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Farm level economic effects of introducing forage crop silage in the feed regimen in fattening pig production

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Background

- Perennial crops like grass and clover have potential to contribute to sustainable pig production.
 - Improve soil richness and biodiversity and provide more effective land use by turning less fertile land into valuable feed resources.
 - Increase the carbon sequestration and reduce the risks of nitrogen (N) and phosphorus (P).
 - In organic systems leguminous forage crops have a central role in crop rotation to fixate atmospheric nitrogen.
 - Limited availability of high-quality organic feed protein.
 - Grass and clover have demonstrated significant promise as protein components in pig feed mixtures.
 - Fulfil pigs' behavioural needs and increase the animal welfare.



Background

- Potential improvement of the farm profitability.
 - Include leguminous crops in the crop rotation
 - Adopt an alternative feed strategy and use these crops as a locally produced feed ingredient
- The size of this potential in practical farming is not yet well understood.
- Farm level feeding cost could be reduced
 - by cutting dependency on purchased feeds (e.g., soy, whey, fish meal)
 - achieve increased yields (hectare harvest) of subsequent crops.



Objective , aim and hypothesis

Offer key insights for designing more viable and sustainable pig feeding systems with less environmental impact, increased biodiversity, and healthier pigs.

- Simulate and evaluate the economic outcomes associated with inclusion of forage crops in conventional and organic pig diets of typical conventional and organic pig production.
- To test the overall positive economic outcome of including forage crops in feeding regimen for pigs.
 - Reduced feeding cost by cutting dependency on purchased feeds (e.g., soy, whey, fish meal)
 - Achieve increased yields (hectare harvest) of subsequent crops

A farm simulation model

- Four theoretical conventional and organic pig farm systems.
 - Simulated farm model of 100 ha.
 - Location in the south-west of Sweden with sandy loam soil type, 0.2 m topsoil depth.
 - Pig farmers were assumed to produce their own cereals or partly purchased concentrate and premix plus the addition of chopped silage of grass and clover mixed with the diet and fed as a TMR.
 - All feed ingredients (except for smaller amounts of fishmeal, amino acids, and premixes) in the diets in the different systems were supposed to be grown on the farm.
 - Diets optimized to fulfill the nutritional demands of growing pigs and fatteners formulated in EvaPig®
 - Crop rotation plans were assumed to follow a seven- or eight-year rotation
 - Represent a traditional and well-designed, traditional and organic crop rotations
 - Cereal crops, oilseeds and legumes and in a rotation with grass/clover leys (C_TMR, O_Ref and O_TMR)

Four pig systems

- **Reference systems:**

- A typical conventional fattening pig production in Sweden. Feeding system without added silage.
- A typical organic fattening pig production in Sweden (EC, 2008). Access to outdoor runs. Feeding system without added silage, but with supplied silage for behavioural enrichment.

- **Test systems:**

- A conventional feeding system with silage included in the feed ration (fed as TMR)
- An organic feeding system with silage included in the feed ration (fed as TMR)

Conventional feeding system (C_Ref)

- Typical Swedish conventional fattening pig farm.
- Pigs delivered at mean live weight of 32.6 kg
- Indoor housing - no outdoor facilities.
- Straw but no forage crop silage.

Conventional feeding system with silage as part of a TMR (C_TMR)

- Same as in C_Ref, but forage crop silage included in the feed ration (fed as TMR).
- Silage inclusion level was 20% of dietary crude protein.

Organic feeding system (O_Ref)

- Typical organic fattening pig farm.
- Pigs delivered at mean live weight of 38.0 kg
- Indoor housing on deep straw bedding.
- Outdoor facilities on concrete.
- Silage as additional enrichment in racks.

Organic feeding system with silage as part of a TMR (O_TMR)

- Same as in O_Ref, but silage was included in the feed ration and fed as TMR.
- The silage inclusion level was on a CP basis with 20% in the diet.

Assumptions of additional investments required

New feeding system:

- Own produced grass/clover silage cut in the field and into 4–15 mm sized particles and stored in a silage bun.
- Automatic TMR feeding system and inclusion of (20% on CP basis) chopped grass/clover silage in the diet.

Additional investments required:

- Investments of machines and equipment for harvest and storage of ley crop production and silage.
- Adaptions to the buildings and feeding system (pen design, mixer, automatic feeding etc.) to be able to include TMR feed.

Simulation approach

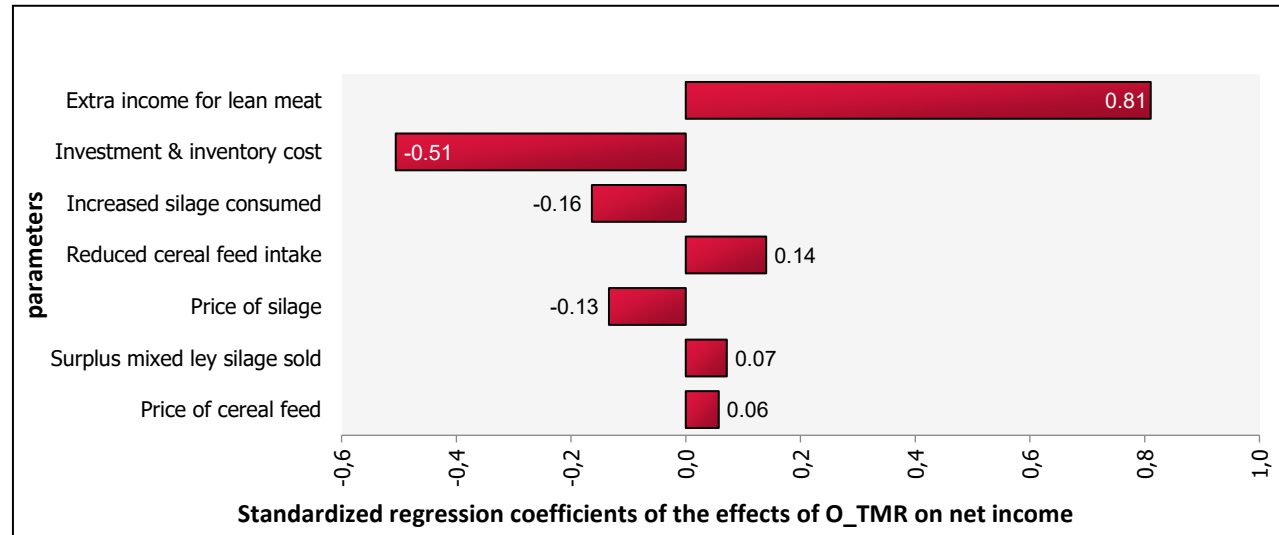
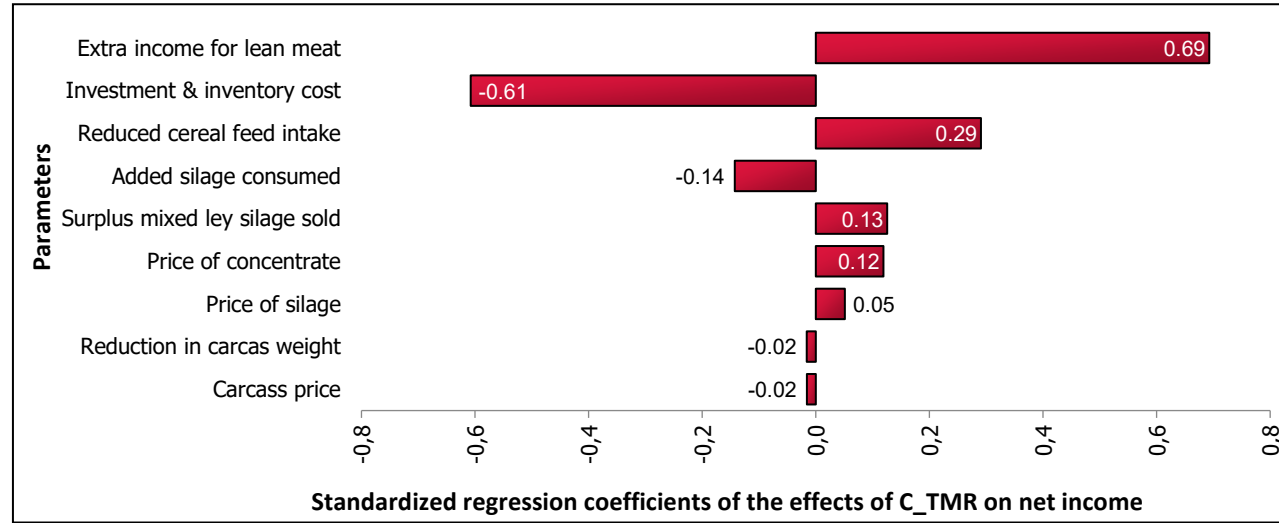
- Stochastic partial budgeting approach to examine economic impact of different changes and investments in livestock production.
 - Microsoft Excel and @Risk (Palisade, Ithaca, NY) software.
 - Quantifying the **added cost and income** and the **reduced costs and income** due to the new changes in the feeding systems.
- The approach takes the riskiness in outcomes into explicit consideration.
- The approach allows for analysis of what are the main drivers for the net-benefit change.

Main findings

- The increase in net income was higher than the increase in operational cost for including silage in the conventional and organic systems respectively.
 - 13% higher in the conventional system.
 - 34% higher in the organic system.
- Incorporating silage as part of a TMR in the conventional pig feeding system had both added costs and income and reduced costs and income.
- Operational costs rose due to added costs related to investments in changing the existing building and feeding system.
- Income rose due to higher lean meat and incomes from sold silage.

Key parameters affecting net farm income

- Effects on C_TMR is mainly driven by
 - Extra income for lean meat (+)
 - Investment and inventory cost (-)
 - Reduced cereal feed intake (+)
- Effects on O_TMR is mainly driven by
 - Extra income for lean meat (+)
 - Investment and inventory cost (-)
- Price of silage, reduction in carcass weight, price of concentrates and cereal feeds has only minor effects.



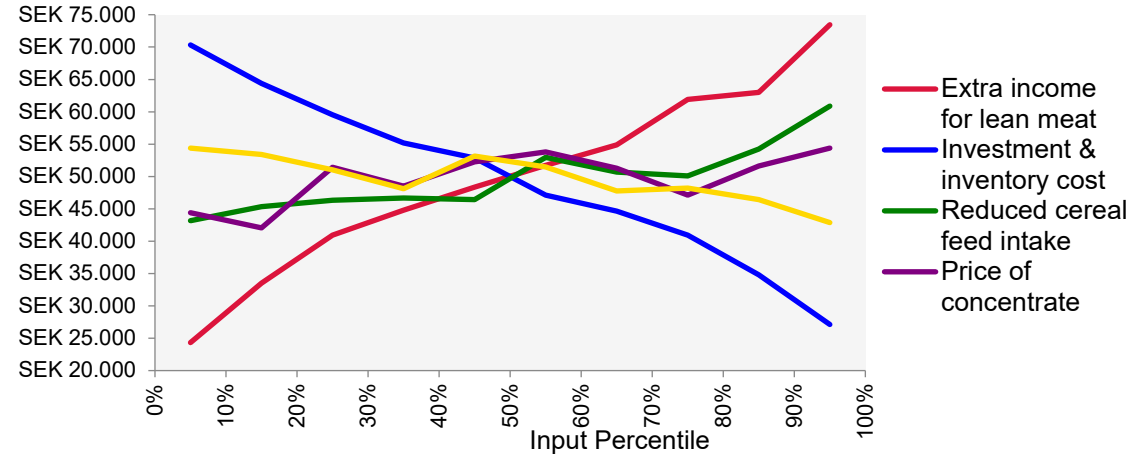
Sensitivity of the changes across the input values

In both figures, for both systems

- From the 5th to 55th percentile
 - The cost associated with the investment and inventory is above all the income adding variables.
- From the 55th percentile
 - all the income-adding variables including extra income from high prices obtained for high lean content and the reduced cereal feed intake are above the investment and inventory cost

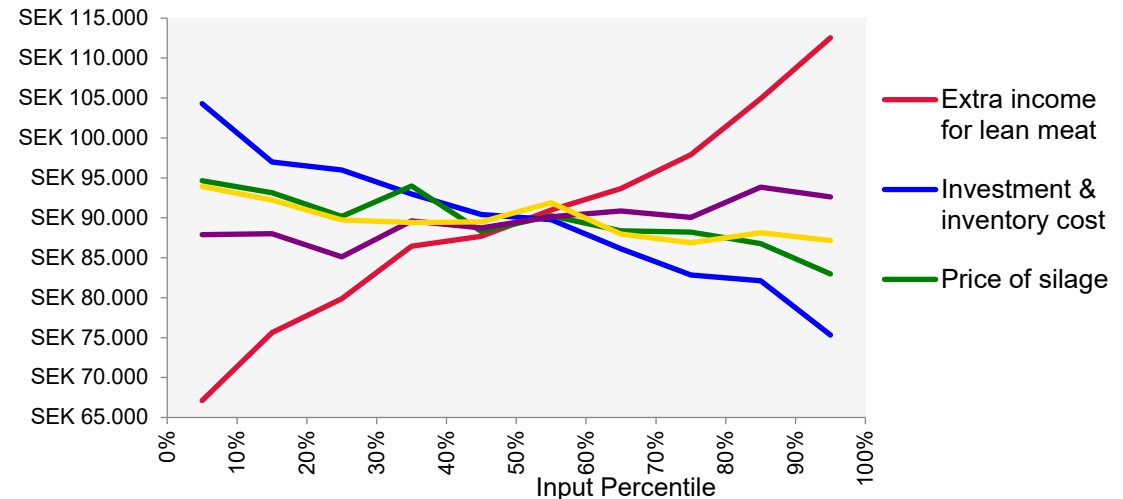
C_TMR

Change in Output Mean Across Range of Input Values



O_TMR

Change in Output Mean Across Range of Input Values



Conclusions

- Incorporating forage crop silage in the pig diets of a typical conventional and organic pig production in Sweden may enhance the economic performance of pig farms.
- Although the incorporation of forage crop silage in the feeding system will require considerable investment and operating cost, we conclude that the total benefit outweighs the cost.
 - Public policy support for sustainable investments of this type could be needed to encourage uptake until the benefits of the practice is better known among farmers.
- Results emphasize how investing in innovative feeding systems can influence the economic results of pig production.
 - Assist pig farmers in deciding whether to incorporate forage crop silage into pig diets, with a focus on economic benefits.
 - The results provide valuable information for pig producers and extension officers to make more motivated decisions about their feeding practices.

Highlights

- Forage crop silage in pig diets may enhance farm-level economic performance.
- Perennial crops are important for increased soil fertility and biodiversity.
- The feed regimen requires investment cost but the increase in income offsets the cost.
- Leaner carcasses, silage sold and reduced purchased feed increased the net income.
- Inclusion of forage crop silage promotes climate- and welfare-friendly pig farming.

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