticultural cooperatives. In line with recent research on cooperative board models in agricultural cooperatives in the Netherlands (Bijman et al., 2013), we classified cooperatives into three board models: traditional cooperatives, exclusively governed by farmers; extended traditional, employing professional, non-farmer management; and managerial model, which consolidates the board of directors and the professional management into one body, consisting only of professional managers.

Material and Methods

The website of the German Raiffeisen Federation shows 77 cooperatives. Of these, 31 answered a short, structured telephone or email questionnaire in 2014. They provided information on their main activities, products, number of members and employees, turnover, internal governance structure, and an evaluation of their economic situation.

Results and Discussion

All cooperatives in the sample operate as marketing organizations, either marketing fresh produce or performing primary processing. Also, they often provide additional services to their members. Most participating cooperatives are engaged in fruit production and located in Southern Germany (Bavaria and Baden-Wuerttemberg). Cooperatives are classified into traditional (14), extended traditional (15), and managerial (2) board models. Results indicate that cooperatives employing professional management assess their economic situation as good, while assessments of traditionally governed cooperatives vary from good to tense. Variation in assessment can be due to differences in cooperatives' strategies (successful when applying cost-leadership, while abortive in case of differentiation strategy) (Nilsson, 1999).

Conclusions

Results show that traditional organizational principles (14 traditionally governed cooperatives) still play an important role among cooperatives in the sample. Those cooperatives that delegate decision-making to non-farmer, expert management operate close to end consumers, indicating better market orientation. Future research will target performance analysis of different governance models. Performance analysis will include financial analysis and members' satisfaction with their cooperative.

Literature

- (1) Bijman, J., Hendrikse G., van Oijen A. (2013). Accommodation Two Worlds in One Organization: Changing Board Models in Agricultural Cooperatives. *Managerial and Decision Economics* 34 (3-5); pp 204-217
- (2) Cook, M.L. (1993). Cooperatives and Group Action. In D.I. Padberg (Eds), *Food and Agricultural Marketing Consortium FAMC 93-1* (pp. 154-169). Texas: A&M University.
- (3) German Raiffeisen Federation (GRF) (2015). Number and membership of cooperatives in the horticulture. Retrieved 18.02.2015, from <http://www.raiffeisen.de/presse/zahlen-und-fakten/>.
- (4) Iliopoulos, C. (2013). Public policy support for agricultural cooperatives: an organizational economics approach. *Annals of Public and Cooperative Economics* 84 (3); pp 242-252.
- (5) Nilsson, J. (1999). Co-operative Organizational Models as Reflections of the Business Environments. *LTA* 4/99, pp 449-470.

Corresponding Author

Nevena Kokovic
TUM, Chair Economics in Horticulture and Landscaping
Alte Akademie 16, 85354 Freising
eMail: nevena.kokovic@tum.de
Telefon: 08161-71-2546

The influence of stress factors typical to the specific environment of rearing piglets and finisher pigs on their feed intake behaviour and other welfare associated measures

Peter Loibl

Bavarian State Research Institute for Agriculture, Dept. for Animal Nutrition and Feed Science, Schwarzenau, TUM, Chair of Animal Nutrition

Introduction

Animal welfare science lacks an objective animal associated evaluation system (Schrader 2013). Hence, the direct effect of changes in the environment on the individual animal cannot be estimated precisely. Many effects on the animal's wellbeing caused by the specific husbandry system influence the feed intake (e. g. heat or social stress,) (Schamun, Hoy 2011; Hyun et al. 1997). Therefore, the individual feed intake behaviour could be a precise indicator of an animal's wellbeing status. The present doctoral project aims at investigating this parameter by real-time monitoring using an automated single space feeding system.

Material and Methods

Two different barns consisting of eight pens, with one automatic single space feeding system each, at the research centre in Schwarzenau are used for a series of feeding trials. In the first already finished experiments the stations recorded the time of the visit, the amount of fodder eaten per visit and the total amount of fodder consumed per day, per individual animal. Barn and outdoor temperature, air humidity in the barns as well as the animal performance parameters (weekly weight gain, carcass quality etc.) were measured. 80 piglets and 96 growers, respectively, were used in two separate experiments. All animals were fed with standard feed stuffs which provided an adequate nutrient composition adjusted to the present production phase. Due to technical requirements the weaning piglets' fodder was pelleted whereas the growers were fed a coarse meal composition. The weaned piglets were fed for six weeks (starting at about 8kg with a final weight around 30kg). The grower trial started at a weight of 28kg and ended with slaughtering at a weight of 120kg. Both groups were exposed to two different artificially induced stress situations (Table 1).

Table 1: The different stress situations simulated in the two conducted trials

stress situation	1	2
reared piglets		
control	---	---
treatment 1	grinded fodder instead of pellets (for 24h)	grinded fodder instead of pellets (for 24h)
treatment 2	feeding system failure (for 8h)	sorting (one heavy group, one light)
treatment 3	reduced water flow rate (0.4 l/min)	reduced water flow rate (0.3 l/min)

growing-finishing pigs		
control	---	---
treatment 1	reduced water flow rate (0.6 l/min)	exchange of 3 animals
treatment 2	only cereals + mineral feed (for 48h)	initial-fattening-fodder during final-fattening period (for 48h)
treatment 3	feeding system failure (for 24h)	restrictively fed (<1 kg/d and animal, 48h)

Project status

As mentioned above, the first two feeding trials have recently been concluded. Therefore, we only can outline possible outcomes of this study because of ongoing chemical and statistical analyses. Regarding statistics we want to describe the feed intake profile of the animals in association with the artificially induced stress stimuli on the one hand. On the other hand we will try to introduce new methodology in this area of animal science and try a hypothesis-free approach in order to identify patterns of variation in a complex dataset consisting of various animal and environmental measures. Therefore, we will have to assess more data in higher resolution (e. g. length of visit or people passing the barn) in future trials. The overall goal of the study therefore is to have an animal individual fingerprint of the production cycle in terms of stress and husbandry measures.

If we find links between these fingerprints and the feeding behaviour there might be the possibility to establish an early-warning-system via the assessment of fodder consumption. At the moment problems influencing the feed intake normally are recognised when a loss in performance is inevitable. Furthermore, if such a link can be found we will have to conduct an additional feeding trial using the more practical relevant liquid feeding system.

Literature

- (1) Hyun, Young; Ellis, Mike; McKeith, F. K.; Wilson, E. R. (1997): Feed Intake Pattern of Group-Housed Growing-Finishing Pigs Monitored Using a Computerized Feed Intake Recording System. In *Journal of Animal Science* 75, pp. 1443–1451.
- (2) Kirschbaum, Clemens; Hellhammer, Dirk H. (1994): Salivary cortisol in psychoneuroendocrine research: recent developments and applications. In *Psychoneuroendocrinology* 19 (4), pp. 313–333.
- (3) Schamun, Sonja; Hoy, S. (2011): Untersuchungen zum Futteraufnahmeverhalten von Mastschweinen an einer elektronischen Abrufstation unter Berücksichtigung der Rangordnung. In *Züchtungskunde* 83 (6), pp. 426–438.
- (4) Schrader, Lars (2013): Indikatoren für Tiergerechtigkeit. In Carmen Fahn, Wilhelm Windisch (Eds.): 51. Jahrestagung der Bayerischen Arbeitsgemeinschaft Tierernährung e.V. "Tierernährung und Tierwohl". pp. 1–5.

Corresponding Author

Peter Loibl, LfL, Institut für Tierernährung und Futtermittelkunde
 Stadtschwarzacher Str. 18
 97359 Schwarzach am Main
 eMail: Peter.Loibl@lfl.bayern.de
 Telefon: 0172/3639054

Analysis of Influencing Factors on Infield-Logistics

Michael Mederle

TUM, WZW, Lehrstuhl für Agrarsystemtechnik

Introduction

Agricultural Logistics extremely increased in the last years. For process optimization several software tools have been developed to navigate vehicles to the fields [BE13]. Regarding infield-logistics and navigation in the fields only first steps have been made [SHB14]. The main question is the systematics of doing the field work and the corresponding influencing factors. Common strategies of different farmers should be investigated and analyzed in terms of efficiency, process- and down time.

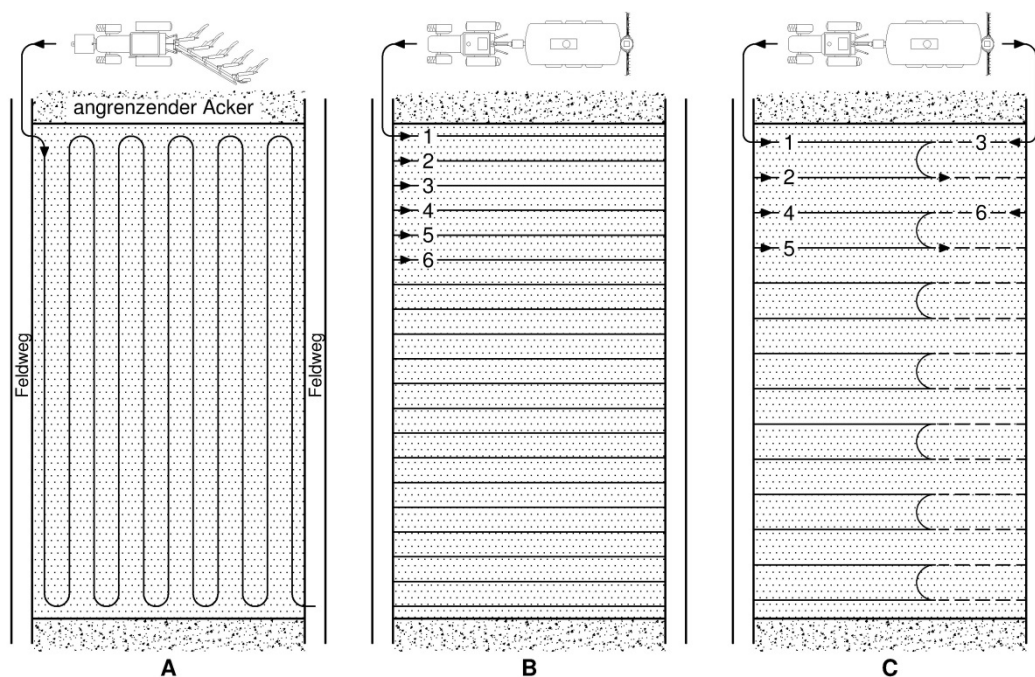


Figure 1: different infield strategies depending on various working steps

The three scenarios in Figure 1 show a rectangular field, which is surrounded with lanes on the left and on the right, as well as with neighbouring fields up and down. Operations that do not require direct supply or removal logistics, e.g. tillage, are carried out in long lines to reduce turnaround times (scenario A). Dirt roads and adjacent fields have no influence. For manure- or crop protection applications the working vehicle always has to come back to a specific point on the edge of the field to replenish or leave the field to get manure or spray mixture from the farm. Field roads or other field limiting elements influence the driving strategy and lead to the acceptance of shorter track lengths.

Material and Methods

In the first step several infield patterns of multiple operations have been recorded by GNSS data logger in different regions of Germany to investigate the current situation on different farms. This database is intended to reveal potential factors influencing infield strategies in different cultures (including cereals, maize, sugar beet), as well as in all steps of the tillage, about sowing and crop management to harvest and to quantify the extent of their influence. The second part of the research project includes a survey of farm managers in different agricultural structures and conditions.

Outlook

The initial analysis of the data recorded in the grain harvest show that deciding factors for certain infield strategies can be divided into two main categories. On the one hand there are influences that cannot be changed, including e. g. field geometry, field access or different landscape elements. On the other hand, there are "soft" factors, such as weather, several varieties on one field or different capabilities of the machine operators. More detailed analyzes of this are discussed in the following publications.

Literature

[BE13] Bernhardt, Heinz; Engelhardt, Dirk: Logistik. In: Frerichs, Ludger (Hrsg.): Jahrbuch Agrartechnik 2013. Braunschweig: Institut für mobile Maschinen und Nutzfahrzeuge, 2014. – S. 1-9

[SHB14] Streicher, Gabriel; Heizinger, Valentin; Heinz, Bernhardt: Optimierungsansätze der Infield-Logistik im Mähdruschprozess. In: Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V. (Hrsg.): 19. Arbeitswissenschaftliches Kolloquium des VDI-MEG Arbeitskreises Arbeitswissenschaften im Landbau, 2014. – S. 146-157

Corresponding Author

Michael Mederle
Technische Universität München, Lehrstuhl für Agrarsystemtechnik,
Am Staudengarten 2, 85354 Freising
eMail: michael.mederle@wzw.tum.de
Telefon: 08161/71-5320

Development of a laboratory plant to produce liquefied biomethane and dry ice from biogas

Korbinian Nachtmann

University of Applied Sciences Landshut, Faculty Mechanical Engineering
TUM, Dep. of Life Science Engineering, chair of Agricultural Systems Engineering

Introduction

Biogas plants are an important part of Germany's renewable energy supply, but often a lack of heat consumer and an inflexible power input because of limited storage capacities lead to a low energy efficiency. In the planned process biogas will be cleaned and subsequently transformed into liquid biomethane (LBM) and solid carbon dioxide (dry ice). Thus biogas is transformed in an energy rich storable and easily transportable energy carrier.

Material and Methods

An important precondition for the process is an individually adapted gas cleaning system, which separates impurities (e.g. NH_3 , H_2O , H_2S etc.) from the biogas. Subsequently the pre-cleaned biogas (now consisting mainly of CO_2 and CH_4) is fed into the liquefaction unit. Core pieces of this system are two heat exchangers connected in series with operating temperatures of about 200 and 120 Kelvin. The first heat exchanger works as a pre-cooler and might also be used as a back-up for freezing out impurities. Triggered by the deep temperatures reached in the second heat-exchanger, the CO_2 flocculates. The necessary refrigerating capacity to finally liquefy the CH_4 is provided by a pressure-less working boil-off-cooling machine. A purity of 99.9 % CH_4 in the liquid phase could be guaranteed, as only CH_4 has its dew-point at the operating temperature of 111 Kelvin. The low pressure and the absence of toxic chemicals are further benefits of the specific process. Additionally a very low methane loss contributes to an almost completely transformation of the raw gas energy content.

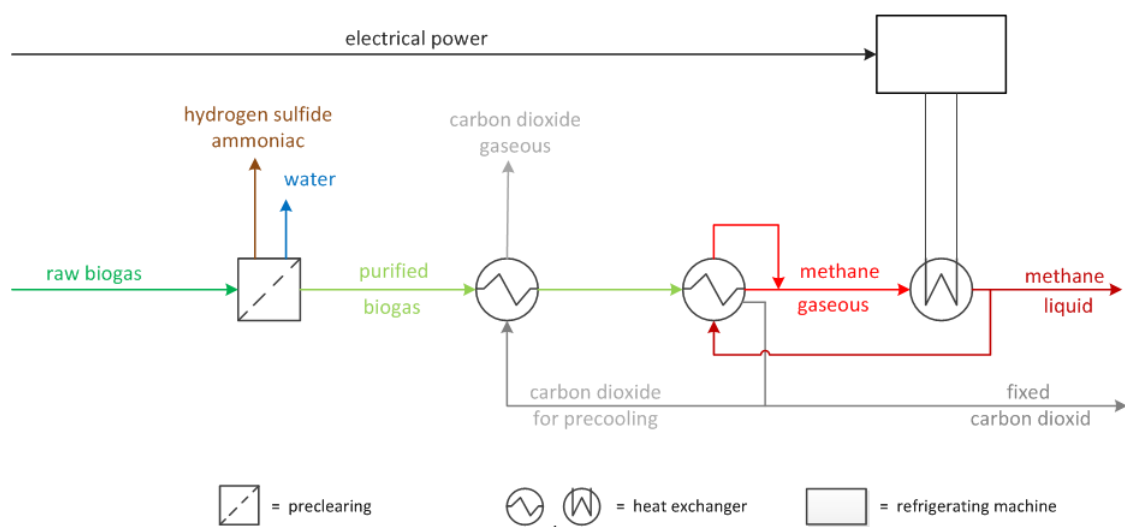


Figure 1: schematic view of the conversion

Results and Discussion

A high-quality cryogenic and liquid energy source arises by cutting off CO₂ and by the liquefaction of CH₄. This energy source has an upper heating value of 5.87 kWh/l at a temperature of 111 K (biogas: 0.0055 kWh/l at 300 K). Especially biogas systems which have no connection to the natural gas grid for energy storage are particularly suitable for the preparation process. By increasing the volumetric energy by the factor of 1000 (compared to biogas), transportation to highly efficient energy plants becomes reasonable. In contrast to other biogas upgrading methods integration to biogas plants with a low volume flow (less than 250 m³/h) is economically suitable. One aim of the project is to develop modularly liquefaction units for volume flows in the range of 25 – 30 m³/h.

Conclusions

Goals of the project are to proof the feasibility of a decentralized long-term storage of large energy amounts, to show alternative ways in using transformed biogas and an efficient usage of the energy content of the raw gas. Additional marketing possibilities of dry ice and LBM could ensure an economical operation outside the German EEG (Renewable energies act). Furthermore LBM can be used as a substitute for fossil fuels in heavy duty traffic or as an ultrapure industry raw material. The marketing of dry ice for cooling or surface treatment could be an additional benefit.

Corresponding Author

M. Eng. Korbinian Nachtmann
Technologiezentrum Energie
Hochschule Landshut
University of Applied Sciences
Am Lurzenhof 1 · D-84036 Landshut
Phone +49 (0)871 – 506 0, Fax +49 (0)871 – 506 506
korbinian.nachtmann@haw-landshut.de, www.uas-landshut.com

Indicators of soil functionality and its assessment in Cerrado - Brazil

Vanessa Oliveira

Hochschule Weihenstephan-Triesdorf, Fakultät Wald und Forstwirtschaft, TUM, Lehrstuhl Bodenkunde

Introduction

Ever-more-pressing demands on the land are driving unprecedented land-use change (Bai et al, 2013). In turn, unsustainable land use is driving soil degradation and loss of soil functions of Cerrado in Brazil. Ecosystem services and soil functions are of great importance and have been frequently discussed; however, their parameters do not enter the discussion. Therefore, this paper reviews publications on soil functions and indicators in the Cerrado region of Brazil and discusses its assessment using multifunction parameters.

Brazilian Savanna Ecosystem - Cerrado

The Cerrado region holds the second largest biome in Brazil (ca. of 25% of its total area), and has great prominence in the national and global agricultural scenario, while being an important reserve of biodiversity and food production potential. Due to its large area, environmental heterogeneity and proximity to other tropical biomes, the Cerrado biome has a rich, and until recently, largely unappreciated biodiversity (Silva et al., 2006).

However, more than half of Cerrado has been transformed into pasture, cash-crop agriculture, and other uses in the past 35 years. Based on MODIS image data from 2002, a recent survey showed that 55% of Cerrado has already been cleared or transformed for human uses. This is about 880.000 km² - three times the deforested area in the Brazilian Amazon (Klink & Machado, 2005).

Soil Functions

Soil is a vital natural resource for the operation of the terrestrial ecosystem, and represents a balance between the physical, chemical and biological factors (Araújo & Monteiro, 2007). It is an integral component of land, and strongly interacts with hydrology, vegetation/biodiversity, landscape, etc. (Lal, 2013), regulating the production of food and fiber and the global balance of the ecosystem, in addition to serving as a means for plant growth, through physical support, availability of water, nutrients and oxygen to the roots. It can act on water regulation, processing and degrading polluting compounds (Araújo & Monteiro, 2007).

Change in land cover and the subsequent effects on ecosystem processes such as water runoff and soil properties do not only affect the quality of the service produced, but reduce the total area and thus the quantity of services produced (Egoh & Maes, 2013). Decline in soil quality, by natural or anthropogenic perturbations, can drastically alter soil capital, ESs and functions, and create trade-offs and disservices (Lal, 2013). Symptoms include soil erosion, nutrient depletion, water scarcity, salinity, pollution, disruption of biological cycles, and loss of biodiversity (Bai et al, 2013).

Soil Indicators

Unlike other concepts such as water quality and air quality, soil quality has no standards and therefore regulations have not been created as a way to measure its quality. Moreover, there is not a consensus to date in relation to its concept (Araujo et al, 2012).

Soil assessment is measured by indicators. Indicators are attributes that measure or reflect the environmental status or sustainability condition of the ecosystem. Soil quality indicators can be classified as physical, chemical and biological (Araújo & Monteiro, 2007). Table 1 shows the main indicators and their relationship with soil quality.

Table 1: Set of Soil Physical, Chemical, and Biological Indicators for Screening the Condition, Quality, and Health of Soil.

Indicators of soil condition	Relationship to soil condition and function, rationale as a priority measurement
Physical	
Texture	Retention and transport of water and chemical; needed for many process models; estimate of degree of erosion and field variability of soil types
Depth of soil, topsoil and rooting	Estimate of productivity potential and erosion; normalizes landscape and geographic variation
Soil bulk density and infiltration	Indicators of compaction and potential for leaching, productivity, and erosivity; density needed to adjust soil analysis to field volume basis
Water-holding capacity (water retention character)	Related to water retention, transport, and erosivity; available water can be calculated from soil bulk density, texture, and soil organic matter
Chemical	
Soil organic matter (total organic C and N)	Defines soil fertility, stability, and erosion extent; use in process models and for site normalization
pH	Defines biological and chemical activity thresholds; essential to process modeling
Electrical conductivity	Defines plant and microbial activity thresholds, soil structural stability, and infiltration of added water; presently lacking in most process models; can be a practical estimator of soil nitrate and leachable salts
Extractable N, P, and K	Plant available nutrients and potential for loss from soil; productivity and environment quality indicators
Biological	
Microbial biomass C and N	Microbial catalytic potential and repository for C and N; modeling; early warning of management effects on organic matter
Potentially mineralizable N (anaerobic incubation)	Soil productivity and N-supplying potential; process modeling; surrogate indicator of microbial biomass N
Soil respiration, water content, and temperature	Measure of microbial activity (in some cases plants); process modeling; estimate of microbial biomass activity

(Source: Doran, et al, 1999)

Conclusions

Soil functions are complex and cannot be measured in a single indicator, in turn, it should be assessed through several parameters which combined can give a good assessment of the soil. This paper is the first step of an ongoing PhD research, which aims at analysing the main studies regarding soil rehabilitation in Cerrado and then creating a rehabilitation guideline, that will give recommendations for soil regeneration.

Literature

- (1) Araújo, ASF & Monteiro RTR (2007): Indicadores biológicos de qualidade do solo. *Biosci. J.*, 23 (3) Uberlândia, p. 66-75.
- (2) Araújo EA, Ker JC, Neves JCL, Lani JL (2012): Qualidade do solo: conceitos, indicadores e avaliação. *Revista Brasileira de Tecnologia Aplicada nas Ciências Agrárias*, Guarapuava, PR, v.5, n.1, p.187-206.
- (3) Bai Z, Dent D, Wu Y, de Jong R (2013): Land degradation and ecosystem services. In: *Ecosystem Services and Carbon Sequestration in the Biosphere*. Edited by: Lal R, Lorenz K, Hüttl RF, Schneider BU, von Braun J.
- (4) Doran JW, Jones AJ, Arshad MA, Gilley, JE (1999): Determinants of Soil Quality and Health. In: *Soil Quality and Soil Erosion*, by Lal Rattan. Soil and Water Conservation Society.
- (5) Egoh BN & Maes J (2013): Preserving regulating and cultural ecosystem services: transformation, degradation and conservation status. In: *Ecosystem Services and Carbon Sequestration in the Biosphere*. Edited by: Lal R, Lorenz K, Hüttl RF, Schneider BU, von Braun J.
- (6) Klink CA, Machado RB (2005): Conservation of the Brazilian Cerrado. *Conservation Biology* 19(3). pp. 707–713.
- (7) Lal R (2013): Soils and Ecosystem Services. In: *Ecosystem Services and Carbon Sequestration in the Biosphere*. Edited by: Lal R, Lorenz K, Hüttl RF, Schneider BU, von Braun J.
- (8) Silva JF, Farinas, MR, Felfili, JM, Klink CA (2006): Spatial heterogeneity, land use and conservation in the cerrado region of Brazil. *Journal of Biogeography* 33. pp. 536–548.

Corresponding Author

Vanessa Oliveira, Wald und Forstwirtschaft, Hochschule Weihenstephan-Triesdorf, Hans-Carl-von-Carlowitz-Platz 3., 85354 Freising
eMail: vanessa.oliveira@hswt.de
Telefon: +49 (0) 8161 71-5942

A typology of online flower shops on the German market

Meike Rombach and Vera Bitsch

TUM, Chair Economics in Horticulture and Landscaping

Introduction

German consumers spend 37 euro per capita annually on cut flowers (BMEL, 2014). Single cut flowers or flower bouquets are sold on weekly markets, in garden centers, supermarkets, discounters, and specialized flower shops (AMI, 2014). According to Gabriel and Menrad (2013), a shift in market share from specialized retailers towards supermarkets and discounters fosters a competitive market situation. Online flower shops gain relevance for both types of retail, since during the past decade E-commerce has been well accepted in Germany. The market development is reflected in the emergence of various online providers selling cut flowers and flower bouquets. Up to now, European research on E-commerce focused rather on online groceries and fresh produce, not on online flower shops (Ramus and Nielsen, 2005, Hansen, 2008).

Material and Methods

In 2014, we conducted comparative case studies based on in-depth interviews with representatives of online flower shops, newspapers and trade magazine articles, homepages of online flower shops, and consumer feedback. All data were analyzed through qualitative content analysis. The study uses a qualitative research approach, since qualitative approaches serve to explore little researched topics, as well as add new perspectives to well researched topics (Bitsch, 2005).

Results and Discussion

Results indicate a highly competitive market, where even successful players do not know their exact market position due to lack of market data. We distinguish six shop types. Type 1 facilitates a global network between local flower shops as intermediary, building on quality, long-term relationships, and trust. This shop carefully screens partners, and ensures service and quality. Type 2 offers standard bouquets or subscription services, based on own production, wholesalers, or other growers via marketing contracts. Type 2 faces fierce competition, and shops actively work with or against each other. Some shops accuse competitors of online defamation by posting unauthentic consumer feedback. Type 3 cooperates with discounters, where consumers can order a limited choice of the flower shop's assortment via the discounter's homepage and under the discounter's brand identity. Type 4 cooperates in a similar manner with other online retailers with a broad product range. Type 5 is a mix between types 1 and 2; within Germany, it directly supplies standard bouquets to consumers, outside it serves intermediary. Type 6 is a wholesaler market or a local flower shop using online business as an alternative distribution channel.

Conclusions

The study examined the market situation and the structures within the online cut flower sector. The absence of market data intensifies the competition. Actors rely on their own market analyses. Therefore, the business activities are exclusively based on estimates and industry knowledge of the decision-makers. Further studies of the market situation would allow current online flower shops to improve their business tactics and strategies. The typology is of interest to the horticultural sector, since it explores the links between different actors within the German online cut flower sector, which were not known, previously. Accordingly the typology is valuable to consultants working with cut flower producers and retailers, since it could help them to develop strategies to improve the business or to find suitable partners. Another venue for the future research would be a more in-depth exploration of relationships and partnerships among online flower shops, as well as their role within the value chain. Relationships with growers or other suppliers of particular interest, since they are key to further improving the functioning of the value chain.

Literature

AMI (2014) Top-10 list of cut flowers in Germany in 2013. http://www.g-net.de/download/presstedienst/2014/Top10_2012_2013.pdf, accessed 03.03.2015.

Bitsch, V (2005) Qualitative Research: A Grounded Theory Example and Evaluation Criteria. *Journal of Agribusiness* 23 (1): 75-91.

Gabriel, A. and K. Menrad (2013) Segmentation of Customers of Horticultural Non-food Products in Southern Germany. *German Journal of Agricultural Economics* 62 (3): 192-202.

Hansen, T (2008) Consumer values, the theory of planned behavior and online grocery shopping. *International Journal of Consumer Studies* 32 (2): 128-137.

Ramus, K. and N. A. Nielsen (2005) Online grocery retailing: what do consumers think? *Internet Research* 15 (3): 335-352.

Corresponding Author

Meike Rombach
TUM, Chair Economics in Horticulture and Landscaping
Alte Akademie 16, 85354 Freising
eMail: meike.rombach@tum.de
Telefon: 08161-712536

Development of a system for selective pasture care by an autonomous mobile machine

Benjamin Seiferth

Bavarian State Research Center for Agriculture, Institute of Agricultural Engineering and Animal Husbandry, Freising

TU Dresden, Chair of Agricultural Systems and Technology

Introduction

Pasture care is an important factor in pasture management. Quantity and quality losses of pasture forage are consequences of insufficient pasture care. An optimal pasture care includes selective mulching of weeds and seeding on areas without vegetation. Until now these operations have been done manually, extensive by machine or there was no pasture care at all. Selective improvement of pasture conditions after grazing should be carried out by the pasture robot selectively and autonomously. The aim of this thesis is therefore the development of a system consisting of selected sensors, which detect necessary information about pasture areas to supply the modified actors of the system (traction drive, mulcher, seeder) for appropriate maintenance operations on pasture.

Material and Methods

The functional model of the pasture robot is designed based on an existing mobile platform. After an analysis of the state of the art, first constraints for this platform must be examined and defined. A main requirement for the operating mobile platform is a stable and reliable movement under pasture conditions. The selected platform is equipped with actors, like a mulcher and seeder, and several sensors. These include sensors to localize pasture spots for maintenance operations, to detect forage data and sensors, which are necessary for vehicle control. Finally the low level vehicle control is developed and the interaction of sensors and actors is technically implemented.

Results and Discussion

To analyze the terrain conditions, especially the roughness of the surface, the soil profile was detected by drawing a developed sensor carriage across typical pastures. By the detected soil profiles the maximal ground clearance for appropriate wheelbases or rather track gauges and the maximal ramp travel index of the mobile platform were determined. Furthermore mulcher types were evaluated in regard to the operation on pasture. Thereby a low power requirement, a high operational reliability, suitability for hilly terrain and safety were criteria, among others. The evaluation resulted, that the flail mulcher is most suitable for autonomous pasture care. Moreover a 2D-laserscanner was tested successfully according localization of leftovers after grazing and the detection of biomass.

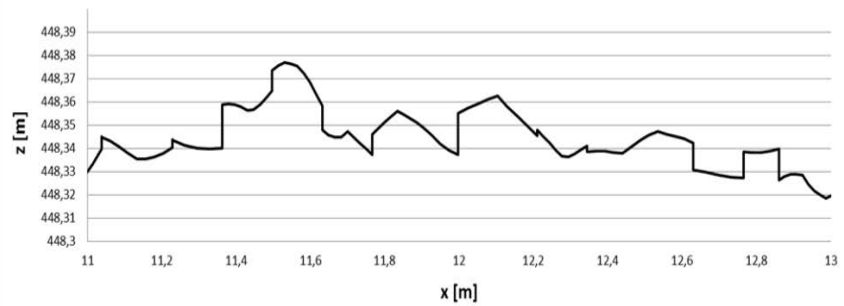


Figure: Detection of soil profiles on pastures; sensor carriage (on the left), detected soil profile

Conclusions

After the analysis and definition of constraints the technique was selected. Now the technical implementation can start. That means equipping the acquired platform with sensors and attachments as well as developing the low level control for autonomous operation. Also further tests of sensors to detect pasture data are necessary to calibrate and to check the reliability under pasture conditions.

Corresponding Author

Benjamin Seiferth
LfL, Institut für Landtechnik und Tierhaltung,
Am Staudengarten 3, 85354 Freising
eMail: Benjamin.Seiferth@lfl.bayern.de
Telefon: 08161-71 3091

Investigating the genetic structure and diversity of the barley pathogen *Ramularia collo-cygni*

Hind Sghyer¹, Aurélien Tellier², Ralph Hückelhoven¹, Martin Münsterkötter³, Ulrich Guedener³, Michael Hess¹

¹ Phytopathology, ² Section of Population Genetics, Center of Life and Food Sciences Weihenstephan, Technische Universität München

³ Institute of Bioinformatics and Systems Biology, Helmholtz Center Munich

Introduction

Ramularia collo-cygni (*Rcc*) is the biotic factor responsible for the disease Ramularia leaf spot (RLS) of barley (*Hordeum vulgare*). The fungus is attracting interest in the scientific community as a result of the increasing number of economically damaging disease epidemics. Still essential parts of the pathogen biology, in particular the life cycle remain poorly understood. To understand more about its epidemiology, the knowledge of its genetic structure and diversity is essential.

Material and Methods

For a better understanding of this pathogen, sequence analysis of four *Rcc* housekeeping genes, glyceraldehyde 3-phosphate dehydrogenase (GAPDH), β -tubulin (β Tub), E2 ubiquitin-conjugating protein (E2Ub) and a Thioesterase family protein (Thios) was used to further address the genetic diversity in *Rcc* isolates from a selection of geographically distinct isolates as well as isolates from hosts other than barley. Moreover, the genome of *Rcc* was sequenced completely and assembled using Allpaths-LG assembler. The fungal RNA from 6 different conditions, especially one that mimics the plant environment was also sequenced to help the annotation.

Results and Discussion

Analysis of the housekeeping genes sequence data indicated substantial genetic diversity between the isolates and a possible *Rcc* population size expansion, which might help explain the recent emergence. (Table 1)

Furthermore, the finished assembled genome of *Rcc* is about 32 Mb and is currently to be found in 78 scaffold. The complete annotation of this genome is underway to generate consensus gene calls. The analysis of the fungal RNA sequence data is in progress and we hope it will help to uncover putative gene of interest that might be involved in the pathogenicity or the fungicide resistances for example.

Tabelle 4: Estimates of gene diversity of four *R. collo-cygni* housekeeping genes

	n	S Waters on 1	Theta- W	Theta per gene 1	R per gene 2	Haplotype number	Tajima's D	Tajima's D coding region	Tajima's D non- synonymo us	Fu and Li D with outgroup 3
GAPDH	21	17	0.006	4.725	17.900	14	-2.648***	-2.724***	-2.705***	-1.282
βTub	18	19	0.007	5.524	13.400	13	-2.498***	-2.549***	-2.580***	0.024
E2Ub	21	18	0.010	5.003	0.001	7	-2.651***	-2.558***	-2.589***	-3.047**
Thios	21	11	0.006	3.057	0.001	3	-2.302**	-	-	-3.258**
Mean		16.25	0.007	4.577	7.826	9.25	-2.611	-2.611	-2.625	-1.891

¹ Analysis conducted after preliminary alignments. Some SNPs are probably Indels.

² Recombination per gene

³ Outgroup: *Mycosphaerella graminicola* strain IPO323.

** P<0.01, *** P<0.001

Conclusions

To evaluate the true genetic diversity of this fungus, full genomes sequencing of Rcc isolates from multiple geographic locations and non-barley hosts are underway. We hope by this approach to provide valuable insights in to the genetic diversity of this organism and to address how this diversity has influenced the evolution of the fungus. The understanding of the diversity is essential to identify sustainable control in Integrated Pest Management.

Corresponding Author

Hind Sghyer,
TUM Lehrstuhl für Phytopathologie,
Emil-Ramann-Str. 2 85350 Freising
eMail: hind.sghyer@tum.de
Telefon: 08161-713737

Biocontrol of *Aphis gossypii* on Okra in Cameroon

Akanksha Singh

Lehrstuhl für Terrestrische Ökologie, Dept. für Ökologie and Ökosystemmanagement,
Technische Universität München, Freising

Introduction

Tropical systems harbor great species diversity and for pest biocontrol it is crucial to understand how species interact on a multi-trophic level. In Cameroon, West Africa, Okra (*Abelmoschus esculentus*) is a commonly cultivated vegetable and the melon-cotton aphid (*Aphis gossypii*) is one of the major insect pests. The natural enemies of aphids on Okra include parasitoid wasps, syrphid fly larvae and spiders; however, the parasitism rate of aphids here is low, possibly due to frequent pesticide spraying. Furthermore, ant-aphid interactions can be beneficial or harmful for biocontrol measures. Mutualistic associations between aphids and ants can protect aphids from their natural enemies, and hinder biological control efficiency or; on the contrary, okra produces pearl bodies which can possibly attract ants and distract them from protecting aphids.

Materials and methods

In field studies and a controlled greenhouse study we investigated the role ants play in the interactions between okra and aphids. The experiments were located at the International Institute of Tropical Agriculture (IITA) research station in Yaoundé, Cameroon. We used four okra varieties and conducted fully factorial randomized block design experiments; where we manipulated the presence absence of aphids, aphid natural predators and ants for all okra varieties.

Results and conclusion

We found that ants did not benefit aphids on Okra and their effect on aphids differed on different Okra varieties. We further found ant preference of okra pearl bodies or aphid honeydew to vary amongst different ant species. We suggest that developing okra breeds which produce pearl bodies of specific characteristics can assist in aphid biocontrol.

Corresponding Author

Akanksha Singh
Chair of Terrestrial Ecology
Department of Ecology and Ecosystemmanagement
Technische Universität München
Hans-Carl-von-Carlowitz-Platz 2, D-85350 Freising-Weihenstephan
Phone: +49.8161.71.4149
Fax: +49.8161.71.4427
eMail: ga46jim@mytum.de

Characterization of the rumen microbiome with DNA-classification by qPCR at a different structure supply of beef bulls

Elisabeth Zißler

TU München, Lehrstuhl für Tierernährung, Wissenschaftszentrum Weihenstephan

Introduction

The extraordinary ability of ruminants to transform non-edible, fiber-rich biomass into edible food is rooted in complex microbial ecosystem of the rumen. However, the rumen microbiome has not been characterized by now. Previous studies have been limited to quantitative measurements of (bio)chemical endpoints (e.g., volatile fatty acids, methane) and ruminal degradation rate of the feed matrix. By using advanced molecular biology methods, an accurate characterization is facilitated. Aim of the present study was to investigate the influence of different structural supply of beef cattle on the ruminal microbiome and the biochemical endpoints of rumen fermentation.

Material and Methods

The experiment was conducted using 67 Simmental bulls (live body weight 800 kg) in Grub/Poing at the Institute of Animal Nutrition and Feed economy of the Bavarian State Research Center for Agriculture. In the pre-experimental phase, animals were fed to a live body weight of 500 kg with a uniform structure value (SW) of 1,2. Following, the animals were divided into three experimental groups with varying structure values. The animals of group SW 1,2 (control group) were fed a total mixed ration (TMR) based on corn silage, concentrate (about 30% of dry matter (DM)) and straw with a structural value (SW) of 1,2. The second experimental group (SW 1,1) received a similar diet without straw. The bulls in the third experimental group (SW 0,6) were supplied with a ration containing 70% concentrate and 30% corn silage in the dry matter without straw supplementation. . More information of the feeding trial can be found at Etle et al. (2014).

Animals were slaughtered at an age of app. 500 days after overnight fasting.

At slaughtering, 200 ml rumen fluid was sampled from each animal and was freeze-dried. Total DNA in rumen fluid was extracted by MP Fast DNA Spin Kit for Feces (MP Biomedicals; Santa Ana; California; USA). The abundance of total bacteria was analysed via qPCR using specific primers from Bach et al. (2002). Concentration of ammonia and volatile fatty acids (acetate, propionate and butyrate) in rumen fluid was analysed using spectrophotometry and gas chromatography, respectively. Microbial DNA copy number was expressed as log₁₀ per gram of dry matter. The statistical analysis was performed using SAS software (SAS 9.3, Cary, USA). The statistical analysis of variance and a comparison of means were performed by Student-Newman-Keuls test with a significance level of 5%.

Results

Table 1 shows a numerical trend for a decrease of the amount of all measured volatile fatty acids (acetic acid, propionic acid, and butyric acid) in the experimental groups with a lower supply of structure.

According to the concurrent change in the concentrations of acetic acid and propionic acid, the ratio of acetate and propionate remained unchanged.

Contrary to volatile fatty acids, the pH value in the rumen fluid significantly increased with decreasing SW.

In addition to the endpoints of microbial fermentation, the totality of the bacterial population was analyzed in the rumen fluid. With decreasing structure the total density of bacterial DNA dropped from 9,76 through 9,87 to 9,89 log 10 gene copies / g DM. These effects did not reach statistical significance.

	SW 1,2	SW 1,1	SW 0,6	p-value	SEM
pH	7,04 ^b	7,06 ^{ab}	7,15 ^a	0,040	0,03
acetate [mmol/l]	38,35	35,56	31,28	0,120	0,15
propionate [mmol/l]	8,08	7,50	6,51	0,199	0,05
butyrate [mmol/l]	4,58	4,05	3,77	0,142	0,03
total bacteria [log10/gTM]	9,76	9,87	9,89	0,399	0,08

Table 5: Mean pH and content of volatile fatty acids in rumen fluid (acetic, propionic and butyric mmol/l) and mean density of bacteria in the rumen (log 10 of copy number per gram of dry matter); ^{a,b} values with different superscripts indicate significant difference

Conclusions

It was shown that a different structure supplementation of beef bulls has an effect on the fermentation endpoints and the density of total bacteria in the rumen. Because the sampling was conducted 24 hours after the last feeding, the observed effects indicate an interaction between the ruminal microbiome and the host.

Literature

- (1) Bach H.-J., Tomanova, J., Schloter, M., Munch, J.C., 2002: Enumeration of total bacteria and bacteria with genes for proteolytic activity in pure cultures and in environmental samples by quantitative PCR mediated amplification Journal of Microbiological Methods 49 (2002) 235–245.
- (2) Etle, T., Obermaier, A., Edelmann, P.; 2014: Untersuchungen zur „Strukturversorgung“ beim Mastbullen. Tagungsband Forum angewandte Forschung in der Rinder- und Schweinefütterung, 23-26

Corresponding Author

Elisabeth Zißler

Lehrstuhl für Tierernährung, TU München, Liesel-Beckmann-Str. 2, 85354 Freising

eMail: elisabeth.zissler@wzw.tum.de, Telefon: 08161-713116

