Production risks on dairy farm level - Differences between pasture and confinement

H.D. Schulte and O. Musshoff [1]

***Abstract* - Recently, pasture-based dairy production has delivered advantages in comparison to confinement systems. Consumers are willing to pay higher milk prices, and on the farm-level, it requires lower input costs. However, previous calculations of gross margin were only based on small sample sizes or averaged yearly data, and did not account for the production risks of these systems. The objective of this study was to calculate the certainty equivalent of gross revenue for both systems, which accounts for production variability as a risk premium, and is therefore comparable across systems. After calculating the certainty equivalent, evidence was found that dairy farmers need to save 1.07 € per cow and day if a change from confinement to pasture is to be beneficial.**

INTRODUCTION

The amount of milk production per cow per day is dependent on the animal husbandry system and nutritional management by dairy farmers (Bargo et al., 2002; White et al., 2002). For instance, the milk output is higher if cows are fed by total mixed rations instead of a pasture-based diet (Bargo et al., 2002).

However, pasture-based (PB) milk production is an interesting opportunity for dairy farmers because consumers are willing to pay higher prices (Hellberg-Bahr et al., 2012) and milk processors are establishing special trademarks for this production system (Fahlbusch et al., 2009). Furthermore, White et al. (2002) argue that PB production systems can be better off in comparison to confinement (CF) systems if the production change reduces input costs.

Recent studies have already analysed production differences, but these calculations were only based on averaged yearly values of input costs and milk output (Kiefer et al., 2013) or small sample sizes (Steinwidder et al., 2010). Thus, no study has considered production variability between season and production systems. Therefore, the objective of the study was to calculate the certainty equivalent (CE) of gross revenue to explain differences in greater detail. The CE of gross revenue is a comparable value which monetizes production risks of both systems as a risk premium. In the end, it helps dairy farmers to decide between systems because it explains how much they need to compensate with lower input costs or higher output prices if they want to change to PB dairy production.

MATERIAL AND METHODS

Data

To analyse and asses the differences in production risks, 56 farms located in North-Western Germany with 42 observations between 2011 and 2014 were used. The observations consisted of milk yield, fat content, and protein content. These variables were used to calculate the energy-corrected milk (ECM) yield with respect to 4% fat and 3.4% protein. The milk price was collected from the database of the German Federal Ministry of Food and Agriculture, and reflected the monthly averaged energy-corrected milk price in Lower Saxony (BMEL, 2016). The animal husbandry systems included 27 CF and 29 PB systems. PB implies that cows are on pasture at least 6 hours per day from April to September.

Methodological Approach

El Benni and Finger (2013) used the CE to explain differences between agricultural policies. A similar approach is applied to explain differences between the aforementioned production systems. The starting point is the calculation of the expected revenue E(rev):

$$E(rev) = \mu_p\mu_q + cov_{p,q} \quad [1]$$

The variables μ_p and μ_q reflect the average values of the milk price respectively milk output. The covariance is added to reflect the common distribution of both variables.

Furthermore, to calculate how milk price and milk yield influence revenue variability, the variance decomposition method was applied (Burt and Finley, 1968). It is an approximation of the variance of revenue and is calculated as follows:

$$Var(rev) = \mu_q^2 var(p) + \mu_p^2 var(q) + 2\mu_p\mu_q cov_{p,q} \quad [2]$$

This approximation is possible because a simple t-test proved that no differences in the observed variance of gross revenue exist. Furthermore, it is necessary to calculate a value which reflects the different production risks of the CF and PB systems. Therefore the certainty equivalent (CE) of gross revenue was used. It is the difference between expected revenue and a risk premium (RP):

$$CE = E(rev) - RP \quad [3]$$

The risk premium covers the costs of uncertainty. Thus the expected revenue is not certain and the

[1] Hinrich D. Schulte and Oliver Musshoff are working at the Farm Management Group, Georg-August University Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany (hinrich.schulte@agr.uni-goettingen.de).

risk premium is introduced to cover the monetary costs of risk. The risk premium is dependent on the risk attitude of farmers, expected revenue, and the variance of revenue. Assuming the case of a risk-averse dairy farmer, the risk premium can be calculated as follows:

$$RP \approx 0.5\gamma\ (var(rev))/(E(rev)) \quad [4]$$

As already shown, the expected revenue and the variance of revenue can be calculated by equations [1] and [2], but the attitude towards risk needs to be considered. Assuming a moderate level of risk aversion, γ takes a value of 2 (Gardebroek, 2006). Finally, the CE and RP are calculated for different production systems and seasons.

RESULTS AND DISCUSSION

Table 1. Production risks of pasture-based dairy production.

AHS[1]	μ_p	μ_q	E(rev)[2]	RP[2]	CE[2]
Overall	33.73	29.19	9.83	0.21	9.62
CF	33.75	30.53	10.30	0.17	10.12
Summer	32.63	30.35	9.90	0.17	9.73
Winter	34.86	30.71	10.68	0.15	10.53
PB	33.72	27.94	9.40	0.21	9.20
Summer	32.63	28.01	9.13	0.19	8.94
Winter	34.84	27.86	9.70	0.24	9.46

Note: μ_p in ct/kg ECM respectively μ_q in ECM in kg/cow and day

[1]AHS = Animal Husbandry System

[2]Expected revenue, risk premium and certainty equivalent in €/cow and day

The results in table 1 show that PB dairy farmers are willing to pay a higher risk premium to get rid of the production risk. The CE explains that the CF dairy farmers are generating higher gross revenues. For instance, in the winter term, the difference between CF and PB is 1.07 € per cow per day. Furthermore, it is only possible to compare the results within the same season because then it is guaranteed that different variabilities of prices have the same influence on the production risk.

Evidence was found that CF systems are generating higher gross revenues than PB systems. However, it does not mean that the gross margin is also higher for CF than for PB. Considering lower input prices and likely higher output prices for PB milk, these systems could deliver a higher gross margin. Thus the PB production of milk can still be beneficial and should be chosen if this is the case. These results facilitate this decision by quantifying how much dairy farmers need to improve with respect to input costs and higher output prices. However, further assumptions and scenarios with respect to herd size and γ need to be considered more thoroughly in the extended paper.

CONCLUSION AND OUTLOOK

Consumers are willing to pay higher prices for PB milk and on the farm level, it can be produced with lower input costs than CF systems. To facilitate the decision of farmers to choose the most profitable system, the CE of gross revenue was calculated, which accounts for different production risks. By applying this, evidence was found that dairy farmers need to compensate 1.07 € per cow and day if the change from CF to PB is to be beneficial. However, further different circumstances need to be modelled. For instance, different values for γ in equation [4] or herd sizes of dairy farms need to be considered. Therefore stochastic simulation with different γ values and herd sizes will be conducted in the extended paper as well to pro-vide more thoroughly results of the production risks between both systems.

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