



## FEED-A-GENE

**Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems**

### **Deliverable D6.3**

### ***Cost Benefit Analysis of Proposed Management Systems***

**Due date of deliverable: M52**

**Actual submission date: M52**

**Start date of the project: March 1<sup>st</sup>, 2015**

**Duration: 60 months**

**Organisation name of lead contractor: CREDA-UPC-IRTA**

**Revision: V1**

Dissemination level	
Public - PU	X
Confidential, only for members of the consortium (including Commission Services) - C0	
Classified, as referred to in Commission Decision 2001/844/EC - C1	



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# 1. Summary

## **Objectives**

The objective of this report is to assess the economic impacts of alternative feeds and feeding systems on pig and broiler production at the farm level. The analysis includes innovative feedstuffs (WP1), precision feeding systems (WP4), and breeding solutions (WP5) considered across the alternative management systems examined in Task 6.2.

## **Rationale**

The benefits of the alternatives feeding systems for both pig and broiler production are examined through a cost benefit analysis (CBA). The latter is often used to help farmers and policy makers make better informed decisions about the impact of adopting new technologies to enhance the economic performance of the sector. The rationale behind adopting this approach is to discover whether or not it is profitable for farmers to switch to new production systems rather than continue using existing production technologies. To answer this question, measuring and comparing the costs and benefits of new feeding methods helps to determine their potential benefits for the pig and broiler industries. A CBA is performed for each alternative and the results are presented as the impact on farm net income (FNI). The model has been estimated using data from the Farm Accountancy Data Network (FADN) database. Given the fact that the technologies are at an intermediate TRL level, It was not possible to collect “real” cost and benefit data from the project and the empirical analysis relies on “reasonable assumptions” instead. Sample farms specialised in pig and broiler production were selected from five EU countries (Germany, Spain, France, Poland, and Denmark) covering the period 2013-2015.

Baseline scenarios were defined to describe the current economic status of pork and poultry production systems in these countries over the last three years. Baseline results allow us to examine the impact of the innovations obtained from WP1, WP4, and WP5. Additionally, a sensitivity analysis was performed to evaluate the impact of new feedstuffs based on different cost scenarios and alternative feeding strategies. The alternative that has the highest benefit would be preferred. The next section presents the methodology that was applied. The results section provides an overview of production costs and margins by country and year and presents the economic performance of farms for different feeding strategies compared to the baseline model.

**Teams involved:** CREDA-UPC-IRTA, UdL, AU, KU

**Species and production systems considered:** Pigs and broiler production across Europe

## 2. Introduction

Feed-a-Gene aims to improve and adapt monogastric livestock production systems with the objective to improve their efficiency and reducing the environmental impacts. To achieve this goal, the project developed alternative feed resources and feed technologies, while at the same time identified robust animals that are better adapted to fluctuating conditions and optimizing feeding techniques to ensure the most efficient use of feeds. Task 6.3 of the project was designed to identify and evaluate the benefits of the alternative feeding systems for both pig and broiler production systems. Cost benefit analysis (CBA) is carried out for this purpose. This study was limited to the five leading producers of pork and poultry meat in the European Union (i.e., France, Denmark, Germany, Poland, and Spain) representing almost 70% and 50% of the total production, respectively. A total of 511 and 204 farms specialising in pig and broiler production respectively, were chosen for this analysis. Farm-level data were obtained from the FADN dataset and covered the period 2013-2015. FADN data include structural and accountancy data for farms and is often used to monitor the income and business activities of agricultural holdings in EU member states and allow evaluating the impact of the Common Agricultural Policy. Data available include production (e.g., the number of pigs or broilers sold each year), input use, and the financial and structural characteristics. Input costs are mainly composed of feed costs, other specific costs (e.g., piglets and veterinary costs), operating non-specific costs (e.g., upkeep of machinery and buildings, energy costs, contract work, taxes and other dues, and other direct costs), and non-operating costs (e.g., wages, land rent, taxes on land and buildings, cost of capital: depreciation, and insurance for farm buildings).

Information on the technical impact of, and costs attributed to, feeding innovations obtained from experimental samples, were compiled from a survey gathering data from work package leaders and researchers involved in the relevant tasks (WP1, WP4, and WP5). Information obtained included the main outcome of each innovation and its corresponding costs, expected change in feed costs, feed intake and feed conversion indicators, mortality rates, lean meat content, and expected change in the output prices. The change in both technical and economic performance is expressed as a percentage compared to the control group. The empirical analysis has been extrapolated to the micro-economic dataset obtained from FADN to estimate the economic impact of these technologies.

The costs of each alternative method varied according to the feeding technologies assumed to be used by farmers. The costs associated with alternative feeding methods are classified into three categories. The first consists of a precision feeding innovation, which can operate for 10 years. The additional investment costs borne by farmers to adopt the necessary equipment ranges from 1300 € to 2000 € to feed on average 20-25 pigs. Both an ad libitum feeding strategy (S5a) and a restricted feeding strategy (S5b) were evaluated.

Innovative feedstuffs developed by WP1 are mainly green protein from green biomass, local (EU) soybean meals treated with an innovative trituration process, and local soybean meals with the innovative trituration process plus seed dehulling. Estimating the costs of these new feedstuffs is not straightforward at this early stage of development. To deal with this issue, different cost scenarios were assumed to estimate the new feed prices. A sensitivity analysis was performed as a suitable approach to examine how FNI changes for each alternative if costs and benefits deviate from their assumed values. Different scenarios based on variations in input costs were simulated, especially when prices and costs of new feedstuffs are not

available. The purpose of these scenarios was to find to what extent new technologies would be profitable and improve FNI compared to current production methods.

Breeding solutions developed by WP5 to improve selection accuracy in livestock populations were also evaluated. The innovation consists of identifying new traits for selection for feed efficiency. Two diets namely, a conventional diet and an alternative diet with a higher crude fibre content, were used to evaluate the benefits of new traits in animal selection. Farmers can take advantage of these innovations without additional costs. From a private financial perspective, the estimation of cost and benefits for each method mainly relies on the comparison of technical and economic performance (e.g., feed and new equipment costs, output gain) with the baseline model.

### 3. Results

#### 3.1 Pig production

The main pig producing countries in Europe have a calculated cost of about €133 per animal. Germany and France are the most expensive with a cost of €160 in 2013. This is due to the relatively high veterinary expenses and rather small German farms, while France has high feed costs.

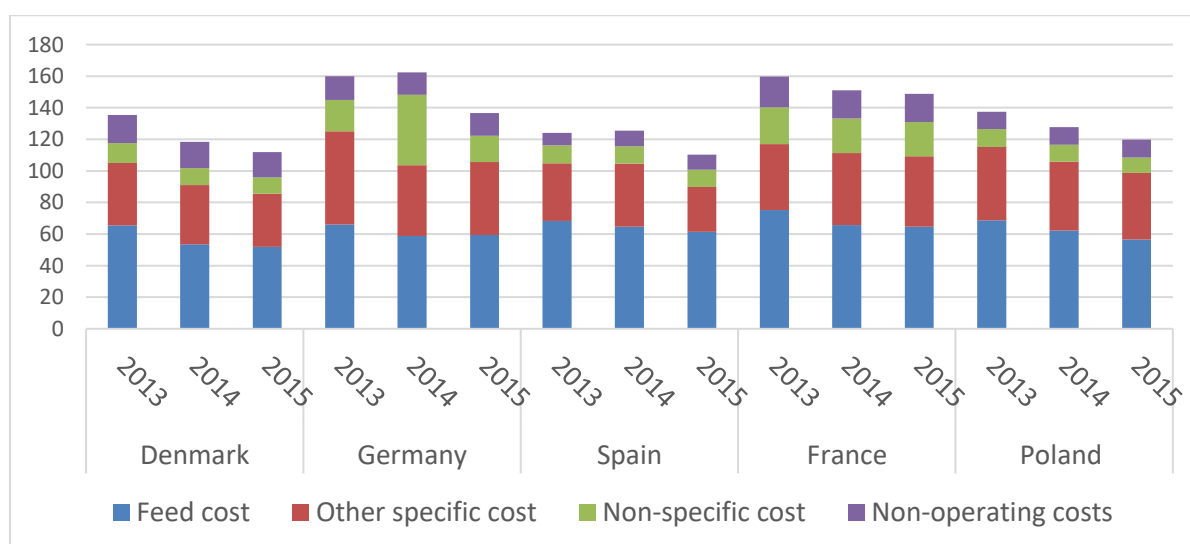


Figure 1: Evolution of production cost (€/Pig) in selected EU countries (2013-2015).

The cost of pig production in selected EU countries has improved over the period studied. Figure 1 shows the evolution of the production cost between 2013 and 2015. For instance, Germany and Spain have shown a serious cost reduction from €160 per pig in 2013 to about €138 per pig in 2015. The same trend is also observed for other countries included in the study. Tables with more detailed results are provided in the annex.

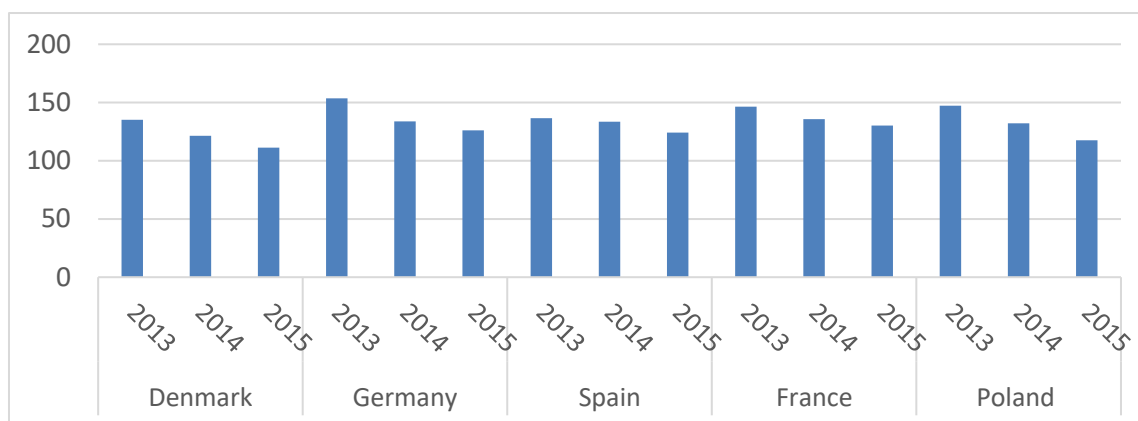


Figure 2: Revenue per fattened pig in selected EU countries (2013-2015).

Figure 2 shows the development of revenue per fattened pig in the main pig producing countries in Europe from 2013 to 2015. The total revenue represents the sum of receipts sales per pig plus national aids. The results show that, across these five countries, the between-year variation of revenues per pig was relatively high. Average total revenue per pig was higher in 2013 and 2014 than in 2015. The decline in selling prices was largely due to the significant reduction in production costs. The same results were observed for the five countries included in the analysis. The results show only yearly averages; therefore, it is possible that total revenue per pig may also have changed during the year. However, this was beyond the scope of the analysis, as FADN contains only annual data.

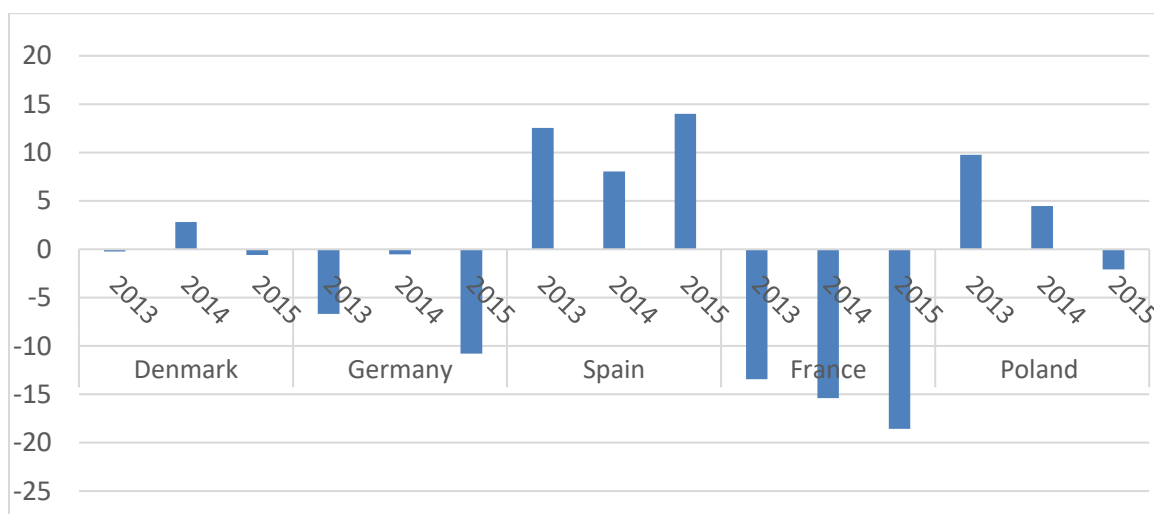


Figure 3: Evolution of the margin over total inputs in selected EU countries (2013-2015).

Figure 3 shows the change in the average margin over total inputs in Denmark, Germany, France, Spain, and Poland. Results demonstrate that the margin over total inputs varies significantly between the selected countries. In 2013, the largest positive margin per pig produced was achieved in Spain (€12.5/pig), followed by Poland (€10/pig). Due to the higher production costs for France and Germany, results there show negative margins. Due to lower revenues, a downward trend was reported for the five countries in 2014. The same downward tendency was also observed in 2015, except for Spain, where feed costs and other specific costs (such as veterinary costs) decreased resulting in a positive margin per pig produced.

**Alternative feed ingredients and real-time characterisation of feeds (WP1)****Green protein from green biomass: feed intake (+2.94%) and body weight gain (+3.36%)**

In this part of analysis, the average FNI per fattened pig calculated using FADN data (baseline scenario) was compared to the average FNI that was estimated from collected information based on the daily feed intake and the output gain provided by WP1 partners. The performance data was obtained from a study where an improved precipitation by steam of protein from green biomass was used (green protein produced in 2018, for further details see Deliverable D1.2). Results concerning other profit metrics (e.g., gross margin, margin over operating costs and margin over total inputs) per pig are provided in the annex. Due to the lack of an estimation of the costs associated with the implementation of the green protein from green biomass as a primary source for animal feed, relevant scenarios were evaluated considering likely changes in the feed costs. Figure 4 illustrates the comparison between the baseline scenario and with two alternative scenarios with a one and five percent increase in feed costs respectively.

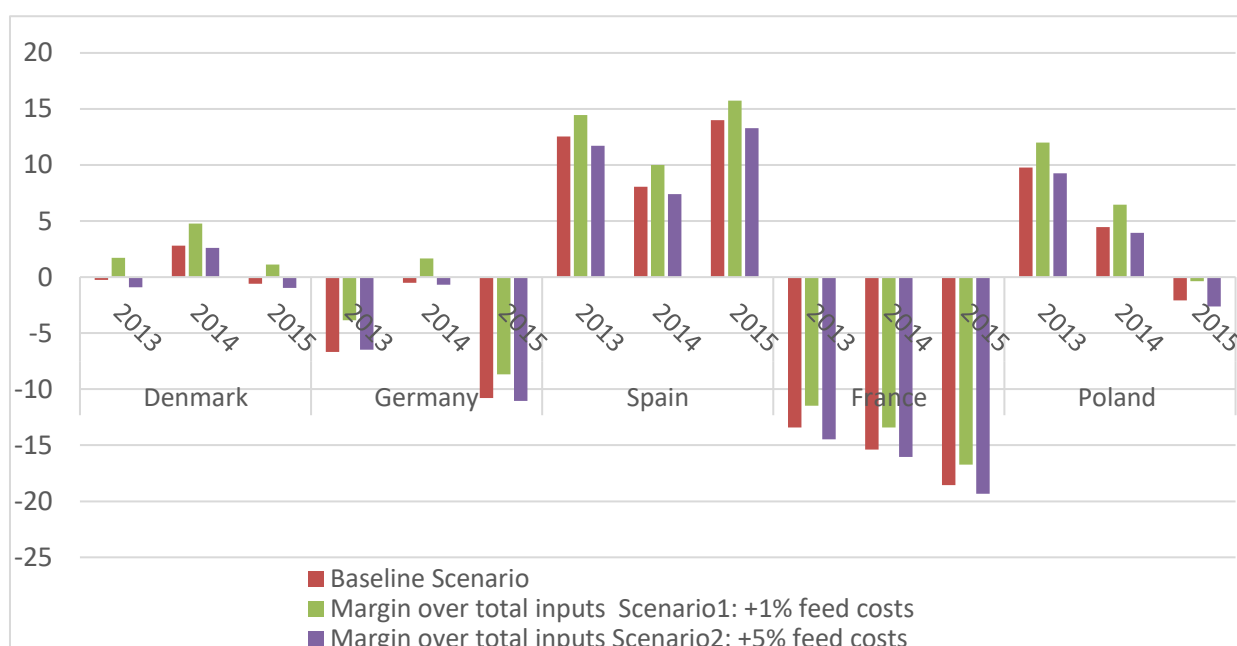


Figure 4: Evolution of the impact of green protein from green biomass on FNI (€/pig).

Empirical findings show that using green protein from green biomass as the main source of protein in pig feed would have a positive impact on FNI when feed costs increase by 1%. For example, in Spain, as a result of using this innovation to feed pigs, the average FNI increases from €12.5 to €14.45 per pig in 2013. The positive effect of the protein from green biomass would also improve the financial results of farms. For instance, in France, the average (negative) FNI per pig would increase from €-13.43 to €-10.72 in 2013. The second scenario illustrates the impact of using green protein assuming an increase in the total feed costs by 5%. This alternative would lead to a negative impact compared to a 1% increase in feed costs. Results also indicate that the average FNI would be negatively affected compared to the baseline scenario. In 2013, the average FNI, after adopting this new protein source, decreased from €12.55 to €11.71 per pig in Spain. Overall, results indicate that an increase in the cost of new feed protein sources beyond 5% would have a negative impact on the FNI of pig producers.

**Local rapeseed with physical fractionation of meal (without enzyme): feed intake (-0.65%) and body weight gain (+4.84%)**

Figure 5 shows the difference between the FNI of the baseline scenario and alternatives calculated based on technical information provided by WP1 partners based on two different scenarios: with a 1% and an 11% increase in feed costs respectively. The first scenario shows that using local rapeseed with physical fractionation of meal as the main source of protein in animal feed would have a positive outcome on farm net income when feed costs increase by 1%. For example, in Poland, as a result of using this feeding method, the FNI would increase from €9.78 to €16.66 per pig in 2013. The same trend is also observed for the other countries throughout the period of analysis. The second scenario, assuming an increase of 11% in new feed costs, reveals that this technology would still be profitable as long as new feed prices do not go beyond a threshold of 11% after which it would have a negative impact on farmers' economic performance.

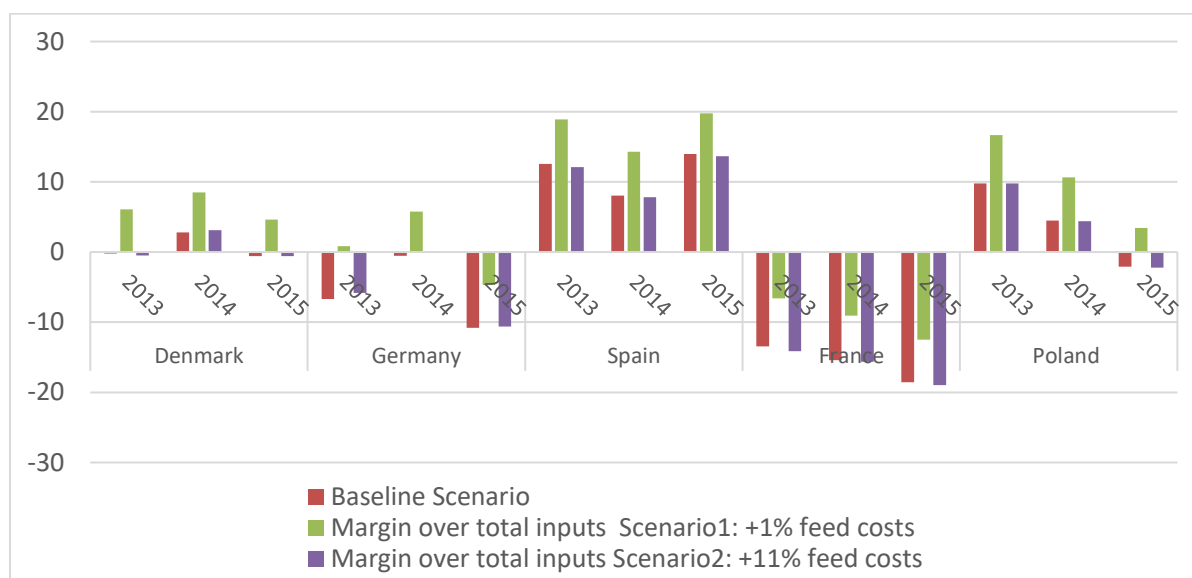


Figure 5: Evolution of the impact of local rapeseed with physical fractionation of meal on FNI (€/pig).

**Management systems for precision feeding to increase resilience to fluctuating environments and improve feed efficiency (WP4)**

**Ad libitum feeding strategy S5a: feed intake (-5.06%) and body weight gain (+1.15%)**

Data on the costs of the development of the ad libitum strategy were provided by WP4 partners. The main results of this analysis are presented in Figure 6. The experiments resulting from the use of this feeding system showed a reduction in feed intake and a slight increase in body weight gain, which would have a positive impact on the average FNI. In Spain, FNI would increase from €12.55 to €14.12 per pig in 2013.



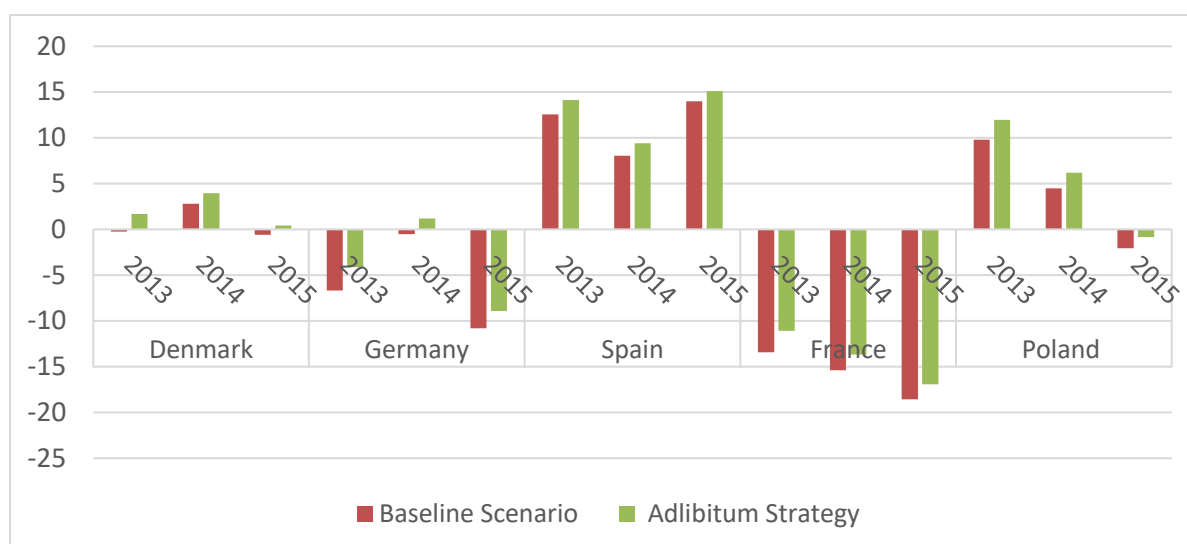


Figure 6: Evolution of the impact of using an ad libitum strategy on farm net income (€/pig).

**Restricted feeding strategy S5b: feed intake (+2.17%) and body weight gain (-1.24%)**

The second feeding system that was evaluated in this analysis refers to restricted feeding in a precision feeding strategy. While the previous feeding system showed a positive impact on FNI, the experiments resulting from the use of the restricted strategy showed an increase in the daily feed intake and a decrease in body weight gain. The impact on the FNI of pig producers is presented in Figure 7. Farmers' income per pig significantly decreases under this alternative feeding method. In Spain, the financial results of farms changed from €14 to about €8 in 2015. In some countries, the use of this feeding system worsens their situation, for example in France, where average farm net income would fall from €-18.6 to €-24.7.



Figure 7: Evolution of the impact of using the restricted strategy on farm net income (€/pig).

**Use of traits in animal selection, a new trait was evaluated for selection and its advantage was studied two diets (WP5)**

**Conventional diet: feed intake (-14.01%) and body weight output gain (-0.99%)**

Based on the technical and economic information provided by WP5, we can see that the new (improved) trait (residual feed intake to improve feed efficiency) that was evaluated for selection and examined with a conventional diet would be profitable. Results are shown in Figure 8. Spain stands out as the country with the highest average FNI using this selection trait

and results improved from €12.55 to €20.77 in 2013. The positive effect of the new trait was also demonstrated for other countries in the study.

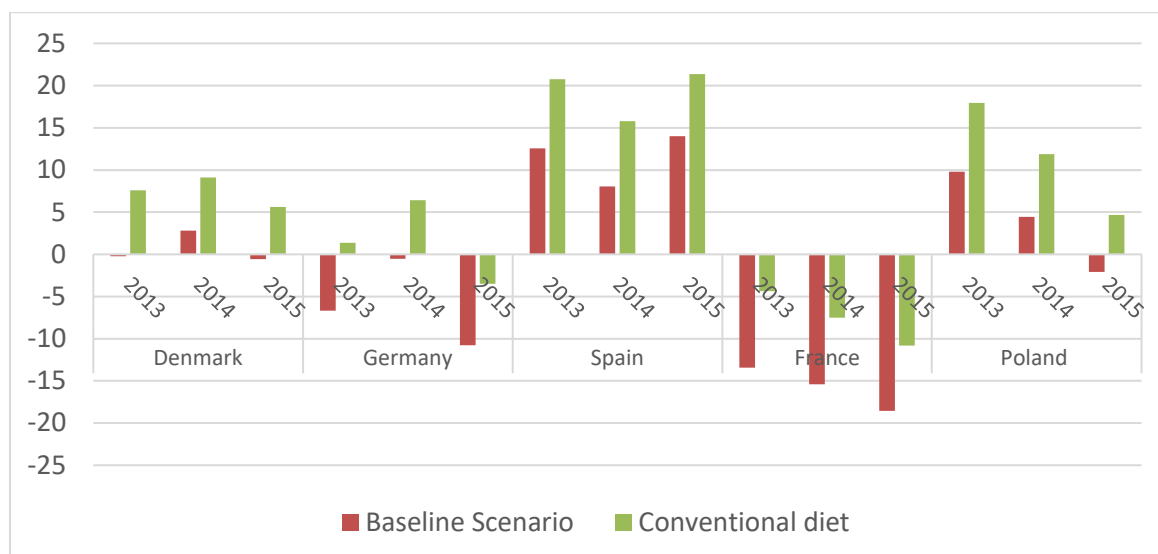


Figure 8: Impact of improved population using residual feed intake as a new trait for animal selection on FNI (€/pig) - Conventional diet.

**Alternative diet (more dietary fibre, less energy and amino acids): feed intake (-20.75%) and body weight gain (-5.63%)**

The same innovation was evaluated using an alternative feed with a higher dietary fibre content, which resulted in lower energy and lower amino acid content compared to a conventional diet due to the inclusion of by-products from the industry. While the previous data showed a high positive impact of the new trait as selection criterion, the experiments resulting from the use of this diet showed a lower positive effect compared to the former, which can be explained by a more important decrease in body weight gain in the newly improved animals with this diet. Figure 9 shows that the average FNI per pig under this feeding strategy increases from €12.55 to €19.05 in Spain. However, the alternative diet would have a lower cost, which could not be accounted for in the evaluation due to limited information of the ingredients used and lack of realistic hypotheses to estimate this cost.

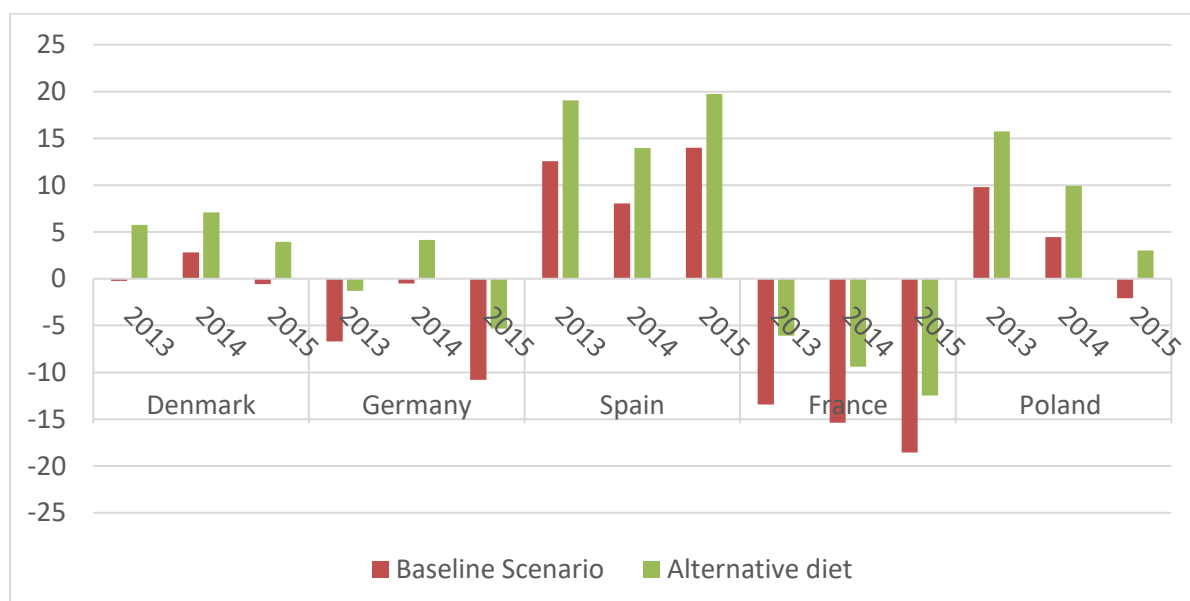


Figure 9: Impact of improved residual feed intake in pig selection on farm net income (€/pig) when animals are fed an alternative high fibre diet based on by products.

### 3.2 Broiler production

The main chicken producing countries in Europe have an average cost of about €2.20 per bird. The analysis shows that French farms have the highest average costs (€2.98) in 2013. This is due to the relatively high operating non-specific costs, that include upkeep of machinery and buildings, energy expenses, and contract work.

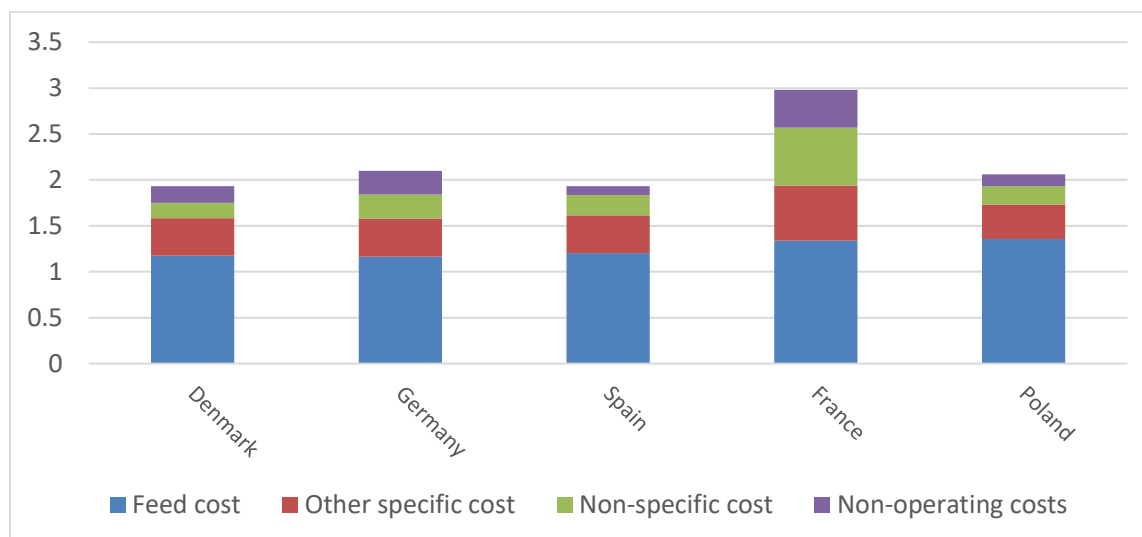


Figure 10: Structure of production costs (€/animal) in selected EU countries (2013).

Figure 11 shows the total revenue per broiler in the main producing countries in Europe from 2013. The highest total revenues are achieved in France, Spain, and Poland with €2.73, €2.28 and €2.26, respectively. While the lowest are found in Denmark (€1.98) and Germany (€2.00)

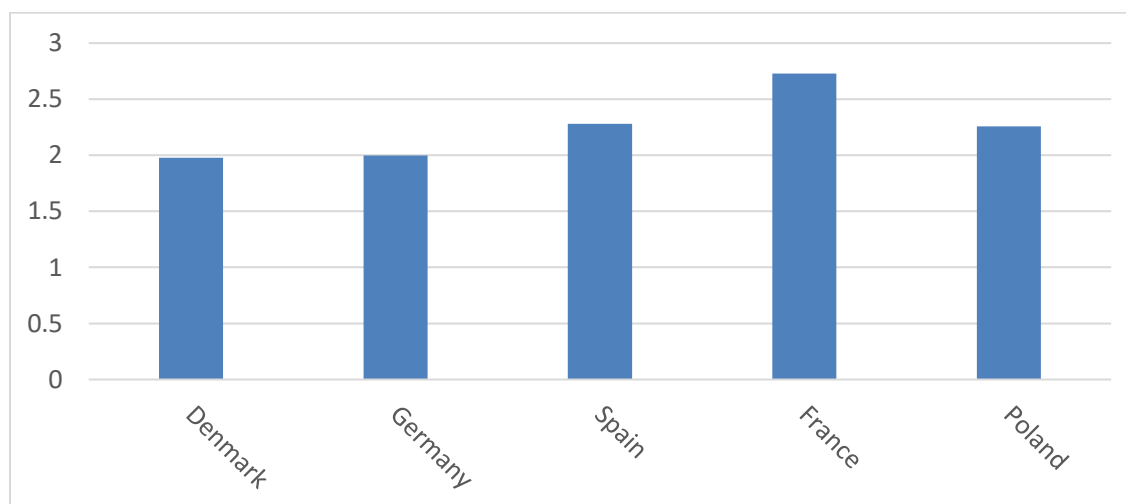


Figure 11: Total revenue per broiler in selected EU countries (2013).

Figure 12 shows the average margin over total inputs in Denmark, Germany, France, Spain, and Poland. The data show that FNI significantly varies among the selected countries. Results indicate that the largest FNI per chicken produced is achieved in Spain (€0.35/chicken), followed by Poland (€0.19/chicken) and Denmark (€0.04/chicken). While, they are negative in France and Germany.

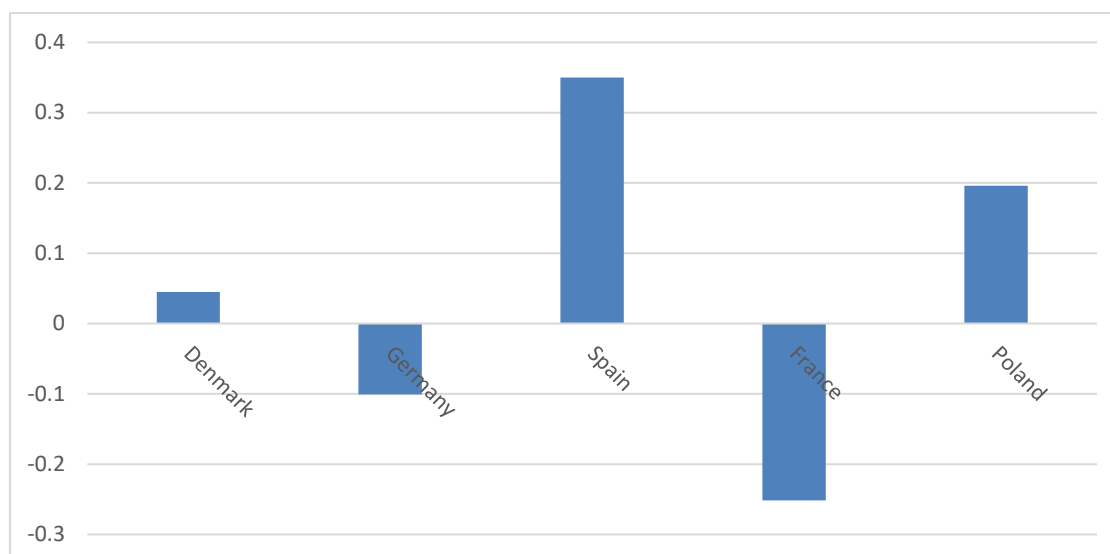


Figure 12: Margin over total inputs in selected EU countries (2013)/

### **Alternative feed ingredients and real-time characterization (WP1)**

#### **Innovative feedstuffs: Green protein from green biomass: feed intake (-7.02%) and body weight gain (-14.79%)**

In this section, feed cost scenarios were proposed to account for possible changes in the total feed costs attributed to new feedstuffs. The performance data was from an experiment performed before implementing an improved method for precipitating the protein (green protein produced 2017, for further details see Deliverable D1.2). Results indicate that using protein extracted from green biomass using the technology applied in 2017 as the main source of protein to feed chicken would have a negative impact on farm net income (Figure 13). The estimated scenario indicates that the impact would be profitable only when total feed costs can be reduced by 20%.

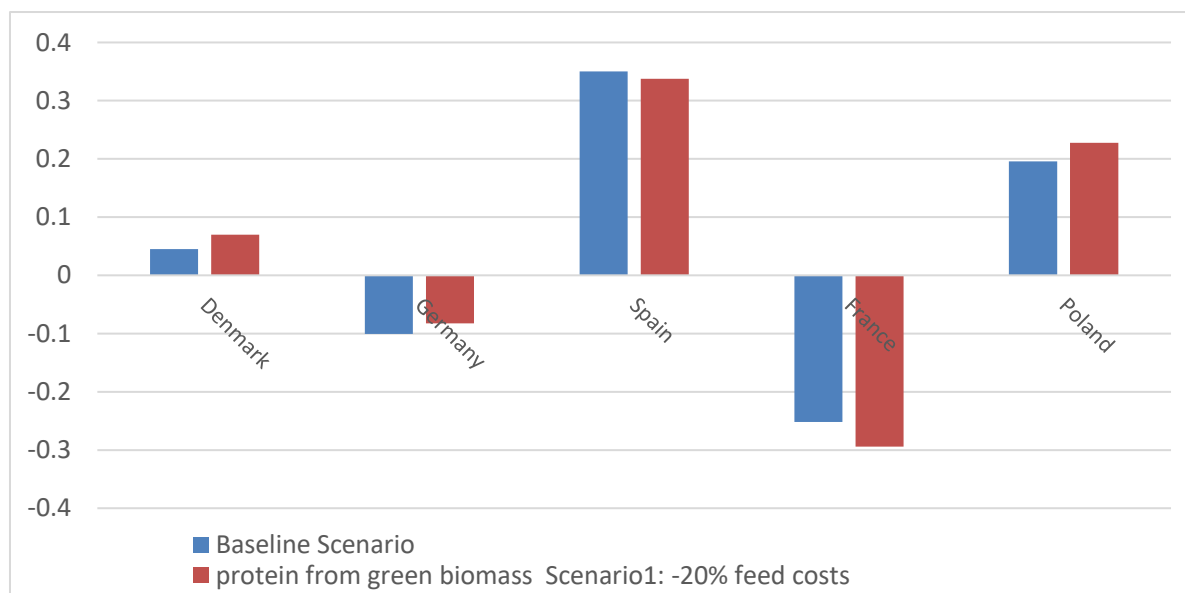


Figure 13: Impact of green protein from green biomass on farm net income (€/chicken)

*Innovative feedstuffs: Local soybean meals with innovative trituration process (without enzyme): feeding intake (+1.48%) and body weight gain (+1.62%)*

The second alternative protein source from WP1 that was evaluated in this analysis is local soybean meal prepared using an innovative trituration process. Findings suggest that the impact of this innovation would improve farm economic performance as long as new feed costs do not increase by more than 2%.

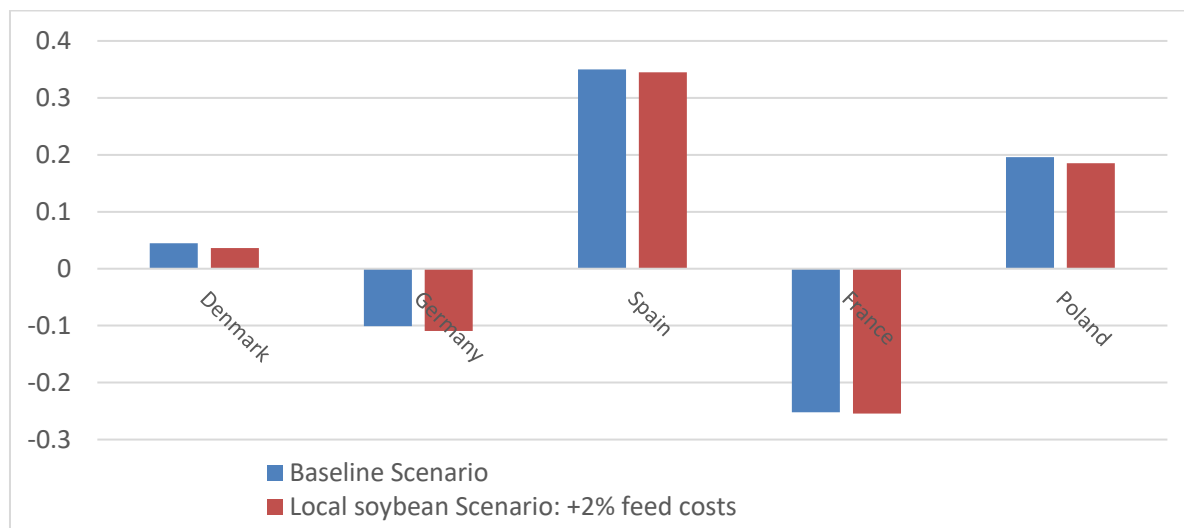


Figure 14: Impact of local soybean meals on farm net income (€/chicken).

*Innovative feedstuffs: Local soybean meals with innovative trituration process with seed dehulling (without enzyme): feed intake (+1.34%) and body weight gain (+0.35%)*

The third alternative protein source that was studied in this analysis is local soybean meals prepared using innovative trituration process with seed dehulling. Results show almost no difference between the farm net income of the baseline scenario and the new feeding alternative indicating that the latter could be promoted only if the total feed costs can be reduced.

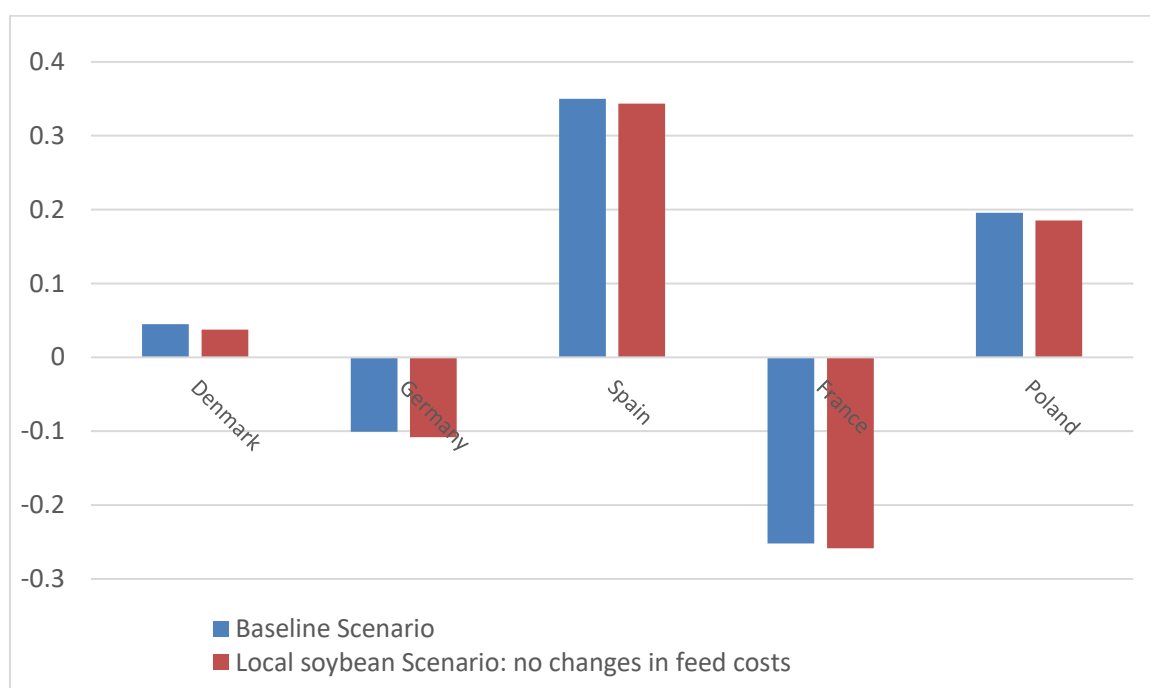


Figure 15: Impact of Local soybean with seed dehulling on farm net income (€/chicken).

### Genotype by feed interactions (WP5)

A comparison of two commercial types of chicken corresponding to very different breeding and market options (slow growing label rouge chicken reaching market weight at 12 weeks versus rapid growing standard chicken reaching market weight at 5 weeks) was run to evaluate if genotype by feed interactions would give an advantage to the alternative genetic line (slow growing) when fed diets with alternative feedstuffs instead of the traditional soybean and corn diet. The alternative diet included more local feedstuffs, and a higher proportion of by-products of agriculture that cannot be used for human food. They are not designed to be deficient in energy or nutrients. This new diet would reduce feed costs by 14.5% compared to the classical diet.

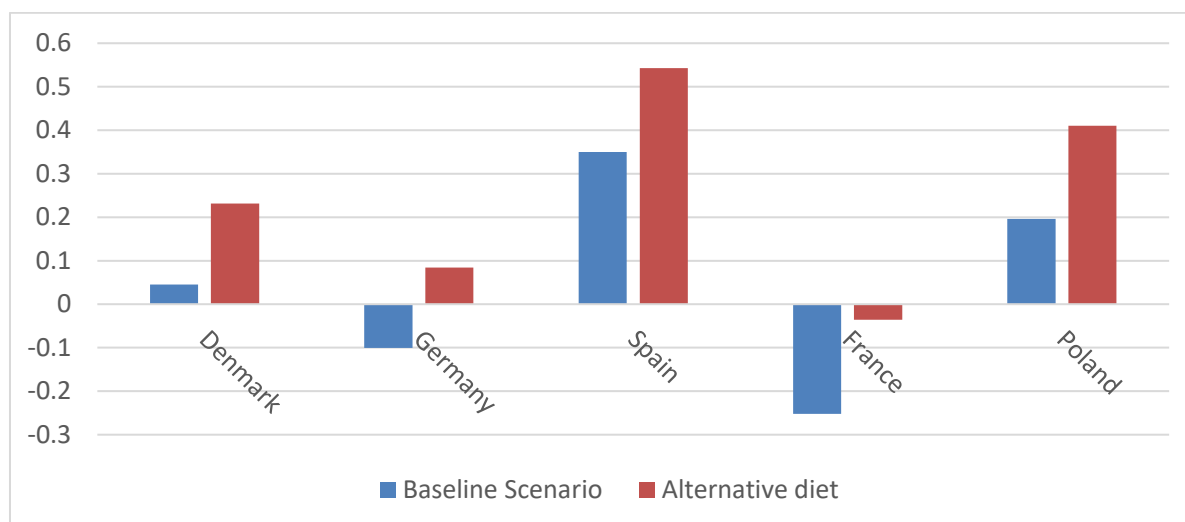


Figure 16: Impact of using traits in animal selection on farm net income (€/chicken); Alternative diet (2013).

Based on the technical information on daily feed intake, body weight gain and implementation costs provided by WP5, Spain is the country with the highest effect. The farm net income improved from €0.35 to €0.54 per standard chicken. On the other hand, the positive effect of this new diet could help other countries such as France to improve their financial results from €-0.25 to €-0.03 per chicken.

## 4. Conclusions

The aim of this study is to provide an estimate of production costs and margins of farms specialising in pig fattening and broiler production for different production strategies. A cost allocation model for both pig fattening and broiler production has been used for this purpose. The analysis is based on the most recent Farm Accountancy Data Network database (2013-2015). The study attempts to provide insights into the economic impact of adopting new feeding strategies developed in the Feed-a-Gene project. We present the main results of the analysis and its implications for pig and broiler production at the EU. Based on empirical findings, the new alternatives developed by the WP1 have a positive impact on farm net income, particularly for the local rapeseed with physical fractionation of meal whereas the results obtained with green protein show positive results only after implementing the improved method for protein precipitation. For the implementation of precision feeding, results also prove that the use of an ad libitum feeding strategy will lead to a slight improvement in farm economic performance, while the use of a restricted strategy is less effective and leads to an increase in feed intake and a decrease in body weight gain. The selection innovation implemented by WP5 on conventional and alternative diets showed a positive margin to improve the technical performance of pig production, and thus FNI. Regarding broiler production, a slight improvement in farm financial results are obtained compared to the baseline model with

respect to local soybean meals prepared using an innovative trituration process with and without seed dehulling, while the green protein from the green biomass-based feed yields a negative impact on FNI.

To assist pig and broiler farmers in adopting the most efficient feeding technology, policy makers should implement policies through promoting the adoption of innovative environmental-friendly technologies, such as the use of new feedstuffs/sources, use of precision feeding tools, and adoption of an alternative diet rich in fibre. Furthermore, it would be possible to provide technical and financial support to encourage farmers who are using less efficient production techniques to switch to more sustainable production methods. On the other hand, more complementary studies based on ex-post cost benefit evaluation are needed to ensure that the most efficient feeding solutions are identified. Furthermore, real-world data are still required to complete this analysis, since physical and financial performance levels (e.g., slaughter weights, length of time) attributed to new feeding technologies can vary greatly between farmers. Finally, other factors should be considered such as farmers' preferences and drivers towards adopting and using new technologies. Such analyses would provide more reliable results and derive consistent policy implications.

## 5. Annexes

### *Cost-benefit analysis for pig production: Baseline model*

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	117.57	101.82	95.97	144.94	120.40	122.19	116.13	115.61	100.82	140.31	133.19	131.06	126.43	116.67	108.48
Specific cost	104.99	91.05	85.46	125.18	103.57	105.67	104.83	104.56	89.81	117.10	111.38	109.30	115.12	105.77	98.65
Feed cost	65.51	53.59	51.98	66.17	58.82	59.50	68.35	64.69	61.49	75.14	65.67	64.62	68.77	62.31	56.54
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	44.74	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	17.93	16.67	15.87	14.94	14.00	14.52	7.86	9.95	9.41	19.47	17.82	17.66	10.97	11.14	11.27
Total inputs	135.50	118.49	111.83	160.37	134.99	137.62	123.99	125.56	110.23	159.78	151.00	148.71	137.40	127.80	119.75
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	135.26	121.29	111.25	153.49	133.89	126.14	136.54	133.62	124.22	146.35	135.61	130.14	147.18	132.26	117.67
<b>Pig fattening margins (€/pig)</b>															
Gross margin	30.27	30.24	25.78	28.30	30.32	20.46	31.71	29.06	34.41	29.29	24.23	20.84	32.05	26.49	19.02
Margin over operating costs	17.69	19.47	15.28	8.55	13.48	3.95	20.41	18.01	23.40	6.05	2.43	-0.91	20.74	15.59	9.19
Margin over total inputs	-0.24	2.80	-0.58	-6.69	-0.52	-10.79	12.55	8.06	13.99	-13.43	-15.39	-18.57	9.78	4.46	-2.08



**Alternative feed ingredients and real-time characterisation (WP1)*****Innovative feedstuffs: Green protein from green biomass: feed intake (+2.94%) and body weight gain (+3.36%)***

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	119.50	103.40	97.50	146.88	122.13	123.94	118.14	117.51	102.63	142.52	135.12	132.96	128.46	118.50	110.15
Specific cost	106.92	92.63	86.99	127.13	105.30	107.42	106.84	106.47	91.62	119.30	113.31	111.20	117.14	107.60	100.31
Feed cost	67.43	55.16	53.51	68.11	60.55	61.25	70.36	66.59	63.30	77.35	67.60	66.52	70.79	64.14	58.20
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	16.83	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	17.93	16.67	15.87	14.94	14.00	14.52	7.86	9.95	9.41	19.47	17.82	17.66	10.97	11.14	11.27
Total inputs	137.43	120.07	113.36	161.83	136.13	138.46	126.00	127.46	112.04	161.99	152.94	150.61	139.42	129.63	121.42
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	139.81	125.37	114.99	158.65	138.38	130.38	141.13	138.11	128.40	151.27	140.17	134.52	152.12	136.70	121.63
<b>Pig fattening margins (€/pig): Scenario1: no changes in prices</b>															
Gross margin	32.89	32.74	27.99	31.51	33.09	22.95	34.29	31.64	36.78	32	26.86	23.32	34.98	29.10	21.32
Margin over operating costs	20.31	21.97	17.49	11.76	16.25	6.44	22.99	20.60	25.77	8.76	5.05	1.56	23.67	18.21	11.48
Margin over total inputs	2.38	5.30	1.63	-3.18	2.26	-8.08	15.13	10.65	16.36	-10.72	-12.77	-16.09	12.70	7.07	0.21
<b>Pig fattening margins (€/pig) Scenario1: +1% feed costs</b>															
Gross margin	32.23	32.21	27.47	30.85	32.50	22.36	33.61	31.00	36.16	31.24	26.20	22.67	34.29	28.48	20.75
Margin over operating costs	19.65	21.43	16.97	11.10	15.66	5.84	22.30	19.95	25.15	8.00	4.40	0.91	22.98	17.58	10.92
Margin over total inputs	1.72	4.77	1.11	-3.84	1.67	-8.68	14.45	10.00	15.74	-11.47	-13.42	-16.74	12.01	6.45	-0.35
<b>Pig fattening margins (€/pig) Scenario1: +5% feed costs</b>															
Gross margin	29.61	30.06	25.40	28.21	30.15	19.98	30.87	28.41	33.70	28.24	23.58	20.09	31.54	25.99	18.49
Margin over operating costs	17.03	19.29	14.89	8.46	13.31	3.46	19.57	17.36	22.69	5.00	1.77	-1.67	20.23	15.09	8.65
Margin over total inputs	-0.90	2.62	-0.97	-6.49	-0.68	-11.06	11.71	7.41	13.28	-14.48	-16.05	-19.33	9.26	3.95	-2.62

**Innovative feedstuffs: Local rapeseed with physical fractionation of meal (without enzyme): feed intake (-0.65%) and body weight gain (+4.84%)**

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	117.15	101.48	95.63	144.51	120.02	121.81	115.68	115.19	100.42	139.82	132.76	130.64	125.99	116.26	108.12
Specific cost	104.57	90.70	85.13	124.76	103.19	105.29	104.38	104.14	89.41	116.58	110.95	108.88	114.68	105.36	98.28
Feed cost	65.08	53.24	51.65	65.74	58.44	59.11	67.91	64.27	61.09	74.65	65.24	64.20	68.32	61.90	56.17
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	16.83	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	17.93	16.67	15.87	14.94	14.00	14.52	7.86	9.95	9.41	19.47	17.82	17.66	10.97	11.14	11.27
Total inputs	135.08	118.14	111.50	159.45	134.02	136.33	123.54	125.14	109.83	159.29	150.58	148.29	136.95	127.40	119.39
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	141.81	127.16	116.63	160.92	140.37	132.25	143.15	140.09	130.24	153.44	142.18	136.44	154.30	138.66	123.37
<b>Pig fattening margins (€/pig)</b>															
Gross margin	37.24	36.46	31.51	36.16	37.18	26.96	38.76	35.94	40.82	36.86	31.23	27.56	39.62	33.30	25.09
Margin over operating costs	24.66	25.69	21.00	16.41	20.35	10.44	27.46	24.90	29.81	13.62	9.42	5.81	28.31	22.40	15.25
Margin over total inputs	6.73	9.02	5.14	1.47	6.35	-4.08	19.60	14.95	20.40	-5.85	-8.40	-11.85	17.35	11.26	3.98
<b>Pig fattening margins (€/pig): 1%</b>															
Gross margin	36.59	35.93	30.99	35.50	36.59	26.36	38.08	35.30	40.21	36.11	30.57	26.92	38.94	32.68	24.52
Margin over operating costs	24.01	25.16	20.49	15.75	19.76	9.85	26.78	24.25	29.20	12.87	8.76	5.16	27.62	21.78	14.69
Margin over total inputs	6.08	8.49	4.62	0.81	5.76	-4.67	18.92	14.30	19.79	-6.61	-9.06	-12.49	16.66	10.64	3.42
<b>Pig fattening margins (€/pig): 5%</b>															
Gross margin	33.97	33.78	28.91	32.85	34.24	23.98	35.35	32.71	37.75	33.10	27.94	24.33	36.19	30.18	22.26
Margin over operating costs	21.39	23.01	18.41	13.10	17.41	7.47	24.04	21.66	26.74	9.86	6.13	2.58	24.87	19.28	12.43
Margin over total inputs	3.46	6.34	2.54	-1.84	3.41	-7.05	16.19	11.71	17.33	-9.61	-11.68	-15.08	13.91	8.15	1.16
<b>Pig fattening margins (€/pig): 11%</b>															
Gross margin	30.04	30.57	25.79	28.88	30.71	20.41	31.25	28.83	34.06	28.59	24.00	20.45	32.06	26.44	18.87
Margin over operating costs	17.46	19.79	15.29	9.13	13.88	3.90	19.94	17.78	23.05	5.35	2.19	-1.30	20.75	15.55	9.03
Margin over total inputs	-0.47	3.13	-0.58	-5.81	-0.12	-10.62	12.08	7.83	13.64	-14.12	-15.62	-18.96	9.78	4.41	-2.24

**Management systems for precision feeding to increase resilience to fluctuating environments and improve feed efficiency (WP4)*****Ad libitum feeding strategy S5a: feed intake (-5.06%) and body weight gain (+1.15%)***

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	114.26	99.11	93.34	141.59	117.43	119.18	112.67	112.34	97.71	136.51	129.86	127.79	122.96	113.51	105.62
Specific cost	101.68	88.34	82.83	121.84	100.59	102.66	101.37	101.29	86.70	113.27	108.06	106.03	111.64	102.62	95.79
Feed cost	62.19	50.88	49.36	62.82	55.85	56.49	64.89	61.42	58.38	71.34	62.34	61.35	65.29	59.16	53.67
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	44.74	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	20.89	19.63	18.77	17.79	16.82	17.31	11.32	13.40	12.84	22.64	20.97	20.78	13.95	14.07	14.24
Total inputs	135.15	118.74	112.10	159.38	134.25	136.49	123.99	125.74	110.55	159.14	150.83	148.57	136.95	127.58	119.86
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	136.82	122.69	112.53	155.26	135.43	127.59	138.11	135.16	125.65	148.04	137.17	131.64	148.87	133.78	119.03
<b>Pig fattening margins (€/pig)</b>															
Gross margin	35.14	34.35	29.70	33.42	34.83	24.93	36.74	33.87	38.95	34.77	29.12	25.61	37.23	31.17	23.24
Margin over operating costs	22.56	23.58	19.19	13.67	18.00	8.41	25.44	22.82	27.94	11.53	7.31	3.85	25.91	20.27	13.40
Margin over total inputs	1.67	3.95	0.43	-4.12	1.18	-8.90	14.12	9.41	15.10	-11.10	-13.66	-16.93	11.96	6.20	-0.84

**Restricted strategy S5b: feed intake (+2.17%) and body weight gain (-1.24%)**

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	118.99	102.99	97.10	146.37	121.68	123.48	117.61	117.02	102.16	141.94	134.61	132.46	127.93	118.02	109.71
Specific cost	106.42	92.21	86.59	126.63	104.85	106.97	106.31	105.97	91.15	118.70	112.80	110.70	116.62	107.12	99.88
Feed cost	66.93	54.75	53.11	67.60	60.10	60.79	69.83	66.09	62.83	76.77	67.09	66.02	70.26	63.66	57.76
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	44.74	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	20.89	19.63	18.77	17.79	16.82	17.31	11.32	13.40	12.84	22.64	20.97	20.78	13.95	14.07	14.24
Total inputs	139.88	122.61	115.86	164.16	138.50	140.79	128.93	130.42	114.99	164.57	155.58	153.24	141.88	132.09	123.95
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	133.59	119.79	109.87	151.59	132.23	124.58	134.85	131.96	122.68	144.54	133.93	128.53	145.35	130.62	116.21
<b>Pig fattening margins (€/pig)</b>															
Gross margin	27.17	27.58	23.28	24.96	27.38	17.61	28.55	25.99	31.54	25.84	21.13	17.83	28.77	23.50	16.34
Margin over operating costs	14.59	16.80	12.78	5.21	10.55	1.09	17.23	14.95	20.53	2.60	-0.68	-3.93	17.43	12.60	6.50
Margin over total inputs	-6.30	-2.83	-5.99	-12.57	-6.27	-16.21	5.91	1.54	7.69	-20.03	-21.65	-24.71	3.47	-1.47	-7.74

**Use of traits in animal selection: Genetic parameter estimations, genetic model developments and evaluation of breeding schemes (WP5)****Conventional diet: feed intake (-14.01%) and body weight gain (-0.99%)**

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	108.40	94.32	88.68	135.67	112.16	113.86	106.55	106.55	92.21	129.78	123.99	122.00	116.80	107.94	100.56
Specific cost	95.82	83.54	78.18	115.92	95.33	97.34	95.25	95.50	81.20	106.54	102.18	100.25	105.49	97.04	90.73
Feed cost	56.33	46.08	44.70	56.90	50.58	51.16	58.77	55.63	52.88	64.61	56.47	55.56	59.14	53.58	48.61
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
Non-specific cost	12.58	10.77	10.50	19.75	44.74	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	17.93	16.67	15.87	14.94	14.00	14.52	7.86	9.95	9.41	19.47	17.82	17.66	10.97	11.14	11.27
Total inputs	126.32	110.98	104.55	150.61	126.16	128.38	114.41	116.50	101.62	149.25	141.80	139.66	127.76	119.07	111.83
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	133.92	120.09	110.15	151.97	132.56	124.89	135.19	132.30	122.99	144.91	134.27	128.86	145.72	130.95	116.51
<b>Pig fattening margins (€/pig)</b>															
Gross margin	38.11	36.55	31.97	36.05	37.23	27.55	39.94	36.80	41.80	38.365	32.09	28.61	40.23	33.91	25.78
Margin over operating costs	25.53	25.78	21.46	16.30	20.40	11.03	28.63	25.75	30.79	15.13	10.28	6.85	28.92	23.01	15.95
Margin over total inputs	7.60	9.11	5.60	1.36	6.40	-3.48	20.77	15.80	21.38	-4.35	-7.53	-10.80	17.95	11.88	4.67

**Alternative diet: feed intake (-20.75%) and body weight gain (-5.63%)**

Country	Denmark			Germany			Spain			France			Poland		
Sample farms	74			108			63			79			187		
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
<b>Pig fattening: production costs (€/pig)</b>															
Operating costs	103.98	90.70	85.18	131.21	108.20	109.85	101.95	102.19	88.06	124.72	119.56	117.65	112.16	103.74	96.75
<i>Specific cost</i>	91.40	79.93	74.68	111.46	91.36	93.33	90.64	91.14	77.05	101.48	97.75	95.89	100.85	92.84	86.92
Feed cost	51.91	42.47	41.20	52.44	46.62	47.15	54.17	51.27	48.73	59.55	52.04	51.21	54.50	49.38	44.81
Other specific cost	39.49	37.46	33.48	59.02	44.74	46.18	36.48	39.87	28.32	41.93	45.71	44.69	46.35	43.46	42.11
<i>Non-specific cost</i>	12.58	10.77	10.50	19.75	44.74	16.52	11.30	11.05	11.01	23.24	21.81	21.76	11.31	10.90	9.83
Non-operating costs	25.87	23.81	21.61	31.76	38.90	34.19	17.13	19.34	18.85	32.10	29.45	29.20	29.14	29.81	30.05
Total inputs	121.91	107.37	101.05	146.15	122.19	124.37	109.80	112.14	97.47	144.19	137.38	135.30	123.13	114.87	108.02
<b>Total Revenue: pig fattening (€/pig)</b>															
Pigs sold	127.65	114.46	104.99	144.85	126.35	119.04	128.85	126.10	117.23	138.11	127.98	122.82	138.89	124.81	111.05
<b>Pig fattening margins (€/pig)</b>															
Gross margin	36.25	34.53	30.31	33.39	34.99	25.71	38.21	34.96	40.18	36.64	30.22	26.92	38.04	31.97	24.13
Margin over operating costs	23.67	23.76	19.81	13.64	18.15	9.19	26.91	23.91	29.17	13.40	8.42	5.17	26.73	21.08	14.30
Margin over total inputs	5.74	7.09	3.94	-1.30	4.16	-5.33	19.05	13.96	19.76	-6.08	-9.40	-12.49	15.76	9.94	3.03

**Cost-benefit Analysis for poultry production: Baseline model**

Country	Denmark	Germany	Spain	France	Poland*
Sample farms	25	19	41	73	46
<b>Parameter</b>					
<b>Production costs (€/broiler)</b>					
Operating costs	1.75	1.84	1.83	2.57	1.93
<i>Specific cost</i>	1.58	1.58	1.62	1.94	1.73
Feed cost	1.18	1.16	1.20	1.34	1.36
Other specific cost	0.41	0.42	0.41	0.60	0.38
<i>Non-specific cost</i>	0.17	0.26	0.22	0.63	0.20
Non-operating costs	0.18	0.26	0.10	0.41	0.13
Total inputs	1.93	2.10	1.93	2.98	2.06
<b>Total Revenue (€/broiler)</b>					
Broiler Sold	1.98	2.00	2.28	2.73	2.26
<b>Margins (€/broiler)</b>					
Gross margin	0.40	0.42	0.66	0.79	0.53
Margin over operating costs	0.23	0.16	0.45	0.16	0.33
Margin over total inputs	0.04	- 0.10	0.35	- 0.25	0.20

**Alternative feed ingredients and real-time characterisation (WP1)**

***Innovative feedstuffs: Green protein from green biomass: feed intake (-7.02%) and body weight gain (-14.79%). No changes in feed prices.***

Country	Denmark	Germany	Spain	France	Poland*
Sample farms	25	19	41	73	46
<b>Parameter</b>					
<b>Production costs (€/broiler)</b>					
Operating costs	1.67	1.76	1.75	2.48	1.84
<i>Specific cost</i>	1.50	1.50	1.53	1.85	1.64
Feed cost	1.09	1.08	1.12	1.25	1.26
Other specific cost	0.41	0.42	0.41	0.60	0.38
<i>Non-specific cost</i>	0.17	0.26	0.22	0.63	0.20
Non-operating costs	0.18	0.26	0.10	0.41	0.13
Total inputs	1.85	2.02	1.85	2.89	1.97
<b>Total Revenue (€/broiler)</b>					
Broiler Sold	1.68	1.70	1.94	2.33	1.92
<b>Margins (€/broiler): Scenario1: no changes in prices</b>					
Gross margin	0.18	0.20	0.41	0.48	0.29
Margin over operating costs	0.02	- 0.06	0.19	- 0.15	0.09
Margin over total inputs	- 0.17	- 0.32	0.10	- 0.56	- 0.04
<b>Margins (€/broiler): Scenario2: Feed cost decreases by 20%</b>					
Gross margin	0.42	0.44	0.65	0.75	0.56
Margin over operating costs	0.25	0.17	0.43	0.12	0.36
Margin over total inputs	0.07	- 0.08	0.34	- 0.29	0.23

***Innovative feedstuffs: Local soybean meals prepared using an innovative trituration process (without enzyme): feed intake (+1.48%) and body weight gain (+1.62%)***

Country	Denmark	Germany	Spain	France	Poland*
Sample farms	25	19	41	73	46
<b>Parameter</b>					
<b>Production costs (€/broiler)</b>					
Operating costs	1.77	1.86	1.85	2.59	1.95
<i>Specific cost</i>	1.60	1.60	1.63	1.96	1.75
Feed cost	1.19	1.18	1.22	1.36	1.38
Other specific cost	0.41	0.42	0.41	0.60	0.38
<i>Non-specific cost</i>	0.17	0.26	0.22	0.63	0.20
Non-operating costs	0.18	0.26	0.10	0.41	0.13
Total inputs	1.95	2.12	1.95	3.00	2.08
<b>Total Revenue (€/broiler)</b>					
Broiler Sold	2.01	2.03	2.32	2.77	2.29
<b>Margins (€/broiler): Scenario1: no changes in prices</b>					
Gross margin	0.41	0.43	0.68	0.81	0.54
Margin over operating costs	0.24	0.17	0.47	0.18	0.34
Margin over total inputs	0.06	- 0.09	0.37	- 0.23	0.21
<b>Margins (€/broiler): Scenario2: Feed costs increase by 2%</b>					
Gross margin	0.39	0.41	0.66	0.79	0.51
Margin over operating costs	0.22	0.15	0.44	0.16	0.32
Margin over total inputs	0.04	- 0.11	0.35	- 0.25	0.19



***Innovative feedstuffs: Local soybean meals prepared using an innovative trituration process with seed dehulling (without enzyme): feed intake (+1.34%) and body weight gain (+0.35%)***

Country	Denmark	Germany	Spain	France	Poland*
Sample farms	25	19	41	73	46
<b>Parameter</b>					
<b>Production costs (€/broiler)</b>					
Operating costs	1.77	1.86	1.85	2.59	1.95
<i>Specific cost</i>	1.60	1.59	1.63	1.96	1.75
Feed cost	1.19	1.18	1.22	1.36	1.37
Other specific cost	0.41	0.42	0.41	0.60	0.38
<i>Non-specific cost</i>	0.17	0.26	0.22	0.63	0.20
Non-operating costs	0.18	0.26	0.10	0.41	0.13
Total inputs	1.95	2.11	1.95	3.00	2.08
<b>Total Revenue (€/broiler)</b>					
Broiler Sold	1.99	2.01	2.29	2.74	2.27
<b>Margins (€/broiler): Scenario1: no changes in prices</b>					
Gross margin	0.39	0.41	0.66	0.78	0.52
Margin over operating costs	0.22	0.15	0.44	0.15	0.32
Margin over total inputs	0.04	- 0.11	0.34	- 0.26	0.19

**Use of traits in animal selection: Genetic parameter estimations, genetic model developments and evaluation of breeding schemes (WP5). Standard chicken, alternative vs classical diet**

***Feed intake (-1.6%) and body weight gain (+0.8%)***

Country	Denmark	Germany	Spain	France	Poland*
Sample farms	25	19	41	73	46
<b>Parameter</b>					
<b>Production costs (€/broiler)</b>					
Operating costs	1.58	1.67	1.66	2.38	1.73
<i>Specific cost</i>	1.41	1.41	1.44	1.75	1.54
Feed cost	1.01	1.00	1.03	1.15	1.16
Other specific cost	0.41	0.42	0.41	0.60	0.38
<i>Non-specific cost</i>	0.17	0.26	0.22	0.63	0.20
Non-operating costs	0.18	0.26	0.10	0.41	0.13
Total inputs	1.76	1.93	1.76	2.79	1.87
<b>Total Revenue (€/broiler)</b>					
Broiler Sold	1.99	2.01	2.30	2.75	2.28
<b>Margins (€/broiler)</b>					
Gross margin	0.58	0.60	0.86	1.01	0.74
Margin over operating costs	0.41	0.34	0.64	0.37	0.54
Margin over total inputs	0.23	0.08	0.54	- 0.04	0.41