Horizon 2020 programme

Call: H2020-SFS-2018–2020 ● Sustainable Food Security

Topic: SFS-08-2018–2019 ● Improving animal welfare

Type of action: RIA

PPILOW

Poultry and PIg Low-input and Organic production systems' Welfare

Start date of the project: September 1st, 2019	**Duration:** 60 months
End date of the project: August 31st, 2024	**Project ID:** 816172

D7.3- List of economically viable measures/strategies to enhance poultry welfare and assessment of their benefits and costs

Deliverable number	D7.3
Deliverable title	List of economically viable measures/strategies to enhance poultry welfare and assessment of their benefits and costs.
Due date of deliverable	54
Actual submission date	25.07.2024
EC version	V1
Lead partner	TI-BW
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Dissemination level	PU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°816172.

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Summary

Objectives:

The aim of this deliverable 'List of economically viable measures/strategies to enhance poultry welfare and assessment of their benefits and costs' is to assess the economic viability for meat production of males and egg production of females, and concerns three different levers of welfare improvement in poultry. Besides that, the added economic value to the poultry production system was considered (e.g., for raising slow-growing broiler genotypes (e.g., dual-purpose offsprings) and for raising male chicks from the layer type) in order to identify the economic viability and feasibility of the proposed strategies and its influences to the whole production chain of each type of production (broilers, eggs). Notably, the Deliverable is presenting the synthesis of the trials in experimental and farm units completed in France, Germany and Denmark on the use of dual-purpose females for egg production and dual-purpose males for meat production.

Rationale:

The economic impact of the different strategies of improvement (e.g., Novel Dual-purpose genotypes, on-farm hatching, comparison of breeds and range use) were assessed by utilizing results from consumer surveys (task 1.2) and field evaluations on real and experimental farms (e.g. of dual offspring introduction in the system organization) obtained from WP1 (tasks 1.2 and 1.4), WP5 (tasks 5.1 and 5.2) and WP6 (tasks 6.1 and 6.2) as well as quantitative data applied to production costs calculations. Based on standardized tools (indicators) developed in WP3 (task 3.3) and the exchange with farmers and stakeholders (Poultry NPGs in WP2, task 2.2), the economic model has been developed following the "agri benchmark" methodology (http://www.agribenchmark.org/home.html) by TI-BW. For the model, the expected costs and benefits of the developed strategies of improvement for slow-growing broilers (e.g., dual-purpose offspring, male chicks of laying strains) was assessed and a price and profit margin was derived. A business model was developed to show the impact on the overall production chain. The outcomes included costs and benefits of studied strategies per kilogram of slaughter weight/live weight or per egg, biological performance indicators (feed conversion, mortality rate, final weight, etc.) and qualitative information on its influences on the whole production chain (breeding companies, transport, slaughterhouses, etc.).

Teams involved:

Thuenen Institute, LUKE, INRAE

1. Introduction

For decades, animal welfare issues have held significant importance within the EU. Compared to other regions, the EU has demonstrated a higher level of legislative commitment to animal welfare.

The work package 7 of the PPILOW project aims at building multicriteria analyses and proposing business models for the use of the levers of welfare improvements proposed and tested within the project in low-input outdoor and organic farming systems. In particular, practices related to poultry species were economically evaluated in the Task 7.2.2 "Poultry assessment tool" by Thuenen Institute, with the support of LUKE and INRAE.

The Deliverable 'List of economically viable measures/strategies to enhance poultry welfare and assessment of their benefits and costs' is aimed at presenting the economic viability for meat production of males and egg production of females, and concerns 3 different levers of welfare improvement in poultry.

First, on-farm hatching for small batches of chicks of specific slow-growing genotypes is one of the welfares measures tested in one on-field study with the French National Practitioner Group (NPG) of Work package 2 and economically evaluated in this WP7. This practice was investigated in Work package 6 task 2 as an early management lever to limit chick perturbation due to long transport with feed and water deprivation and stimulating adaptive capacities in slow-growing chicken. Moreover, on-farm hatching limits the risk of dehydration due to different hatching times and delay before delivery on-farm.

Second, one aim of the Work package 6 task one was to study (cross)breeds well adapted to the low-input outdoor and organic farming systems, especially focusing on the individual variability in four strains of slow- to medium-growing broiler chickens. The findings of Task 6.1 show a high variability of range use between individuals in different genetic lines and trade-offs with performance, health and welfare related traits in organic broilers. Key findings on the economic performance will be illustrated in chapter 4.1. First, a slow-growing genotype S757N and an intermediate-growing genotype JA 757 were compared, also including data concerning one genotype of dual-purpose breed (males) reared in French organic experimental facilities. Dual-purpose breeds were studied as a means to avoid the culling of layer male chicks by rearing both females for egg laying and males for meat production (Reithmayer et al., 2020). Some of these genotypes were evaluated in WP5 task 1 and 2, but also for adaptation to the outdoor run in WP6 task1.

Finally, as part of the H2020 project PPILOW, a trial of novel dual-purpose genotypes was conducted. A brother-sister joint analysis was performed as both female and male chicks of one genotype are reared. Males and females of three dual-purpose genotypes were evaluated on-station in Work package 5 task1, and from this one dual-purpose genotype also at the farm under organic rearing conditions and compared with a representative high-performing genotype in Work package 5 Task 2. The economic viability for meat production of males and egg production of females of four genotypes chosen to experiment in Work package 5 Task 1 in three different countries (Germany, Denmark, France) and of one genotype (C) chosen for on-farm trial (Germany). The three dual-purpose genotypes had different performance profiles: a meat-type (A) and an egg-type (C) dual-purpose genotype and a rustic breed (B) with a balanced performance profile. The economic analysis focused on how the performance and product characteristic of these genotypes regarding the males and females differed and how this was reflected in the economic efficiency. Specifically, we showed which dual-purpose genotypes used the least resources while producing the highest yield to be economically viable depending on the country.

2. Data and Methods

2.1 Economic evaluation of male/broiler trials

The Technology Impact Policy Impact Calculations (TIPI-CAL) model was used to analyse the data collected from the trials. The TIPICAL model was used because it allows a detailed analysis of economic and physical parameters at farm level (Kress and Verhaagh, 2019). There were three main areas of data collection: i) whole farm and land use data, ii) feed data and iii) technical and economic data of meat.

The TIPICAL model organizes costs into two categories: i) cash and non-cash costs, and ii) factor and non-factor costs. Cash costs involve monetary payments for production inputs, such as payments for chicks, feed, medicine, and veterinary services. Non-cash costs encompass depreciation and opportunity costs. Here it is important to note that feed costs were calculated using valuation prices at the points of purchase for the respective times plus processing cost. Furthermore, no premium prices for products of dual-purpose genotypes were considered. Depreciation costs account for the reduction in value of farm assets like buildings and machinery, while opportunity costs refer to the cost of a forgone alternative, such as the opportunity cost of family labour on a broiler farm, which could be paid off-farm. Factor costs include expenses related to land, labour, and capital. Non-factor costs encompass all other costs (including depreciation), such as purchased feed and day-old chicks, machinery maintenance and contractor fees, fuel, energy, lubricants, water, building maintenance, veterinary services and medicines, insurance, and taxes (Chibanda et al., 2022).

The model calculates profitability on a per-production-unit basis across three timeframes: short-term, mid-term, and long-term profitability. Short-term profitability is determined by subtracting cash costs from total returns, which include income from meat sells, manure sells, and subsidies (when relevant). However, short-term profitability does not account for depreciation and opportunity costs. In contrast, mid-term profitability considers both cash and depreciation costs. For a farm to be considered long-term profitable, its returns must cover all costs: cash, depreciation, and opportunity costs.

2.2 Economic evaluation of female trials

A simplified Excel-based model focusing on the poultry enterprise (Isermeyer, Thobe, 2018) was used to analyse the female data collected from the trials. This model was used because a detailed dataset at farm level, including non-cash costs such as depreciation and opportunity costs, was hardly available. Fixed costs for buildings and machinery and labour input were estimated based standard values (Geflügeljahrbuch 2022 according to Isermeyer and Thobe, 2019).

There were two main areas of data collection: i) Technical data (biological performance parameters) and ii) Economic data (encompass input and output prices). The egg prices were differentiated between eggs produced in fixed or mobile barns and between grade A (=marketable) and B (=non-marketable) eggs. The same output prices were assumed for all genotypes. No premium prices for products of dual-purpose GT were considered. The total revenue per egg was calculated as a function of the total revenue (Grade A and B eggs, slaughter hens) divided by the total number of eggs produced per production cycle, encompassing production phases in fixed and mobile barn within one cycle. No premium prices for products of dual-purpose genotypes were considered. Manure returns were assumed to be cost neutral as the costs and revenues offset each other under the specific experimental conditions.

Costs are differentiated into variable and fixed costs. Variable costs vary with the level of production and include expenses for production inputs such as payments for pullets, feed, fuel, energy, lubricants, water, medicines and veterinary services. Fixed costs encompass costs for buildings and machinery and the outside area.

The profitability was taken into account on a production unit basis within three breakdowns: short-term, mid-term, and long-term profitability. The short-term profitability of egg production was calculated by deducting cash (variable) costs from total returns (egg, slaughter hen and manure prices, potential subsidies). Medium-term profitability reflects both cash and depreciation costs. Long-term profitability reflects also the opportunity costs of labour, land and capital (Chibanda et al, 2020; Chibanda et al, 2022; Kress and Verhaagh, 2019).

3. Economic evaluation of on-farm hatching

The on-farm hatching trials from Work package 6 task 2 concerned the comparison of rearing slow-growing G657N chickens issued from the same batch of eggs, either completely incubated and hatched at the INRAE experimental facilities, or incubated at the same place, but transported after 18 days of incubation, and hatched on-farm by using the One2Born trays system in an organic French farm about 300 km away from the hatchery. From 683 eggs incubated at INRAE experimental facilities, the economic comparison dealt with data issued from 274 hatchery-hatched (HH) and 238 on-farm hatched (OFH) chicks raised on the organic farm.

3.1 Economic results

Comparison of farm performances

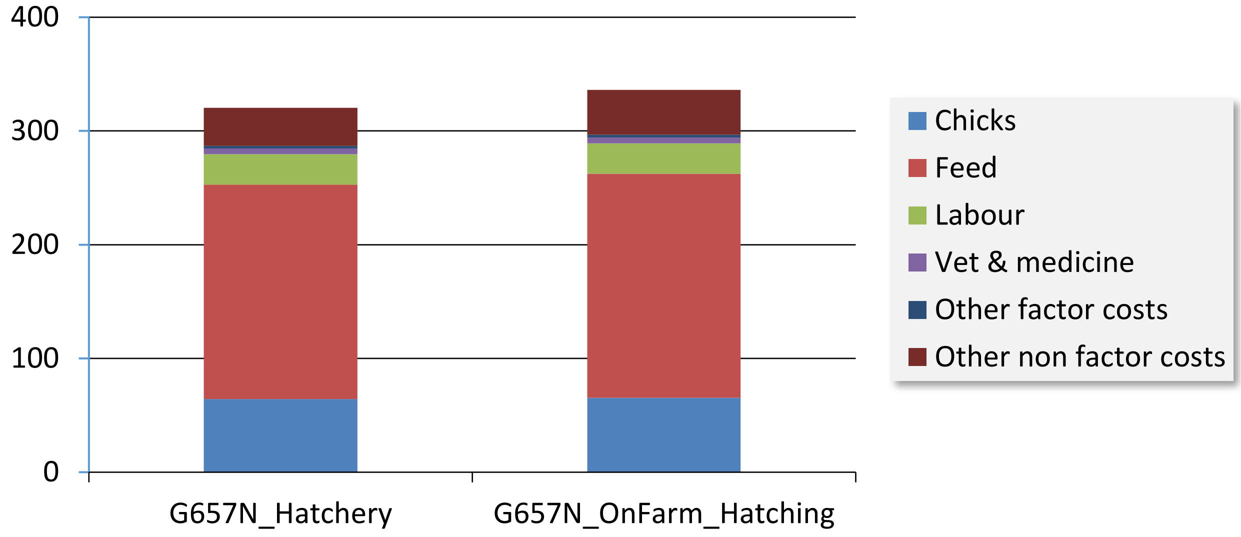
Hatchability and chick quality showed relatively good results on-farm (Hatchability 90.4% on-farm versus 94.0% in the hatchery). Hatchery-issued chicks were 36.6 ± 0.4 g, whereas on-farm hatched (OFH) chicks were 40.6 ± 0.5 g at day1 ($P < 0.001$), showing a great impact of delay before feeding and drinking and transport on the control chick's weight. Both batches of chicks were evaluated for chick quality by using the Tona score grid with additional scoring of dehydration state as evaluated from the saphene vein volume. Scoring of hatchery-hatched (HH) chicks was of 99/110 whereas that of OHF chicks was of 102/110, with much less dehydration for the on-farm hatched chicks (4.6/5) than for control chicks (1.8/5). However, in terms of body weight and carcass weight % at slaughter age (91 d), the average body weight for HH chickens was of 2106g whereas that of OFH chicks was of 2079g. The total carcass yields measured on the females sampled after slaughter were of 66.93 and 66.13% ($P<0.05$), respectively. The feed conversion ratios were of 3.028 and of 3.219 for control HH and OFH chickens, respectively, between d1 and d91 of age, with slightly less efficient birds with on-farm hatching. Mortalities occurred during the first week were of 0% in HH chicks and 0.84% in OFH chicks, respectively, while the overall mortality rates were of 1.46 and 4.20%, respectively on the whole rearing period.

Comparison of production costs

Figure 1 shows that the organic farm that applied on-farm hatching had slightly higher production costs (+4,9 %) compared to the organic farm using chicks originated from the hatchery.

The higher production costs required for on-farm hatched chick could be attributed to the higher feed costs because rearing chicks from the hatchery in the organic farm was slightly more efficient in terms of feed use as it had lower FCR and higher daily weight gain than with on-farm hatched chicks. On farm hatching also required more energy at start which impacted variable costs.

Figure 1: Comparison of production costs (EUR per 100 kg Live weight)



Source: Own servey and calculations

The two conditions were however profitable since in direct sale as 9.20 EUR per kg carcass, the returns were significantly higher compared to the total costs of production.

3.2 Discussion/ Conclusion

The applicability of on-farm hatching is mainly dependent on the farm structure, density and the number of cycles per year (Thobe et al., 2021, Deliverable 1.4). Production performance per square meter was impaired when hatching rate was reduced.

Additional information is needed on the price differential between eggs hatched on-farm and day-old chicks delivered by hatchery. Price assumptions for hatched chicks at the hatchery were higher (+0,02 Eurocents/chick) compared to the price of on-farm hatched chicks. The chick price assumptions did not take into account that the hatchery does not use the hatching part and the people who are working there. Therefore, costs may be overestimated and additional cost information is needed on the pre-hatching phase at the hatchery.

Performance gains that may not always compensate for egg costs, time and energy spent and need to be valorized commercially, especially by the organic farmer ensuring here direct sales. The use of more efficient radiants (e.g., gas radiants, Guyot Y et al., 2022) for ensuring a better hatchability on-farm and choosing this practice only when energy needs for heating are lower (e.g., at the warm season) could allow to reduce the costs and hence improve the profitability of this new practice in low-input and organic farms.

4. Ranger comparison

Trials from Work package 6 task 1 allowed to compare the performance, health and welfare indicators of extreme animals in term of range use, so-called High and Low rangers, in three different genetic breeds (Bonnefous C et al., 2023). These breeds were the slow-growing S757N strain commonly reared in French label- or organic-type farms, the medium-growing JA757 strain which is commonly used in organic farms in Northern Europe, and a new dual-purpose genetic cross-breed rather egg-type oriented and also studied in Work package 5, the C strain, with a much lower growth rate.

4.1 Economic results (breeds and High/Low ranger)

Comparison of farm performances

Table 1 shows a comparison of farm performance indicators and production costs of low and high rangers for slow growing genotype S757N, intermediate growing genotype JA757 and dual-purpose C genotype.

The findings show that higher range use impaired final body weight for both S757N and JA757 genotypes. S757N chickens were less efficient in terms of feed use compared to JA757 chickens due to the higher feeding period and the lower final live weight associated with a higher amount of feed consumed per bird.

Table 1: Comparison of farm performance and cost indicators

Strain	**JA757**		**S757N**		**Dual C genotype**	
Range use	Low ranger	High ranger	Low ranger	High ranger	Low ranger	High ranger
Feed Conversion Ratio (FCR)	2.181	2.360	2.674	2.825	3.094	2.960
Daily weight gain (g/day)	40.1	37.1	30.0	28.4	15.9	16.6
Average feeding period (days)	70	70	84	84	99	99
Total feed consumed per bird (g)	601.6	601.6	662.42	662.42	475.12	475.12
Final live weight (g)	2.807	2.598	2.516	2.384	1.578	1.647
Mortality at farm level (%)	1.91	1.91	0.95	0.95	5.58	5.58
Total production, kg per square meter and cycle	27	25	24	23	15	16

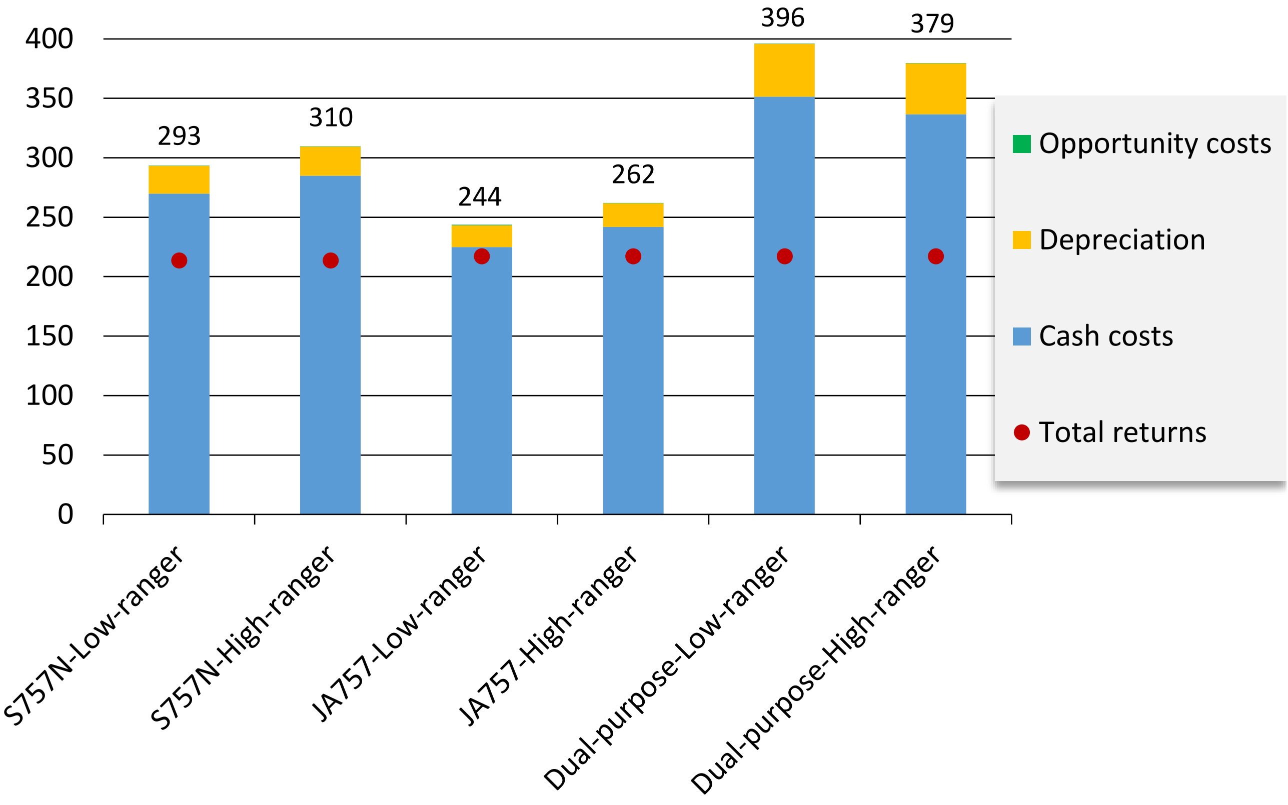
Source: INRAE, T6.1.

In terms of total production per square meter results showed the higher production per square meter of the S757N and JA757 Low Rangers compared to their high-ranger counterparts, that were all much higher than the genotype C High Rangers, followed by C low rangers. Taking into account the dual-purpose C low and high rangers, the relationship was inverse, i.e., the higher production per square meter was recorded for the genotype C High Rangers compared to the genotype C Low Rangers, which was reflected in the production costs and the feed conversion ratio (Figure 2).

Comparison of production costs

Figure 2 shows very high costs for Dual-purpose C due to higher feeding period and lower final weight compared to S757N, JA757. Moreover, Figure 4.2 highlights that intermediate growing strains were much less costly to produce and already used in organic production, but only in some countries (Denmark, Germany) whereas they were not allowed on this purpose in other countries like France.

Figure 2: Comparison of production costs (Euro/100 kg live weight)



Source: Own servey and calculations

4.2 Discussion

The higher cost of the Dual-purpose C was expected taking into account the economic evaluations of dual-C on-station and on-farm trials showing low growth rates and feed efficiency (see chapter 5.1). Because the C high rangers had a slightly better body weight than the C low rangers (even if not significantly) according to the data in INRAE experimental unit, it seemed to be sufficient to make them little less costly. The costs calculated in the “faster-growing” genotypes JA757 and, to a lower extent, S757N, were much less, with an opposite rank between high rangers (more costly) and low-rangers probably due to the energy lost due to physical activity on the free range. Overall, the production costs of the medium growing JA757 chickens were lower than those of the slow-growing S757N chickens.

5. Dual-purpose breeds

This section presents the results of the analysis of the economic viability of rearing dual-purpose breeds for meat and egg production. Specifically, it analysed production performance indicators, production costs, and profitability associated with rearing male and female chickens from three newly developed dual-purpose poultry genotypes (Genotypes A, B, C) within organic rearing conditions on farms and research stations located in Germany, France and Denmark. Deliverable 7.3 is based on the data that were the most consolidated in the three countries.

5.1 Males

Males of three dual-purpose genotypes were evaluated on-station under organic rearing conditions and compared to a representative high-performing genotype in each country. The three dual-purpose genotypes had different performance profiles: a meat-type (Genotype A), an egg-type (Genotype C), and a rustic breed (Genotype B) with a balanced performance profile. The analysis focused on the performance and product characteristics of the males in these genotypes and how these differences were reflected in their economic efficiency.

5.1.1 Germany on-station (GT A-C)

TI-BW, with the support of other PPILOW partners, evaluated the results of rearing dual-purpose males on-station under organic rearing conditions in Germany. The farm economic analysis focused on farm performance, production costs, and the profitability of rearing dual-purpose breeds. The economic performance of these dual-purpose breeds was compared to that of a representative genotype (control group) classified as "intermediate growing" (or medium-growing) in Germany: Genotype JA757.

Farm performance

The analysis revealed that Genotype JA757 chickens were more efficient in terms of feed use than the dual-purpose breeds, as they had the lowest feed conversion ratio (FCR) and the highest daily weight gain (see Table 2). The dual-purpose chickens (Genotypes A, B and C) had high FCRs that were comparable. However, Genotype C chickens had the lowest daily weight gain. Also, notably, Genotype A and B had the lowest mortality rate.

Table 2: Comparison of farm performance indicators

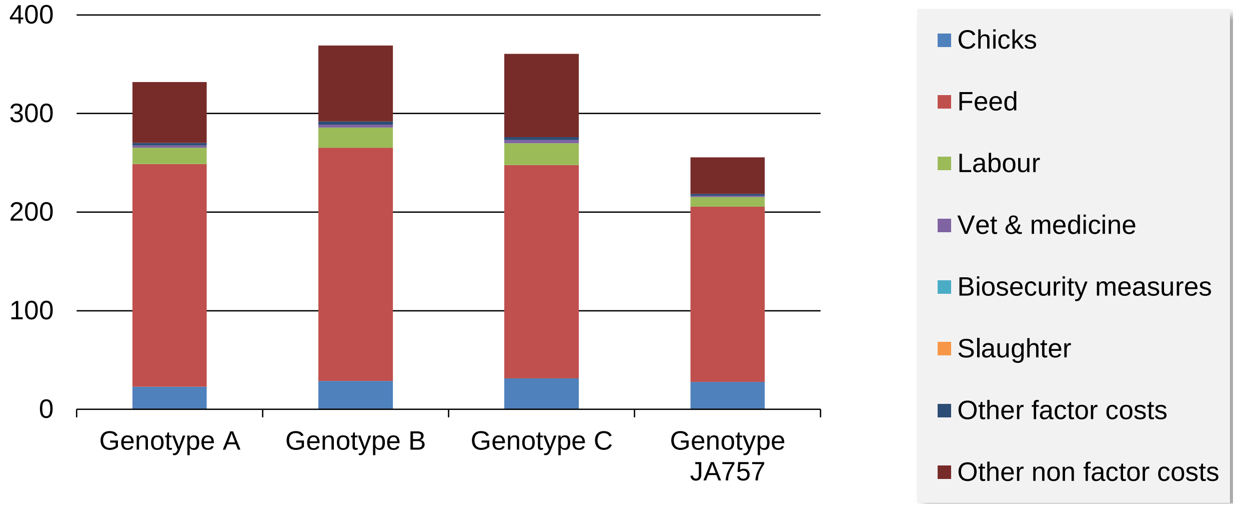
	Genotype A	Genotype B	Genotype C	Genotype JA757
Feed Conversion Ratio (FCR)	3.48	3.66	3.33	2.74
Daily weight gain (g/day)	26.08	20.84	19.32	44.58
Average feeding period (days)	83	83	83	85
Total feed consumed per bird (g)	7.536	6.332	5.335	10.373
Final live weight (g)	2.203	1.763	1.634	3.831
Mortality at farm level (%)	1.1	1.1	2.1	3.3

Source: Own survey and calculations

Comparison of production costs

Figure 3 shows that Genotype JA757 chickens had the lowest production costs. Among the three dual-purpose genotypes, Genotype A chickens (meat-type) had the lowest production costs. In contrast, rearing chickens of Genotype C was associated with the highest production costs due to higher labour costs and "other non-factor costs", which included fuel, energy, water, insurance, and taxes.

Figure 3: Comparison of production costs (Euro/100 kg live weight)

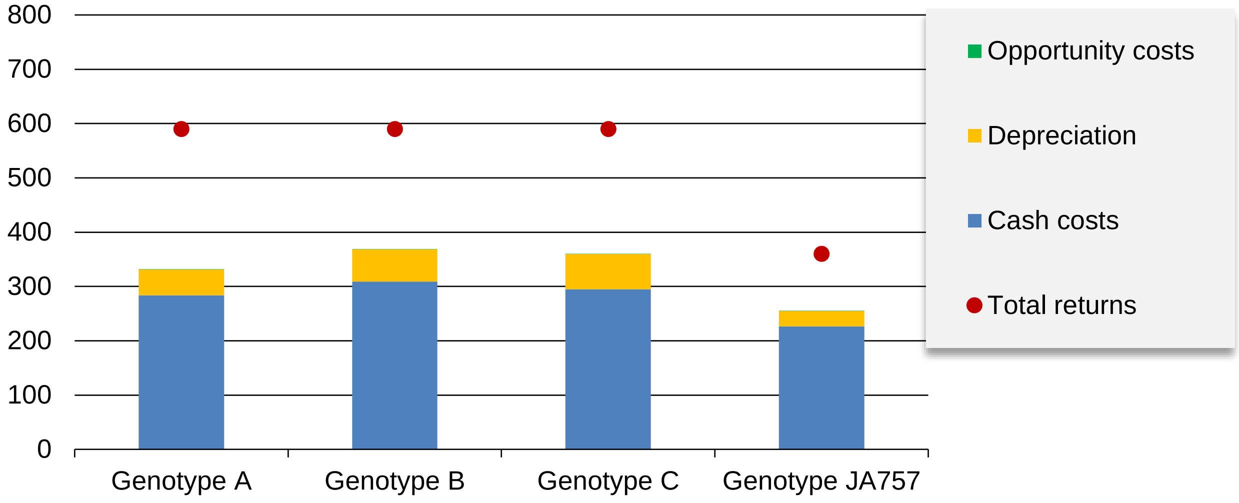


Source: Own survey and calculations

Comparison of profitability

Profitability was calculated in terms of short-term, mid-term and long-term profitability (see notes below Figure 4). Figure 4 shows that it was more profitable to rear Genotype A chickens. The results also showed that rearing Genotypes A, B and C chickens was profitable in the short, medium and long term as the production was able to cover cash, depreciation and opportunity costs. The profitability could be attributed to the high selling price (5.90 Euro/kg live weight) which allowed the farms to cover the costs and to realize a profit.

Figure 4: Total costs, returns and profitability (Euro/100 kg live weight)



Source: Own survey and calculations
Notes:

- Short term profitability = total returns – cash costs.
- Medium term profitability = total returns – cash costs – depreciation costs.
- Long term profitability = total returns – cash costs – depreciation costs – opportunity costs.

Based on the findings of the trials conducted in experimental farms, NPG members from France, Denmark and Germany selected the genotypes which are the most promising to be reared on farms. The French and German NPGs decided to rear male birds from Genotype C on the farms. In each country, a Control group that corresponds to a breed usually used in organic farming was reared in the same conditions as Genotype C males.

5.1.2 Germany on-farm (GT C)

On-farm trial

The on-farm analysis focused on how the performance, costs of production and profitability of the Males of Genotype C (egg-type) differed compared to that of the control genotype (JA757).

Farm performance

Table 3 shows that the control genotype birds (Genotype JA757) had the lowest feed conversion ratio (FCR) and the highest daily weight gain, making them the more feed-efficient birds. The results also showed that Genotype C males had a significantly higher mortality rate of 6.7 %.

Table 3: Comparison of farm performance indicators

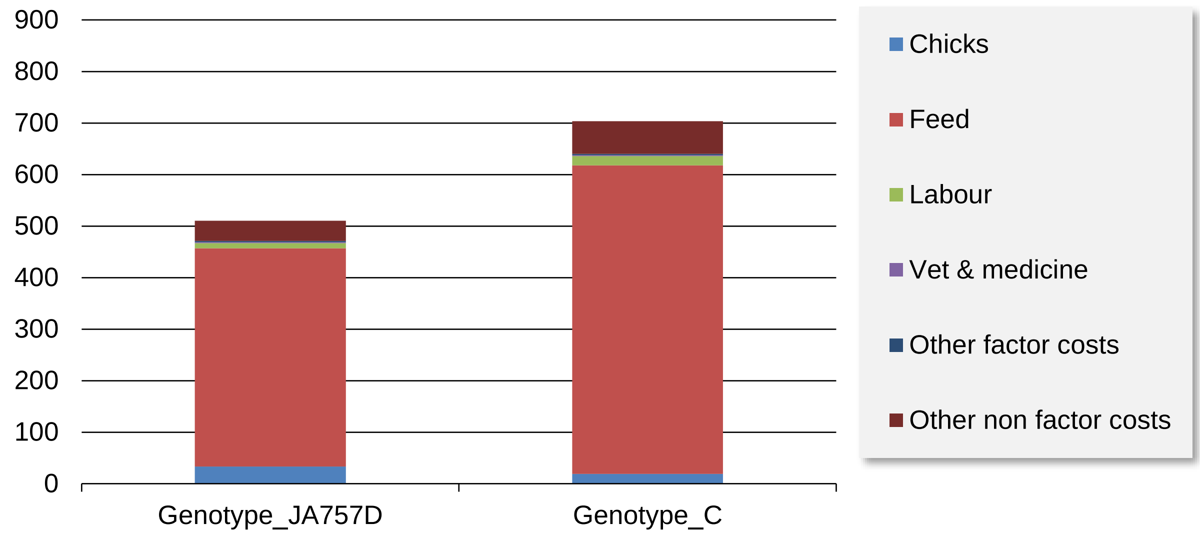
	Genotype JA757	Genotype C
Feed Conversion Ratio (FCR)	2.744	3.887
Daily weight gain (g/day)	41.03	24.88
Average feeding period (days)	89	112
Total feed consumed per bird (g)	10021	10832
Final liveweight(g)	3488	2821
Mortality at farm level (%)	1.15	6.7

Source: Own survey and calculations

Comparison of production costs

As shown in Figure 5, broilers of Genotype C had higher production costs than those of Genotype JA757 (D). The process of rearing Genotype C cockerels incurred the highest production costs due to higher feed and non-factor costs. The increased feed costs were attributed to the cockerels' lower feed efficiency, indicated by a higher Feed Conversion Ratio (FCR). Additionally, the fattening period between the two groups differed, with 89 days for Genotype JA757 D and 112 days for Genotype C.

Figure 5: Comparison of production costs (Euro/100 kg live weight)

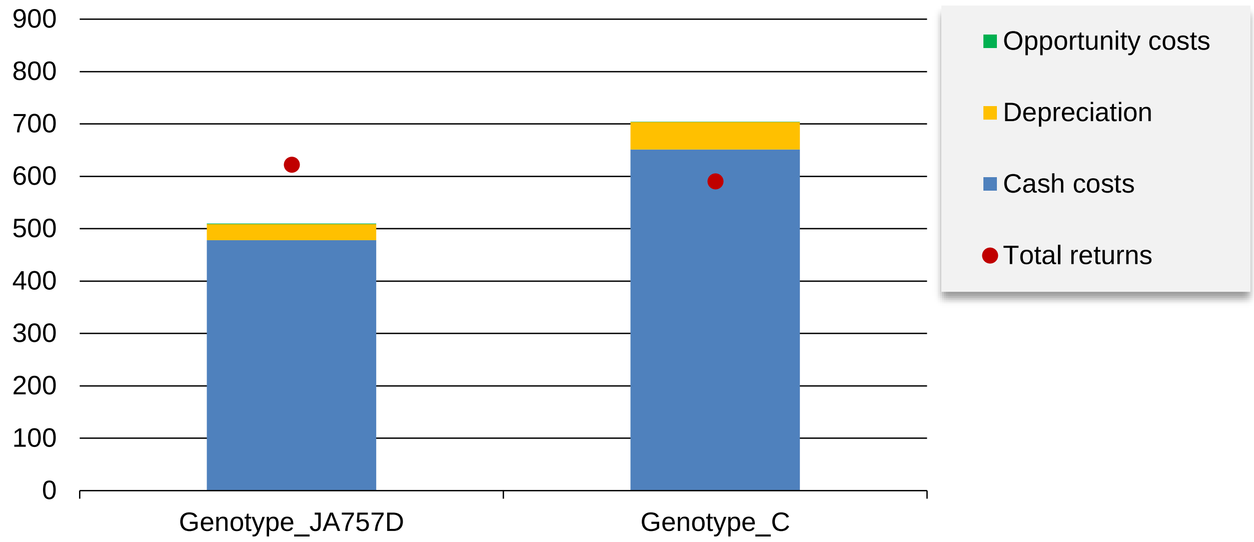


Source: Own survey and calculations

Comparison of profitability

Profitability was calculated in terms of short-term, mid-term and long-term profitability (see notes below Figure 6). Figure 6 shows that rearing broilers of Genotype JA757 was profitable while rearing Genotype C cockerels was unprofitable. The unprofitability of rearing Genotype C could be attributed to the high cash costs that were much higher than the returns.

Figure 6: Total costs, returns and profitability (Euro/100 kg live weight)



Source: Own survey and calculations
Notes:

- Short term profitability = total returns – cash costs.
- Medium term profitability = total returns – cash costs – depreciation costs.
- Long term profitability = total returns – cash costs – depreciation costs – opportunity costs.

The analysis showed that there were significant differences between Genotype C and the representative control genotype (JA757), especially in feed conversion ratio and daily weight gain, resulting in significantly higher feed costs. The difference in costs between the on-farm and on-base trials in Germany is due to the feeding regime in the on-farm trial (mix of on-farm-produced and purchased feed), which resulted under the given conditions in higher feed prices.

5.1.3 France on-farm (GT A-C)

Cockerel trial (experimental farm)

This section presents the results from the French farm. The French farm received 220 Genotype C birds (males) and 220 control males. The results were grouped into four as half the birds for the Control group and Genotype C were reared for 89 days and the other half for 103 days.

Farm performance

Table 4 shows that the Control group birds were more efficient than Genotype C birds in terms of feed-use, as they had the lowest feed conversion ratio (FCRs) and the highest daily weight gain. Table 4 also shows that rearing the cockerels for a longer period (103 days) resulted in higher final weights but this also increased the FCRs. Although the Control group and Genotype C cockerels were reared under the same conditions, the Genotype C cockerels had a significantly higher mortality rate than the Control group which appeared mainly in the first weeks of life.

Table 4: Comparison of farm performance indicators

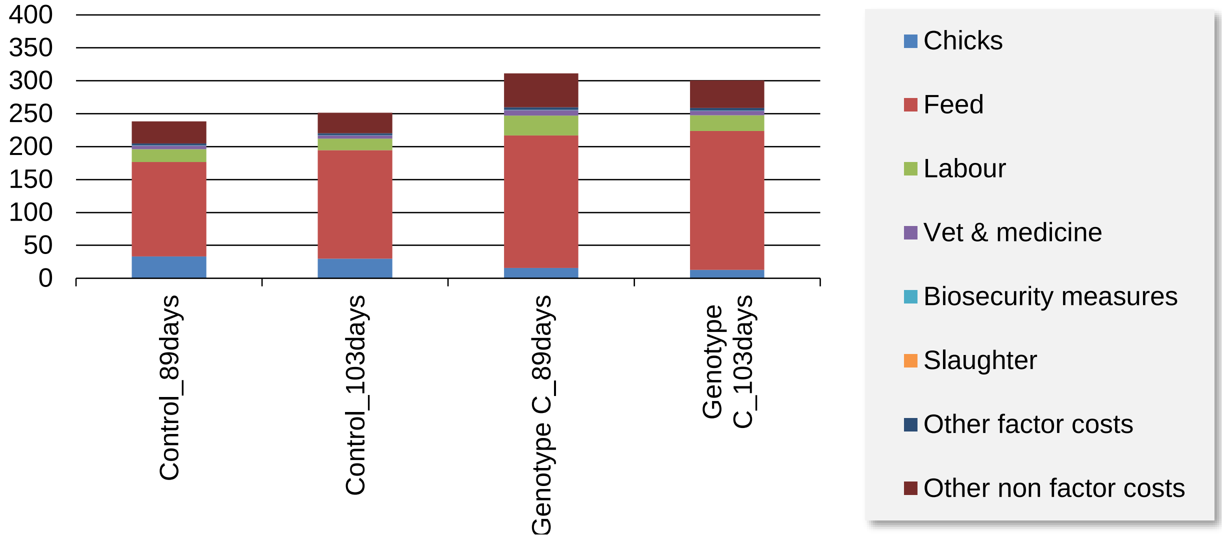
	Control (89 days)	Control (103 days)	Genotype C (89 days)	Genotype C (103 days)
Feed Conversion Ratio (FCR)	2.65	3.04	3.74	3.91
Daily weight gain (g/day)	32.28	31.14	21.71	23.60
Average feeding period (days)	89	103	89	103
Final liveweight (g)	2919	3252	1977	2475
Mortality (%)	1.36	1.36	4.57	4.57
Total feed consumed per bird (g)	7601	9738	7233	9506

Source: Own survey and calculations

Comparison of production costs

Figure 7 shows that rearing the Control group had lower production costs than rearing the Genotype C cockerels. Rearing Genotype C cockerels had the highest production costs, primarily due to higher feed costs. The higher feed costs could be attributed to the fact that cockerels with Genotype C were less efficient in terms of feed use (higher FCR). The findings also show that rearing the Genotype C birds for up to 103 days will result in slightly lower production costs than rearing them for 89 days. This is because the bird weighed much more at 103 days than at 89 days, therefore, the costs per 100 kg live weight became less.

Figure 7: Comparison of production costs (Euro/100 kg live weight)

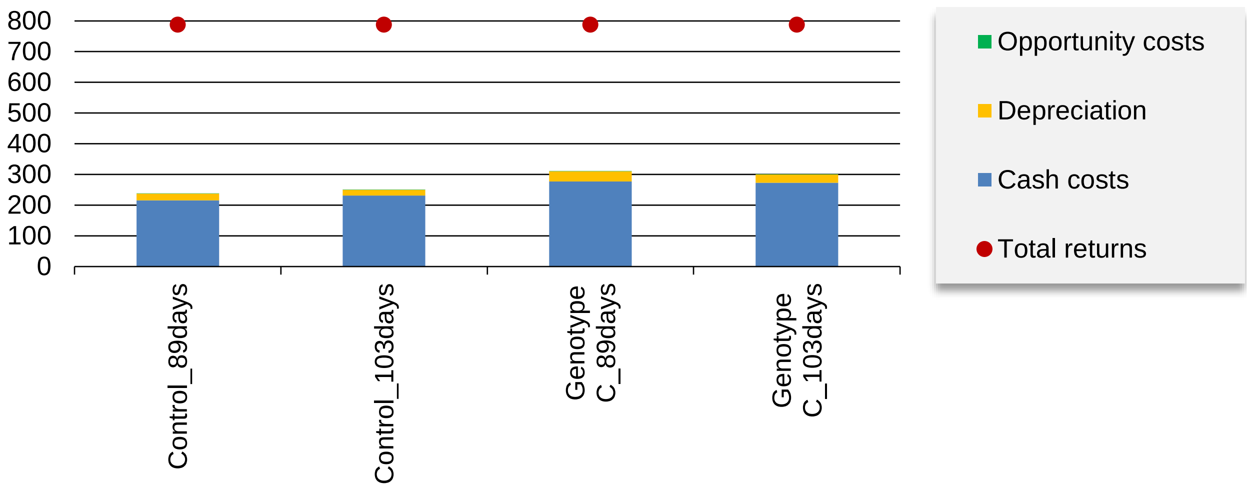


Source: Own survey and calculations

Comparison of profitability

Profitability was calculated in terms of short-term, mid-term, and long-term profitability (see notes below Figure 8). Figure 8 shows that rearing both the Control and Genotype C cockerels was profitable in the short, medium, and long term. It is also important to note that the profitability was calculated based on the assumption that the selling price for the Control and Genotype C birds was 10,50 Euro/kg (carcass weight), which is quite high.

Figure 8: Total costs, returns and profitability (Euro/100 kg live weight)



Source: Own survey and calculations
Notes:

- Short term profitability = total returns – cash costs.
- Medium term profitability = total returns – cash costs – depreciation costs.
- Long term profitability = total returns – cash costs – depreciation costs – opportunity costs.

5.1.4 Denmark on-station (GT A-C)

A brother-sister joint analysis was conducted since female and male chicks of one genotype were reared. Males and females of three dual-purpose genotypes were evaluated on-station under organic rearing conditions and compared to a representative high performing genotype. The three dual-purpose genotypes had different performance profiles: a meat-type (A), a layer-type (C), and a rustic breed (B) with a balanced performance profile. Genotype D, a local broiler type breed (Black Forest chicken) was provided by a local hatchery and used as the control. The analysis focused on how the performance and product characteristic of these genotypes regarding the males differed and how this was reflected in the economic efficiency.

Farm performance

Table 5 shows that the chickens of Genotype D were the most efficient in terms of feed use, as they had the lowest feed conversion ratio (FCR) and the highest daily weight gain. Chickens of Genotypes A, B and C had high FCRs that were comparable. However, Genotype B cockerels had the lowest daily weight gain. Also, notably, Genotype C birds had the highest mortality rate.

Table 5: Comparison of farm performance indicators

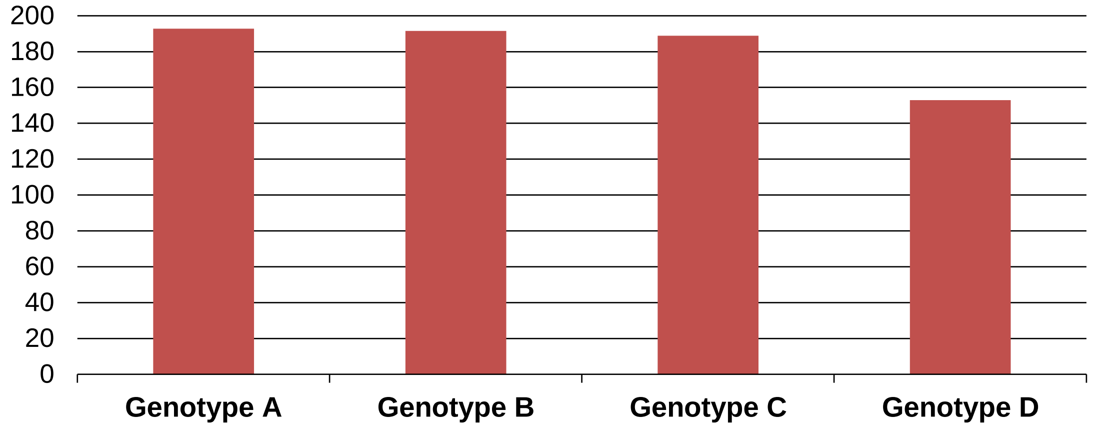
	Genotype A	Genotype B	Genotype C	Genotype D
Feed Conversion Ratio (FCR)	3.47	3.38	3.34	2.96
Daily weight gain (g/day)	24.38	20.37	21.65	39.78
Average feeding period (days)	97	97	97	83
Total feed consumed per bird (g)	8201	6681	7023	9780
Final live weight (g)	2404	2015	2141	3347
Mortality at farm level (%)	1,70	0,68	2,80	0

Source: Own survey and calculations

Comparison of feed costs

Feed costs were the most important cost item in chicken production as they often account for between 60 % and 70 % of the total production costs. This section compares the feed costs associated with rearing the different genotypes. Figure 9 shows that chickens with Genotype D had the lowest feed costs while the three dual-purpose genotypes (A, B, C) had higher feed costs. However, Genotype C chickens had slightly lower feed costs in comparison to Genotypes A and B. The differences in feed costs were most likely due to differences in feed use efficiency (reflected by the FCR). This means that chickens which are more efficient in terms of feed use (lower FCR), have less feed costs as they do not consume more feed than they need to.

Figure 9: Comparison of feed costs (Euro/100 kg live weight)

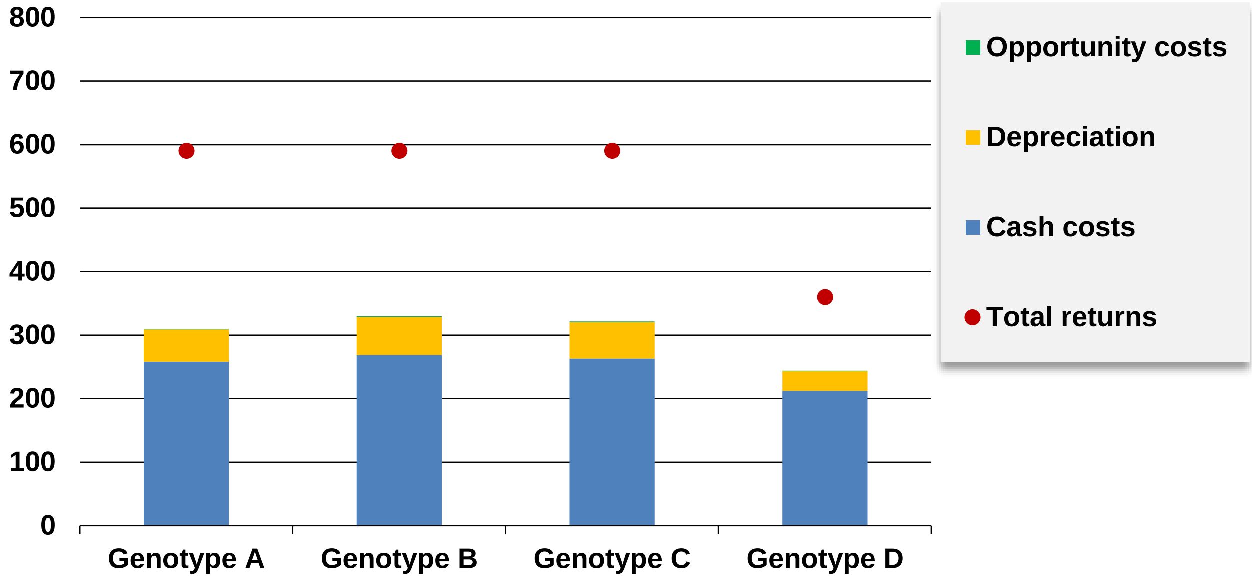


Source: Own survey and calculations

Comparison of profitability

Profitability was calculated in terms of short-term, mid-term and long-term profitability (see notes below Figure 10). Figure 10 shows that it was more profitable to rear Genotype A, B and C chickens. The results also show that rearing all Genotypes was profitable in the short, medium and long term as the production was able to cover cash, depreciation and opportunity costs. The profitability could be attributed to the high selling prices (5.90 Euro/kg live weight for Genotypes A, B, and C; and 3.60 Euro/kg live weight for Genotype D), which allowed the experimental farm to cover the costs and to realize a profit.

Figure 10: Total costs, returns and profitability (Euro/100 kg live weight)



Source: Own survey and calculations
Notes:

- Short term profitability = total returns – cash costs.
- Medium term profitability = total returns – cash costs – depreciation costs.
- Long term profitability = total returns – cash costs – depreciation costs – opportunity costs.

5.1.5 Discussion

The findings from the trials in all three countries showed that the dual-purpose breeds exhibited lower feed-use efficiency (higher FCRs) in comparison to the control genotypes (existing slow-growing breeds) that were selected in each country. The reduced feed-use efficiency translated to higher feed costs. Cognisant that feed costs are the most important cost item in chicken production as they often account for between 60 % and 70 % of the total production costs, the higher feed costs consequently increased costs of production (see Annex 1).

Therefore, to compensate for the increased production costs, the rearing of the dual-purpose breeds was only profitable in cases where the selling prices of their meat was relatively high. Annex 1 shows that the trials in France had the highest profit in comparison to the other countries because they also had the highest selling price. These findings suggest that the economic viability of raising the dual-purpose breeds is heavily dependent on securing premium prices for their meat products. This means that the cost-effectiveness of these breeds is particularly sensitive to market dynamics, including consumer willingness to pay higher prices for dual-purpose breed products.

5.2 Pullets

The female trials were organized in two steps: the pullets rearing and the laying hen period. The pullets for the on-farm trials in France and Denmark were reared on a farm (farm 1) in France. The economic performance and costs of the on-farm pullet trials are presented first followed by the laying hen trials. For the rearing of the pullets, we have analysed how the differences in physical performances (see Lombard et al., 2024, Deliverable 5.2) were reflected in the economic efficiency and viability.

5.2.1 France on-farm – (GT A, C)

Pullets trial (GT A, C)

According to the results from the trials on experimental farms, NPG members from France, Denmark and Germany selected the genotypes which were the most promising to be reared on farms in each country. Danish NPG decided to rear pullets from genotype C and A whereas French and German NPG decided to rear pullets from genotype C only. Each country was supposed to rear its own pullets, but no farms were found to do it in Germany and Denmark, therefore, all pullets from genotypes A and C were reared on a French farm. The farm is located in the East part of France. One-day-old pullets were delivered on the farm: 440 from genotype A, 880 from genotype C and 220 from a control genotype usually used in France for layers.

Farm performance

Table 6 shows that pullets with Genotype C were the most efficient in terms of feed use, as they had the lowest feed conversion ratio (FCR). Genotype A pullets had the lowest mortality rate, while Genotype C pullets had a significantly higher mortality rate.

Table 6: Comparison of farm performance indicators

	Control	Genotype A	Genotype C
Feed Conversion Ratio (FCR)	5.42	5.20	4.88
Daily weight gain (g/day)	12.90	18.03	16.35
Feeding period (days)	125	125	125
Final liveweight(g)	1654	2296	2086
Mortality at farm level (%)	4.09	2.05	9.16
Total feed consumed per bird (g)	8768	11726	10019

Source: Own survey and calculations

Comparison of production costs and profitability

Table 7 shows that rearing pullets with genotype C had the lowest total cash costs of production (per bird). Table 7 also shows that rearing the Control group had higher production costs than rearing the Genotype A and C pullets. This is attributed to higher feed costs. The higher feed costs can most likely be attributed to the fact that pullets from the Control group were less efficient in terms of feed use (higher FCR).

Profitability was calculated in terms of short-term profitability (Short term profitability = total returns – cash costs). Table 7 shows that rearing all three Genotypes was not profitable in the short term. The unprofitability of rearing the different genotypes of pullets may be due to a combination of two factors: i). High production costs; ii). Low selling price of the pullet birds.

Table 7: Comparison of production costs, returns and profitability (Euro/bird).

	Control	Genotype A	Genotype C
Total cash costs of production	6,25	7,61	7,18
Total returns	4,14	5,74	5,22
Profitability (short-term)	-2,12	-1,87	-1,96

Source: Own survey and calculations

5.2 Females

The economic results of the female dual-purpose trials on-station and on-farm will be presented. For the on-station trials, own pullets were reared, but no economic evaluation was planned. Prior to on-farm case studies, on-station trials were carried out in experimental farms in Denmark, and Germany to experience the different characteristics of the ABC genotypes. The economic analysis focused on how the performance, costs of production and profitability of laying hens of the different dual-purpose genotypes differed compared to that of the control genotype (Lohmann brown plus for German trials and Dekalb White for Danish trials).

Based on the on-station results, National Practitioner Groups (NPGs), consisting of various stakeholders interested in dual-purpose genotypes (vets, feed experts, farmers), decided on which genotype would be most interesting for their farms. It was decided that genotype C both in France and in Germany would be tested on-farm, as Genotype C seemed to be the most promising for higher egg numbers. However, no economic analysis was carried out on the on-farm trial in France because of several problems encountered in this trial (e.g., high number of eggs laid on the ground and lower laying rate of genotype C females) and the resulting high mortality, feather pecking and because of the effects of a dramatic heat wave (Pluschke et al., 2024). As this was not a representative trial, an economic evaluation was not carried out.

5.3.1 Germany on-station (GT A-C)

The economic analysis of the female dual-purpose trials in Germany (2020-2022) focused on how the performance, costs of production and profitability of laying hens of the different dual-purpose genotypes compared to that of the control genotype (Lohmann brown plus). Unpredictably the pullets were reared on a German farm, due to problems with the pullet quality of the pullets reared on the French farm, without possibility of gathering the necessary data ensuring its economic evaluation.

From 18 weeks to week 58 of age, the laying hens stayed in a fix barn. In week 58 the laying hens were moved to a mobile barn facility. Differences in costs due to two different housing environments have been taken into account in the economic analysis. For better comparability of the results, the number of laying hens was adjusted to the same number of starting hens (80 laying hens, number of A hens) for all genotypes (A, B, C, D) while retaining the laying performance.

Farm performances

Table 8 shows that the laying performance in meat-type A was the lowest and in laying-type C the highest. The control group genotype D (LB+) recorded the highest laying performance. Genotype D was the most efficient in terms of feed use, followed by laying type C. Genotype B hens had the lowest mortality rate beyond the dual-purpose genotypes. B and C were comparable in terms of performance, but C had higher proportion of marketable eggs and A had smaller eggs overall.

Table 8: Comparison of farm performances of genotypes A, B, C compared to the control group D from week 18-72

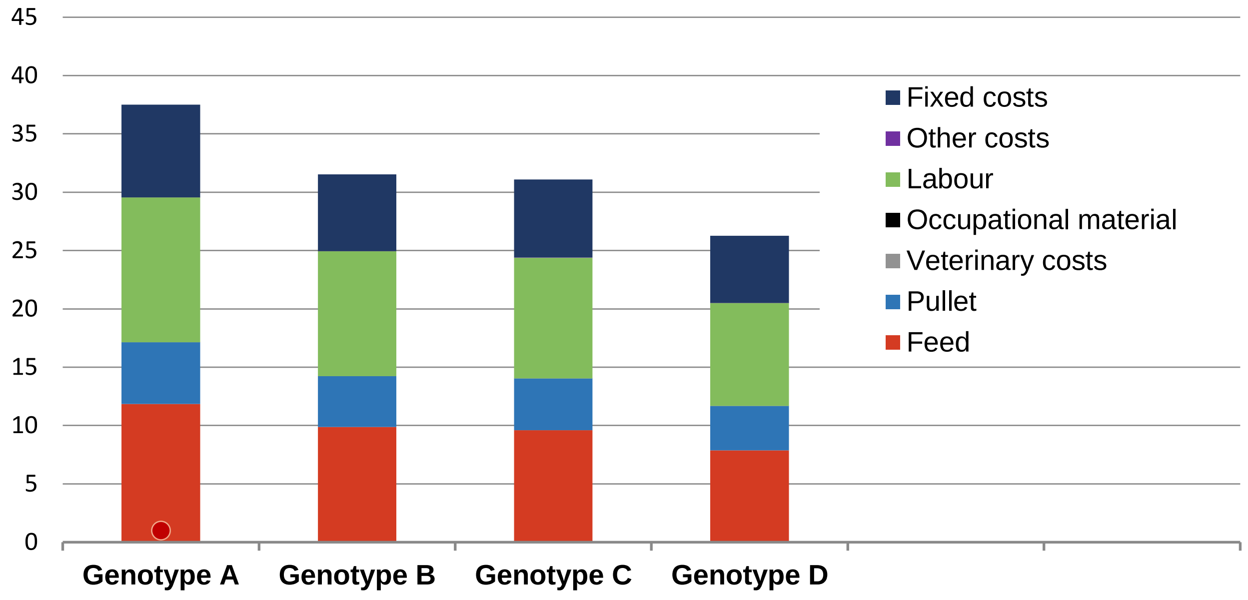
	Genotype A	Genotype B	Genotype C	Genotype D Lohmann brown plus
Eggs per starting hen/l cycle	242	270	276	312
Non-marketable eggs (%)	24.02	23.65	17.88	20.98
Egg weight (g)	61.9	63.2	62.9	64.7
Average laying period (weeks)	72	72	72	72
Feed consumption per bird and day (g)	131	127	125	121
FCR (feed intake g per egg mass g)	3.39	2.77	2.60	2.12
Mortality at farm level (%)	11	7	12	12

Source: Own survey and calculations.

Comparison of production costs

Figure 11 shows that the difference in performance parameters between the genotypes was reflected in the production costs. Production costs were 18-43% higher for dual-purpose hens compared to high performing layers (D). Of the three dual-purpose genotypes, genotype C had the lowest production costs, closely followed by GT B while genotype A required the highest production costs. Feed costs accounted for 30-32% of the total costs. The full cost differences of A, B and C compared to D ranged from 4.8 (C to D) to 11.3 (A to D) cents per egg.

Figure 11: Comparison of production costs (Eurocents/egg)



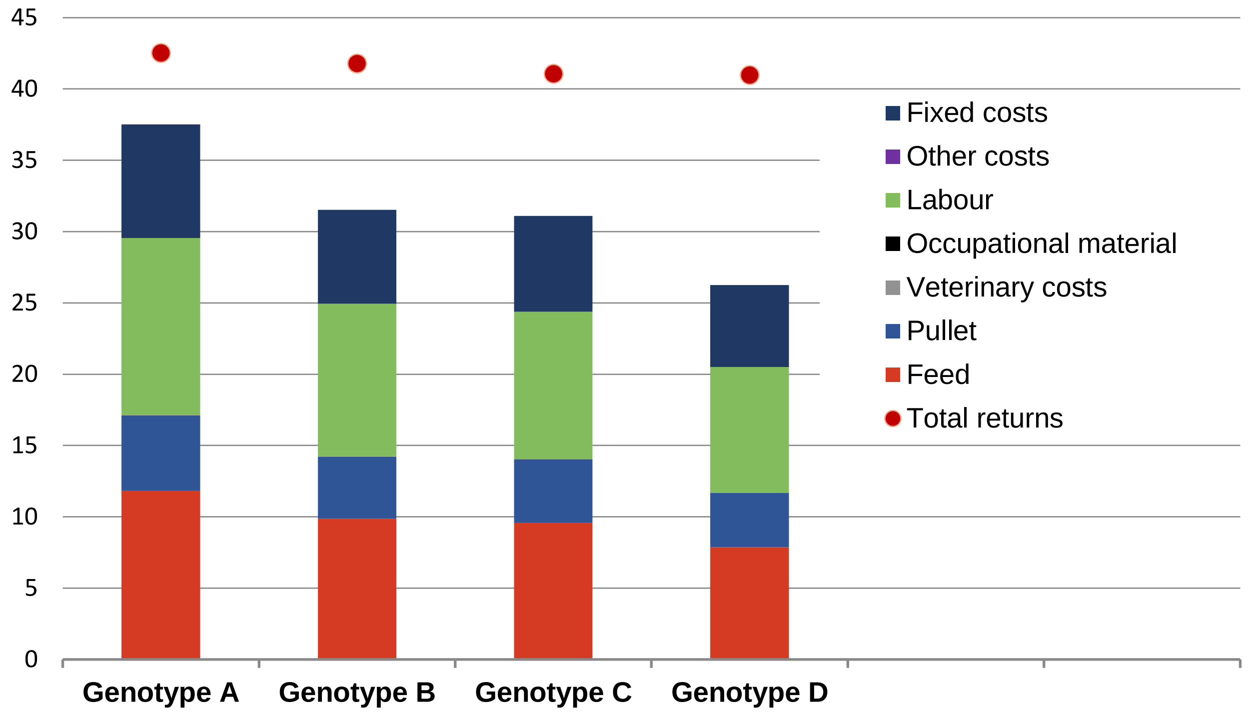
Source: Own survey and calculations

The lower laying performance (per hen and total egg production) and the higher mortality rate were reflected in higher production costs per egg for genotype A compared to the other two dual-purpose genotypes. Genotypes B and C were the best performing of the novel genotypes tested and comparable in terms of egg production. However, C had a higher proportion of marketable eggs compared to B, which compensated for the cost disadvantage due to higher mortality (+4%). In relation to the starting hen, the results showed a lower laying performance for C hens due to higher mortality. While total production costs were slightly higher for B, net income per egg was slightly lower for C due to lower egg production per cycle as a result of higher mortality.

Comparison of profitability

Looking at the difference between total revenue and total costs, **Figure 12** shows that under the specific conditions and price assumptions, egg production using genotypes A–C would be profitable in the short, medium and long term as the total revenues (including the total returns for eggs (A- and B-eggs) and slaughter hens) would enable to cover the full costs of production and to realize a profit.

Figure 12: Comparison of profitability (Eurocents/egg)



Source: Own survey and calculations

5.3.2 Germany on-farm (GT C)

As described in Deliverable 5.3 (Pluschke et al, 2024), problems occurred during the rearing phase of pullets for the French and Danish trials, which led to pecking and mortality in the pullet rearing phase and the successive laying phases in France and Denmark that would have the effect of skewing the economic analysis. Therefore, a complete analysis of the production costs and profitability could only be provided for the German on-farm trial.

As the farmer in Germany did not accept the pullets reared in France for the on-farm testing of the females due to feather pecking behaviour, the pullet trial was restarted and postponed to March 2023 (see Deliverable 5.3). The on-farm trial lasted from 18 to 70 weeks of hen age for the control group and from 18 to 58 weeks of hen age for genotype C. However, data comparisons presented here were between weeks 18-58 for both genotypes (Pluschke et al., 2024). The farm only operated with mobile houses.

The economic analysis focused on how the performance, costs of production and profitability of laying hens of Genotype C (egg-type) differed compared to that of the control genotype (Lohmann brown plus).

Farm performances

Table 9 shows that average daily feed consumption was higher in genotype C than in the control group, which translated into feed conversion ratios of 2.93 and 3.82 for the control and genotype C, respectively. However, the control genotype did not perform as expected for a number of reasons described in Deliverable 5.3 (Pluschke et al., 2024). The mortality rate of genotype C females in Germany were lower than for the control group, which further illustrates the influence of the management of the pullet rearing phase. The proportion of non-marketable eggs was very low in both genotypes.

Table 9: Comparison of farm performance of female chicken of genotype C and the control group from week 18-58

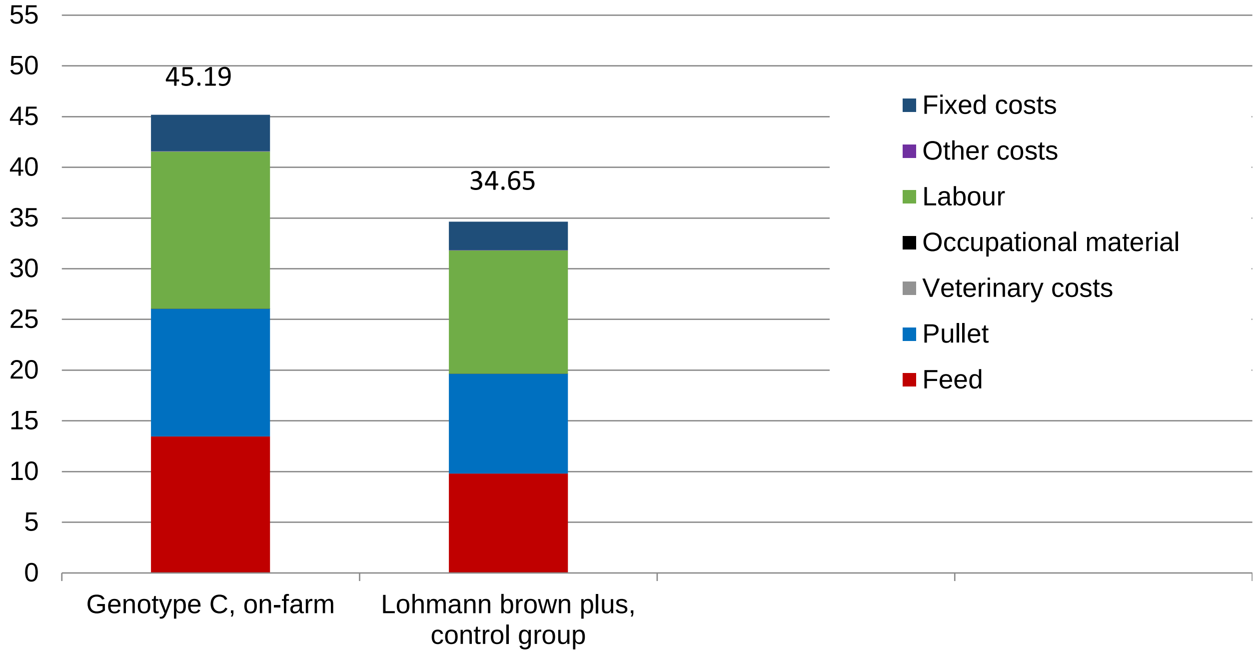
	Genotype C	**Genotype D**
Eggs per starting hen/phase	163	195
Egg weight	63.34	61.01
Average laying period (weeks)	18-58	18-58
Feed consumption per hen and day (g)	140	130
FCR (feed intake g per egg mass g)	3.82	2.93
Mortality at farm level (%)	2.2	4.4

Source: Pluschke et al., 2024, Deliverable 5.3, 2024

Comparison of production costs

Figure 13 shows that differences in laying performance and feed efficiency are reflected in the production costs per egg. The difference in production costs from C to D: was about 10.54 Cents per egg (+30%). The largest shares of total costs were attributed to feed, labour and pullet costs. Feed costs accounted for 27-29 % of total costs. Labour costs accounted for 34-35% of total production costs due to the labour-intensive mobile housing system (labour costs: 12.58 cents per egg for C and 9.85 Cents per egg for D).

Figure 13: Comparison of production costs (Eurocents/egg)

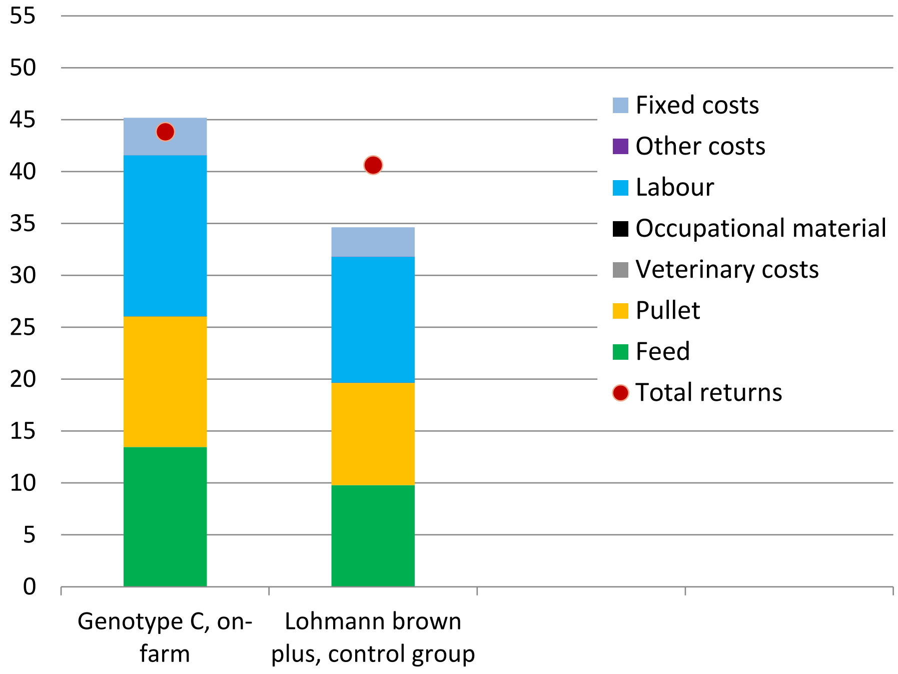


Source: Own calculations

Comparison of profitability

Figure 14 shows that under the specific conditions (trial stopped at week 58) and price assumptions, genotype D would be profitable, whereas egg production using genotypes C would not be profitable in the medium and long term, as the total revenues (including the total revenues for eggs (A and B) and hens for slaughter) would not allow to cover the full production costs and to realise a profit. The unprofitability of rearing genotype C may be due to a combination of two factors: i). High production costs; ii). Low selling price of the eggs produced (i.e., total returns are too low to cover total costs). Considering the laying potential of the entire laying phase up to week 72, there is potential for cost savings.

Figure 14: Comparison of profitability (Eurocents/egg)



Source: Own survey and calculations

5.3.3 Denmark on-station (GT A-C)

Farm performances

Table 10 shows that the laying performance in meat-type A was the lowest and in laying-type C the highest among the three dual-purpose genotypes. The control group genotype D (LB plus) recorded the highest laying performance. Genotype C and D were the most efficient in terms of feed use, the poorest FCR was obtained by genotype A. The FCR of genotype B was also significantly higher than for C and D. As reported in Deliverable 5.2 (Lombard et al., 2024), the results on FCR showed clearly that the heaviest genotypes had the lowest egg production and the highest feed intake compared to the two more light genotypes C and D.

Genotype C hens had the lowest mortality rate among the dual-purpose genotypes. Control genotype D recorded the lowest mortality of all genotypes.

Table 10: Comparison of farm performances of genotypes A, B, C compared to the control group D from week 18-62

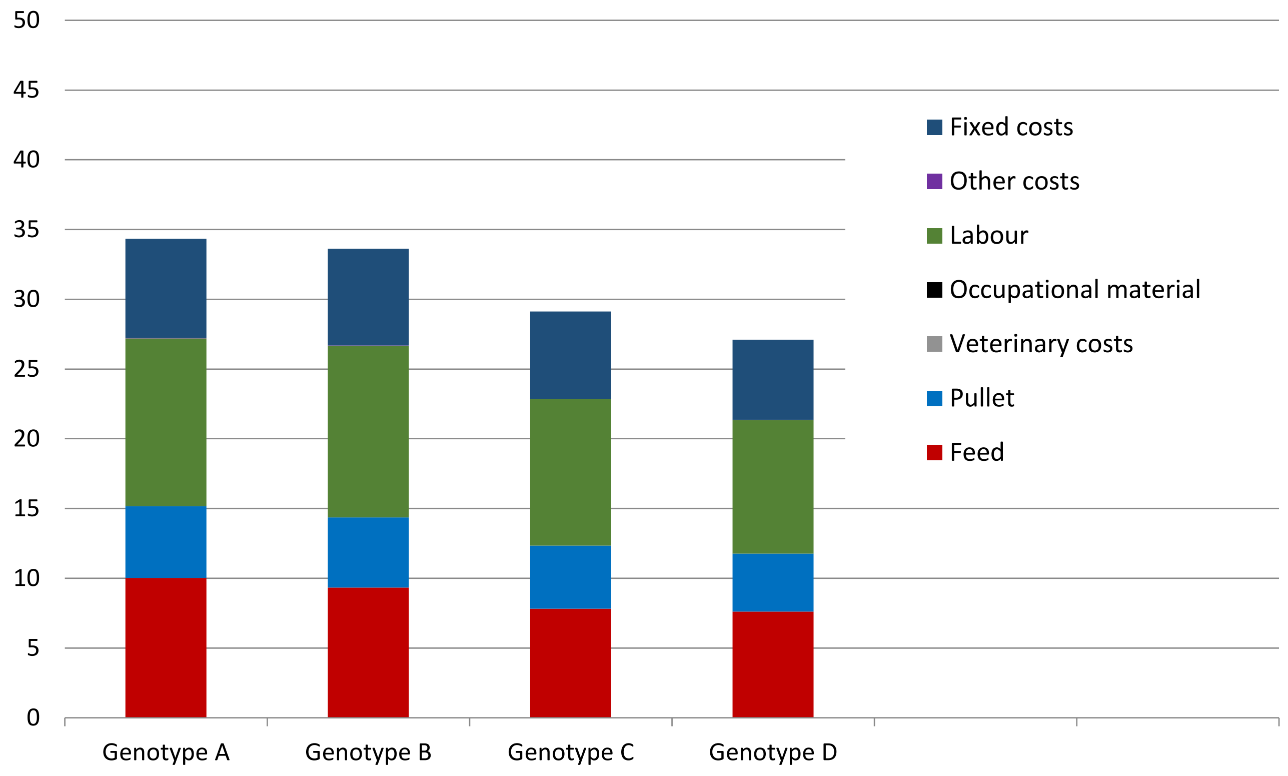
	Genotype A	Genotype B	Genotype C	Genotype D Dekalb White
Eggs per starting hen/l cycle	213	219	243	264
Egg weight (g)	61.9	63.2	62.9	64.7
Average laying period (weeks)	18-62	18-62	18-62	18-62
Feed consumption per bird and day (g)	148	142	131	137
FCR (feed intake g per egg mass g)	3.3	2.9	2.5	2.3
Mortality at farm level (%)	5.8	6.5	4.3	2.0

Source : Lombard et al., 2024, Deliverable 5.2, 2024

Comparison of production costs

Figure 15 shows that the differences in laying performance, mortality and feed efficiency were reflected in the production costs per egg. Production costs were up to 27 % higher for dual-purpose hens compared to high-performing layers (D). Of the three dual-purpose genotypes, genotype C required the lowest production costs while genotype A and B required significantly higher production costs compared to D due to higher feed costs, because genotypes A and B were less efficient in terms of feed use. The lower egg production and the higher feed intake for the heavier genotypes A and B resulted in higher production costs per egg compared to the two lighter genotypes C and D. Feed costs accounted for 27-29% of the total costs. The full cost differences of A, B and C compared to D ranged from 2.2 (C to D) to 7.23 (A to D) cents per egg.

Figure 15: Comparison of production costs (Eurocents/egg)

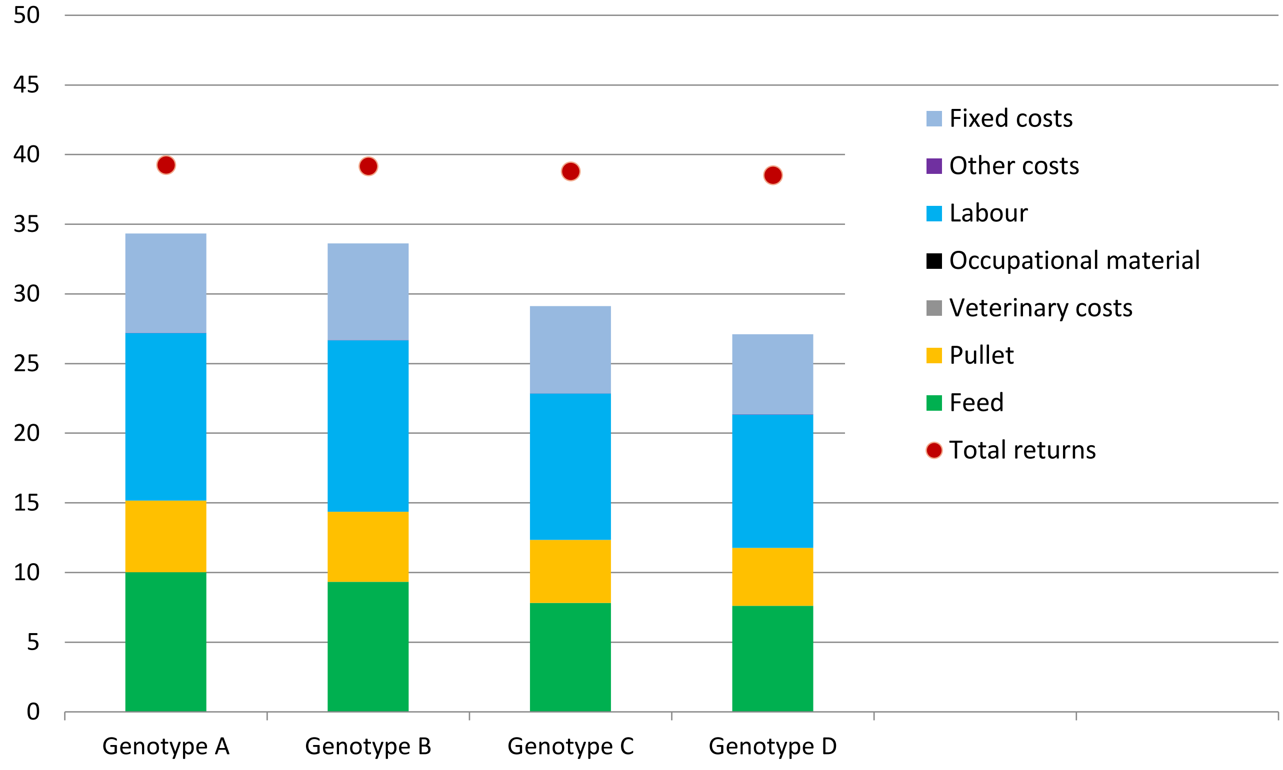


Source: Own survey and calculations

Comparison of profitability

Figure 16 shows that under the specific conditions and price assumptions, egg production using genotypes A–C would be profitable in the short, medium and long term as the total revenues (including the total returns for eggs (A- and B-eggs) and slaughter hens) would enable to cover the full costs of production and to realize a profit.

Figure 16: Comparison of profitability (Eurocents per egg)



Source: Own survey and calculations

5.3.4 Discussion

The findings from the trials in all three countries showed that the more laying-focused the dual-purpose genotype, the lower the full cost difference to the control group. Dual-purpose breeds exhibited lower feed-use efficiency (higher FCRs) in comparison to the control genotypes (existing slow-growing breeds) that were selected in each country. The reduced feed-use efficiency translated to higher feed costs. Cognisant that most of the laying period laying hens spent in mobile houses, labour costs, feed costs and pullet costs were the most important cost items as labour costs accounted for between 33 % and 35 % and feed costs for between 28% and 30 % and pullet costs for between 27 % and 28 % of the total production costs (see Annex 2).

The large difference in production costs between Danish and German on-station trials and the German on-farm trials was due to 1) different labour costs and 2) different pullet costs and the different trial period encompassing different input and output prices. For the production period 2020/2021 a wage of 15 EUR/hour were assumed for the Danish and German on-station trials, but for the German on-farm trial in 2023/2024 the average wage of the farmer and his temporary staff accounted for 22 EUR/hour. The same wage assumptions were taken for the Danish and German on-station trials for comparison purposes and due to the fact that we approximated a high share of missing Danish economic data with values from the German on-farm trial.

The most important indicators reflecting the differences in performance between the three genotypes were mortality and laying performance. The economic findings showed that small differences in mortality between genotypes had a sensitive effect on their economic performance (cost/egg ratio).

Therefore, to compensate for the increased production costs, the rearing of the dual-purpose breeds was only profitable in cases where the returns from egg production were relatively high (Annex 2). These findings suggest that the economic viability of raising the dual-purpose breeds is heavily dependent on securing premium prices for their egg products and to market to advantage in appearance. This means that the cost-effectiveness of these breeds is particularly sensitive to market dynamics, including consumer willingness to pay higher prices for dual-purpose breed products.

6. Business models

When pig and poultry farmers are considering to improve animal welfare, it is essential that the planned improvements are economically viable. Low-input outdoor and organic farming systems are so-called mid-market and high market systems, which enable farmers to receive a price premium for their production. Hence, the PPILOW project has been developing business models that could be used to valorise high welfare in low-input outdoor and organic farming systems.

The PPILOW business models were developed by utilising the approach of a value chain analysis presented by Niemi et al. (2020) and the business model canvas. The business model canvas approach is a strategic management template used for developing new business models (Osterwalder et al. 2010, Boimah et al, 2022). The business model canvas provides a systematic approach to identify and develop nine elements of a business model. These elements include responding at least to the following questions:

1. **Key Partnerships**
    - Who are our key partners and suppliers?
    - Which key resources are from which partner?
    - What key activities are done by partners?
2. **Key Activities**
    - What key activities do our value proposition, channels, customer relationships, and revenue streams require?
3. **Value Proposition**
    - What do we provide our customers?
    - What problem are we solving?
    - What are we offering to each customer segment?

4. **Customer Relationships**
   - What type of relationship does each customer segment want?
   - How costly are the relationships?
   - How do we integrate them with the rest of our business model?
5. **Customer Segments**
   - Who are our customers?
   - From whom are we creating value?
6. **Key Resources**
   - What key resources do our value proposition, channels, customer relationships, and revenue streams require?
7. **Channels**
   - How will we reach our customer segments?
   - How are our channels integrated?
   - Which channels are the most efficient?
8. **Cost Structure**
   - What are the most important costs in our business model?
   - Which key activities and key resources are the most expensive?
9. **Revenue Streams**
   - What are customers willing to pay?
   - What and how do they currently pay?
   - How much does each revenue stream contribute to overall revenue?
   - How can we make profit with the proposed business model (earning logic)?

The business model canvas was applied to different types of supply chains and different levers for improving animal welfare. The dual-purpose lever was first analysed qualitatively using a framework similar to Niemi et al. (2020). This approach aimed to identify the qualitative impacts of each lever on different actors in the supply chains. The qualitative work was extended by the analysis of the financial impacts of the dual-purpose lever at the farm level, as presented in Chapter 5, using calculation models developed by WP7. The concepts and ideas of business models were discussed and validated by consulting the NPGs of the PPILOW project.

The PPILOW WP7 research team has developed a first qualitative analysis of different value chain structures. Table 11 shows the main options considered, including i) a conventional supply chain (farmer-processor-retailer) applied to organic or free-range production, and ii) a short supply chain. The latter included a number of variations such as direct sales from the farm, sales through a specialist farm shop or market, or even online sales.

Table 11: Different value chain structures

Value proposition ➔ **How the product is superior?**	**How the customers are reached?** **Traditional supply chain**	**A short supply chain**
A set of measures for enhanced organic poultry production	Business case 1A	Business case 1B
A set of measures for enhanced low-input outdoor pig production	Business case 2A	Business case 2B

Source : Niemi et al., 2024

Simultaneously WP7 team has considered first production system and few levers and their benefits and disadvantages to different value chain actors. The purpose of this step was to analyse the suitability of each lever to the value chain in order to be able to conclude the most promising combinations.

6.1 Qualitative analysis

Table 12 shows the qualitative impact of the lever "Genetic variability in interaction with outdoor enrichment to investigate the exploratory behaviour of slow-growing broilers" to different actors of the supply chain. This lever is important because it includes dual-purpose breeds which were evaluated in section 4 and 5.

Table 12: Qualitative impacts of genetic variability in interaction with outdoor enrichment to different actors of the supply chain

Broilers	**Lever: Genetic variability in interaction with outdoor enrichment to investigate the exploratory behaviour of slow-growing broilers**
Animal breeding companies	Market for slow and medium growing breeds with better welfare status and adaptability to the organic production cycle.
Feed suppliers	Selling enrichment feeds, higher feed consumption because of exercise, specific feed needed.
Veterinarians, advisors	Need to have a better understanding how animals with new genetics behave and need to share this information.
Pharmaceutical companies	Adjust health protocols so that they take into account the new management methods and breeds, if needed, focus on preventive measures.
Farm workers	Need of more knowledge on the implications of variable genetics in interaction with outdoor solution options.
Housing and equipment suppliers	Implementation of platforms and behavioural material (e.g., straw bales), adapt ventilation systems, shelters outdoors, strategic planning and ground cover.
Finance	Possibly finance needed to outdoor area/fences and equipment.
Certification organisations, including organic certifiers; organic associations	Information and communication about the new practices, strategies and rules; possibly new certification opportunities to check the quality of meat? Probably need of a certification process to prove that animal welfare is increased and how environmental emissions are decreased.
Transporters, logistics	Depending on the volume of sales, number of cycles per year and input use, on the mode of delivering the good to the customer.
Slaughterhouses, egg packing companies	Logistics more complex, may have more or less to trade (depending on the model of market access), selling more valuable products
Retailers, wholesalers, catering, restaurants	Depending on model of market access they might have more or less to trade, can use free-range and natural behaviours arguments in marketing the value-added products.
Consumers	Meets better the needs/interests of the consumers: more natural way of production, animals with outdoor access; higher animal welfare, higher quality and better taste of the product; more satisfaction from consuming the product; social appreciation in their reference group.
Government, authorities	Policies better meet their societal objectives; attention need to be given to animal disease risks outdoors; higher acceptance of farming/production methods with better environmental food print; communication/dialogue between consumers and producers needed; possible adjustments in regulations needed; possibly subsidies needed for production or investments; more organic monitoring may be needed; training needs to be revised.
NGOs (animal welfare organisations)	Higher acceptance of livestock farming by the NGOs; they can endorse these forms of production over other forms; communication campaigns; raising interests to consumers.

Source: Own servey

6.1.1 Business model idea summaries

Novel dual-purpose genotypes

In the context of the qualitative analysis of the business model ideas, each lever has been analysed similarly and in order to derive the most promising combinations of supply chains and levers to be able to conclude the most promising combinations (see Annex 3).

Value proposition

The dual-purpose lever aims to respond to the ethical concerns raised by citizens about the practice of killing one-day-old male chicks in egg production. This is an ethical issue rather than an animal welfare issue and dual-purpose breeds therefore reduce the ethical challenge.

Male chicks from dual purpose breeds are reared for meat. They can replace slow-growing breeds in organic production. This would meet the expectations of consumers who appreciate slow-growing broilers, and it may also reduce the need for parent flocks, thus reducing the overall size of the bird population.

Dual-purpose breeds are less demanding in terms of nutritional requirements and more resilient to climatic challenges than traditional breeds. This could be a benefit to the farmer, if their feed efficiency was improved, or at least not reduced by feeding them with alternative feedstuff (e.g. by-products, etc.).

Key partners

Key partners in the value chain are farmers, genetics companies, hatcheries, breeders, feed suppliers, certification organisations, transporters, slaughterhouses, retailers, customer advisors/trainers (direct sales) and consumers.

Key resources

Appropriate training and knowledge in the management of dual-purpose breeds can improve the efficiency of birds in terms of feed efficiency, laying and growth performance.

At farm level, a different production system (for meat and eggs) will be needed.

Training for farmers in special care, e.g. feather pecking, pullet rearing, feeding expertise will be needed. More appropriate management skills would improve bird productivity.

In terms of the supply chain, easy access to dual purpose animals will be important.

Further research and development is needed to improve the performance of dual purpose birds.

Key activities

At farm level, where dual purpose genotypes are used, males are reared for meat production.

Consumer education and awareness of the culling of day-old male chicks appears to be key to increasing consumption and willingness to pay.

Customer segments

Eggs and meat from dual purpose genotypes are targeting:

- Dual-purpose breeds are targeting a Niche market for extensive systems that focus on "naturalness“. People would like to see a high number of animals on the free range expressing the natural behaviour of their species.
- Ethically consious and/or better-informed consumers who are aware of and concerned about current practices, and would like to stop the elimination of male chicks in the hatchery. These consumers tend to be smaller families and senior people who eat smaller portions of chicken, as dual-purpose breeds produce smaller chicken.

Customer relationships

Dialogue between retailers and producers about ethical standards has to take place, as well as the transfer of information to the consumers.

Channels to reach customers

Marketing and information are needed to reach the consumer (direct selling).

Cost structure

Lower performance (egg yield, growth rate), which implies that i) feed, labour and housing costs per kg output and ii) environmental impacts per kg output are higher than in single-purpose breed.

However, improved health and robustness of the birds may reduce veterinary costs and animal health and welfare issues.

Section 5.1 indicates that the dual-purpose genotypes are not efficient in terms of feed use, thus feed efficiency is reduced. The rearing of dual-purpose breeds can only be economically viable if the meat produced can be sold at a higher price.

Revenue streams

Consumers will have to pay a higher price for eggs and meat because of the higher production costs and higher welfare of the products.

The new choice of cuts (smaller chicks and pieces of meat) may increase or decrease consumers' willingness to pay for meat (depending on whether they value the higher welfare and ethical quality of meat and eggs or the usability of the cuts available).

Direct selling

Direct sales require marketing and customer information. Additional marketing and logistics costs for alternative production chains must be taken into account. The development of new products depends on the efforts of the chain. A choice has to be made between this approach and in-ovo sexing.

6.1.2 Barriers for improving animal welfare

The following common and farm specific factors that compromise improving animal welfare were identified:

Common factors

- The lack of a price premium
- Unpredictability of rules and regulations
- Strict rules and regulations

Farm-specific factors

- Cost of implementing measures
- Measures are difficult to put into practice
- Increase in labour costs
- Production conditions on the farm
- Lack of information, advice and skills

6.1.3 Most important features and actions to be taken

A PPILOW stakeholder workshop was organized in Brussels at the beginning of March 2024. The aim of the workshop was to examine the most critical features of value chains and the most urgent actions needed to strengthen low-input outdoor and organic pig and poultry production in Europe. The participants discussed how animal welfare could be turned into business value and what policy and market actions would be critical to enable welfare improvements. The main results are summarized below.

When pig and poultry farmers are considering to improve animal welfare, it is essential that the planned improvements are economically viable. Low-input outdoor and organic farming systems are so-called mid-market and high market systems, which enable farmers to receive a price premium for their production. Hence, the PPILOW project has been developing business models that could be used to valorize high welfare in low-input outdoor and organic farming systems. The workshop focused on practices such as rearing entire male pigs and dual-purpose poultry breeds that have been experimented in PPILOW. The workshop identified measures that are pertinent to promote high welfare low-input outdoor and organic farming systems. It was considered important to ensure a level playing field across Europe. As low-input outdoor and organic farms are few in number and the businesses are often small scale, it was considered important to ensure that the markets operate transparently and that unfair trading practices and excessive price margins in the value chain are prevented, for example through regulation. The participants also called for public awareness-raising and promotion measures among consumers. One of the examples was communication with restaurants to promote organic products. The group also discussed animal welfare assessments, the possibility of introducing a harmonized animal welfare label in the European market and sharing animal welfare information to consumers, including the one on the killing of layer male chicks. These could be tools to valorise animal welfare improvements in consumer segments that are willing to pay for premium products, thus making the animal welfare improvements financially more attractive to farmers. Funding of welfare improvements on farms was also found to be an important issue. The common agricultural policy of the European Union Common agricultural policy could be an instrument to support local and small-scale high animal welfare farms to enter the markets. (Niemi et al., 2024).

7. Conclusion

The findings broadly showed that animal welfare improvement strategies led to additional production costs. In general, further replications of on-farm trials are needed for a sound economic analysis of the welfare levers studied.

With regard to on-farm hatching, the applicability depends mainly on the farm structure, density and number of cycles per year. Performance gains may not always compensate for egg costs, time and energy expended and need to be commercially exploited, especially by the organic farmer ensuring direct sales. Additional cost information on the pre-hatching phase in the hatchery is needed for a reliable economic analysis.

As the use of dual-purpose breeds aims to achieve a compromise between fattening and laying performance, the productive performance of dual-purpose chicken genotypes for egg and meat production is generally lower than that of specialized hybrid genotypes. The results showed that the more lay-oriented the dual-purpose genotype, the lower the feed conversion and the higher the production costs of the broiler. Therefore, the higher production costs that are associated with rearing dual-purpose breeds can only be sustained if higher product prices are achieved.

By improving the performance of dual-purpose genotypes through breeding, a compromise must be found between the ethical and societal, environmental and economic constraints of egg and meat production. The emphasis on laying or fattening performance, or a balanced performance profile, should best suit the farm and marketing as well as to the organizational structure of the farms in terms of production cycles to monetize the added value to offset the additional costs and realize a profit. Only a welfare strategy that is economically viable, will succeed on the market.

A comparison of slow growing (S757N), medium growing (JA757) and dual-purpose very slow-growing genotypes for the organic production system showed the higher cost of dual-purpose C, taking into account the economic evaluations of dual C on-station and on-farm trials showing low growth rates and feed efficiency. This economic evaluation interestingly pointed out that, if high-rangers were more costly than low-rangers in the slow and medium-growing genotypes, it was not the case in the dual-purpose strain considered.

For a complete economic assessment of dual-purpose genotypes, the performance (biological and monetary) of males and females should be quantified as a unit. The suitability of a given origin for any dual-purpose utilisation could, for example, be assessed using an index (Hörning, 2023).

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Annexes

Annex 1: Comparison of production costs (cash costs), total returns and profitability of rearing dual-purpose breeds (males) in Germany, France and Denmark (Euro/100 kg live weight)

	Germany						France		Denmark			
	On-station				On-farm		On-farm		On-station			
	A	B	C	JA757	C	JA757D	C (89 days)	Control (89days)	A	B	C	D
Animal purchases	22.95	28.68	31.26	27.80	19.00	33.41	15.90	33.34	21.16	24.99	24.02	30.77
Feed	225.97	236.77	216.39	177.72	598.99	423.21	201.20	143.20	192.76	191.56	188.84	152.89
Vet & medicine	2.36	2.95	3.21	1.39	1.91	1.37	8.33	5.46	2.18	2.57	2.47	1.54
Labour cost	16.29	20.35	22.18	9.79	17.83	10.37	29.82	19.54	27.13	32.04	30.80	16.57
Other	16.07	20.01	21.74	9.56	13.61	9.97	21.55	14.28	15.01	17.66	16.99	10.48
Total cash costs	283.63	308.76	294.78	226.26	651.34	478.33	276.80	215.82	258.25	268.82	263.12	212.25
Total returns	590.00	590.00	59.000	360.00	590.00	622.00	788.00	788.00	590.00	590.00	590.00	360.00
Short-term profitability	306.37	281.24	295.22	133.74	-61.34	143.67	510.70	571.68	331.75	321.18	326.88	147.75

Source: Own survey and calculations

Annex 2: Comparison of production costs (cash costs), total returns and net income of rearing dual-purpose breeds (females) in Germany and Denmark (Eurocents per egg)

	Germany						Denmark			
	On-station				On-farm		On-station			
	A	B	C	Lohmann brown+	C	Lohmann brown+	A	B	C	Dekalb white
Pullet	5.28	4.37	4.45	3.81	12.58	9.85	5.15	5.02	4.53	4.16
Feed	11.85	9.86	9.59	7.87	13.47	9.80	10.02	9.35	7.81	7.62
Vet & medicine	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Labour cost	12.41	10.71	10.33	8.81	15.51	12.15	12.03	12.31	10.51	9.57
Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fixed costs	7.96	6.58	6.70	5.75	3.62	2.83	7.12	6.93	6.26	5.75
Total returns	42.51	41.79	41.07	40.98	43.84	40.61	39.25	39.15	38.80	38.52
Total costs	37.52	31.54	31.10	26.26	45.19	34.65	34.33	33.62	29.13	27.10
Net income	4.99	10.26	9.97	14.71	-1.35	5.96	4.91	5.53	9.67	11.42

Source: Own survey and own calculations

Annex 3: PPILOW business model for using dual-purpose genotypes to reduce the culling of day-old male chicks

<table>
<tr><th>KEY PARTNERS</th><th>KEY ACTIVITIES</th><th>VALUE PROPOSITION</th><th>CUSTOMER RELATIONSHIP</th><th>CUSTOMER SEGMENTS</th></tr>
<tr><td rowspan="3">Farmers
Feed supplier
Supplier of genetics
Hatchery
Slaughterhouse
(Egg packer)

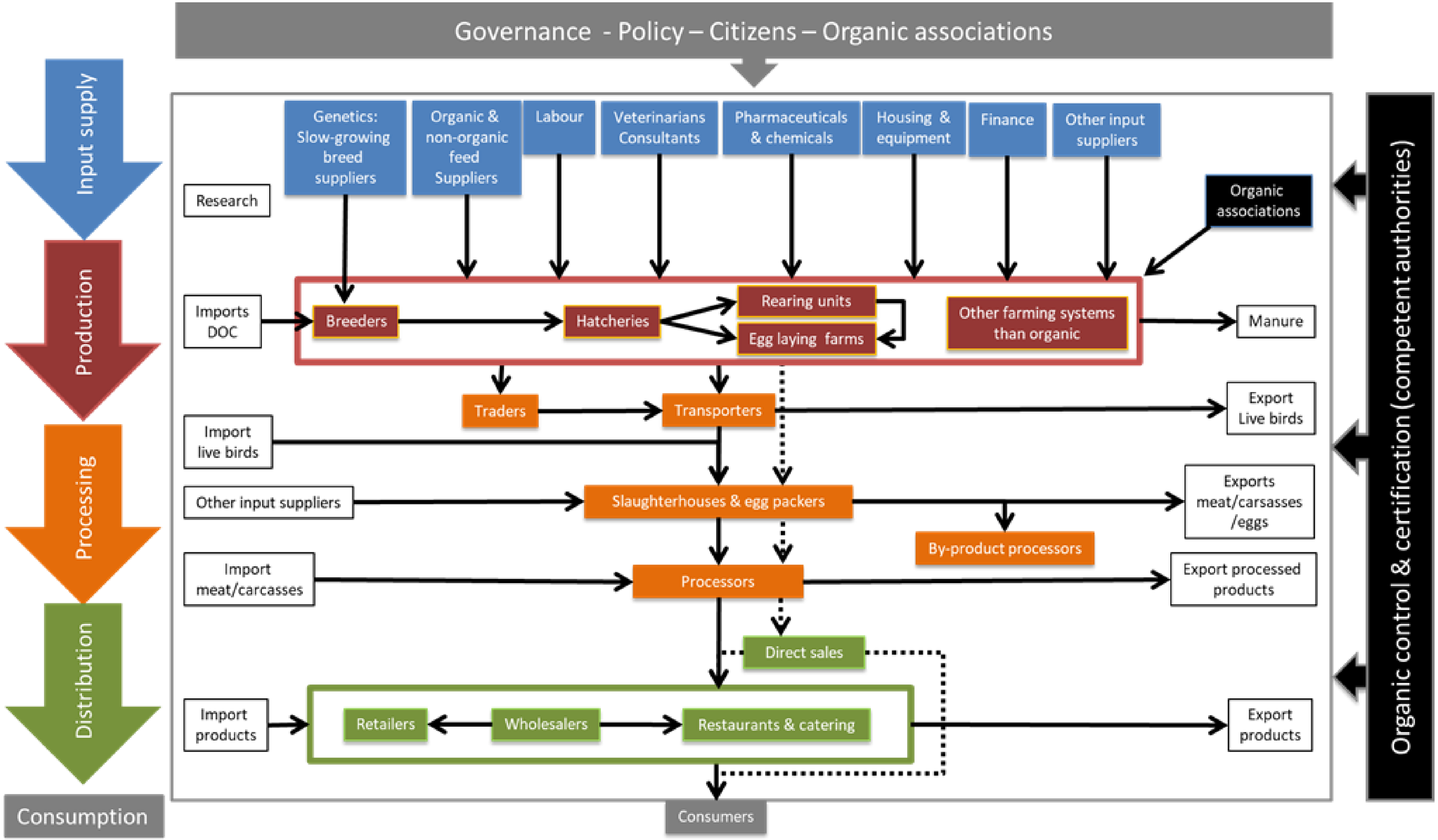
(Local) retailers, restaurants, online stores

Advisers, trainers
(Organic) certification bodies</td><td>Public´s awareness raising,ensure that genetics and special advice are available,
Educate farmers
Design diets suited to the breed and develop products on smaller birds.
Certification?</td><td rowspan="4">Higher animal welfare
No ethical problem (killing male chicks).

Premium organic eggs/chicken meat.
Ethically more sustainable organic animal products.
Animals are healthier and there are less antibiotic residues.
The birds can explore outdoors on the range and express their natural behaviors.
Welfare of animals is monitored continuously and their welfare is cared from birth to the end of their live.
Slow & local food.</td><td>Open, transparent & interactive, offering an alternative food solution
Emphasis on naturalness
Collaboration with local food stores, restaurants and aimal welfare organisations</td><td rowspan="3">Ethically conscious consumers who are in doubt regarding the mainstream farming systems.
Customers with high WTP for premium products and those paying attention to product quality.
Vegetarians who eat eggs?
Smaller households, senior citizens
Consumers, who appreciate locality.</td></tr>
<tr><td>KEY RESOURCES</td><td>CHANNELS</td></tr>
<tr><td>Better feed efficiency needed, laying and growing performance. Proper training and knowledge on management; Collaborative farmers, Knowhow & advice, Ease to obtain dual-purpose animals (supply).
R&D capacity.</td><td>Multi-channel approach: traditional routes & direct contact with customers, including online selling
Branding & awareness-raising.
Website & social media
Open days on the farm.
Multi-channel approach: traditional routes & direct contact with customers, including online selling
Branding & awareness-raising.
Website & social media
Open days on the farm.</td></tr>
<tr><td colspan="2">COST STRUCTURE
May increase production costs (enrichments, labour, planting outdoor area, foraging material). Feed price may be lower, but feed efficiency reduced.
Marketing costs, logistic costs of/in alternative chains,
Working time to use the app.</td><td colspan="2">REVENUE STREAMS
Expected price premium, possible revenues if selling directly to consumers
Regular revenue from customers who have scheduled subscriptions
Avoid some loss of revenue because of diseases
Risk: Will consumer buy small chicken?</td></tr>
</table>

Source: Own survey

Annex 4: An example of a value chain diagram.



Source: Niemi et al., 2024