Co-funded by the European Union

PRIMA SCALA-MEDI

PRIMA PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Deliverable D8.4

Report on tool demonstration at breeding centers

Due date: 31/01/2026

Lead contractor: ITELV

Partners involved: IDELE, INRA-Maroc, FISA, ODESYPANO, ESAM, INAT, NAT4

Dissemination level: PU (public)

INTRODUCTION

In order to set up breeding centers on time to produce two complete generations, founders of breeding centers had to be collected in 2024. At that time, markers for adaptation in chicken had not been yet identified. Furthermore, genotyping of different generations in chicken breeding centers was not programmed in the frame of SCALA-MEDI. Rather, it was planned to collect samples for molecular studies after a few generations, as a follow-up of SCALA-MEDI. Finally, since a breeding center is by definition located in a closed area, modeling genotype x environment interactions by regression could not be applied.

Thus, this deliverable is focusing on the tools that had to be developed to introduce fitness traits into a chicken breeding program: sensors and trap-nests. Sensors were used to record body temperature, as a proxy for adaptation to variable ambient temperatures, and trap-nests were developed to record individual egg production and monitor female fertility, as a proxy of fitness.

Then, data from the lines developed at ITELV breeding centers will be used as a pilot study to compare ranking of individuals considering different objectives (growth only or growth and fitness), and to compare growth of the two lines selected with replication in two sites differing in environmental conditions.

1) Testing of sensors

a. Tlemcen breeding center

The development of temperature sensors for chickens has been described in D2.2.

Temperature sensors were installed on July 1, 2025, on 47 adult hens from the fitness line. They were positioned under the skin, on the hens' back, at the junction of the neck and back, slightly above the wings, so as to remain parallel to the antenna, thus ensuring accurate and reliable data recording. The sensor was inserted with an appropriate device by a veterinarian (Figure 1)

a b c d



Figure 1 *- From left to right: (a) RFID and insertion device, (b) preparation of the hen (c) insertion of the RFID, (d) the RFID is visible just under the skin.*

The round antenna was placed in such a place that the hens had to go through it to reach their feed or the outdoor space. The antenna had to be moved far from the metallic materials to be able to pick up the signal. It was finally installed at the bottom of the wall at the exit to the aviary space of each family (Figure 2).

The assistance of a specialized technician was required to install the software on a local PC with wifi connection and demonstrate how to properly collect the signal of the antenna and transmission to the receiver. The following steps were taken:

- installation of the 4G modem and configuration of the WIFI security at the level of the livestock building.

- configuration of the RFID Reader (SCALAMedi03) with the WIFi key from the Modem through the reader's adminweb tool,

- finding a suitable position for the RFID reader and the Antenna to avoid interference.

- performing several communication tests with the objects (hens) equipped RFID tags (chip + antenna).

- Retrieval of results from the site:

Http://nature4cloud.org:5001/download/rfid/scalamedi03/rfid.txt

- Filtering and sorting of the text file retrieved under Microsoft Excel.

The initial commissioning allowed the identification and recording of the data of 45 out of 47 hens. Data collection started on July 7, 2025 until February 2026.

It was observed that the device temporarily interrupted recording, during power cuts or instability of the local internet network, and during rainy periods due to the accumulation of mud around the antenna carried away on the hens' feet, which required regular cleaning.

In spite of these drawbacks, the receiver could record in a continuous manner body temperature data during six months, across a large range of ambient temperatures, from +37°C in August to +2°C in January, thus demonstrating the reliability and robustness of the system for the precise monitoring of thermal variations in hens under variable environmental conditions, as encountered in Algeria.

a b c



Figure 2 – (a) Hen going through the antenna (b) signal detected (c) antenna placed between the open air space and indoor housing.

b. Baba Ali breeding center

Sensors were installed on July 14, 2025, on 48 hens. Recording took place from August to November 2025.

Antenna was either placed between the outdoor space and the inside housing, or in-house, but feed was provided on one side and water on the other side, so that hens were motivated to go through the antenna (Figure 3).

a b c



Figure 3 *- Two options to set the antenna ; (a) between outdoor and indoor ; (b) signal detection ; (c) between feeding space and water space. Hens are going through the antenna.*

c. Data collected

In Tlemcen, 196,957 datapoints were collected from 45 RFID sensors out of the 47 installed on hens of the fitness line, from July 1, 2025 to February 6, 2026.

In Baba-Ali, 13,089 datapoints were collected from the 48 RFID sensors installed on hens of the fitness line from July 16, 2025 to November, 16, 2026.

Analysis is on-going.

Hens carrying the sensors were identified with a unique number within their generation, so that their family; body weight and reproductive performance were known. Alanysis of relationships with body temperature variation is on-going.

2) Phenotyping egg production

a. Introduction

Our breeding program included a line selected for fitness where individual egg production had to be recorded (see D7.4). The use of trap-nests was an essential tool for accurate collection of laying data by family and female. At the beginning of SCALA-MEDI, not trap-nest was available at ITELV. The design and manufacture of trap-nests was first asked to a specialized supplier who designed a prototype at a cost of 2700 DA per unit (Figure 4). A high number of trap-nests was needed because natural mating was chosen for reproduction, thus, one male was housed in one space with 6 females on average, and trap-nests had to be provided to each family of the fitness line (24 in total, 4 nests per family). The manufacture of all trap-nests needed for the breeding center would have cost 350,000 DA (2600 euros). This cost was exceeding the part of the SCALA-MEDI budget that ITELV could allocate to this step, considering the costs of feed and veterinary products needed to implement the breeding program of two lines (growth and fitness) in two sites (Baba-Ali and Tlemcen). Furthermore, the prototype included a metallic door (Figure 1) which was frightening the hens so that they did not enter it spontaneously. An in-house solution was thus investigated.



Figure 4 *- First prototype of trap-nest by a supplier (length 39 cm, width 26 cm, height 28 cm) with a metallic door (19 x 24 cm) for the hen to enter.*

b. Adaptation of available rabbit nest boxes into trap-nests for hen

ITELV was already equipped with wooden nest boxes for rabbits that were solid, of similar size and that could be manufactured locally. It was decided to transform this box into a trap-nest for hen (Figure 5).

The following transformations were carried:

• Adjustment of internal dimensions in order to ensure the comfort of the hen during laying, a 15 cm extension of the length of the rabbit nest boxes was performed by adding a net that was attached by fasteners to the wire mesh separating each sire family;

• Installation of a 'swinging' door trap of 20 x 20 cm, made of plexiglass (3-5 mm thick), allowing the autonomous closure of the nest after the hen had entered and preventing exit before hen identification and egg collection;

• Improved ventilation, in order to limit humidity and promote hygiene, guaranteed by the extension of the trap-nests by the net (total height of the nest is 27 cm)

• Layout of the bottom of the nest, using suitable materials to improve comfort and reduce egg breakage by straw-based bedding.

All the modifications were carried out with simple and locally accessible materials.

The in-house trap nests made it possible to reach our objectives:

• Reliable individual identification of hens, providing full pedigree information;

• Regular and accurate collection of egg-laying data;

• Significant reduction in investment costs;

• Respect of animal welfare (no cages) thanks to regular collection.

a b



c d e f

Figure 5 *- Adaptation of rabbit nest boxes into trap-nests for hens: (a) initial box; (b) checking dimensions for hens; (c) extension of nest with a net; (d) fastening the extension to the wire mesh separating sire families; (e) hen in a nest; (f) egg collection and identification.*

c) Conclusion

The conversion of rabbit nest boxes into trap-nests for laying hens has proven to be a technically functional and economically advantageous solution. This approach has made it possible to achieve the objectives of the breeding programme while optimising the use of available financial resources. It is therefore a relevant alternative to the design of custom-made trap nests by a specialized supplier and can be recommended for any chicken breeding center with limited financial resources. However, human resources are needed for daily egg collection, which is time-consuming.

In the future, the use of electronic trap-nests would be desirable, taking advantage of the possibility to identify hens with RFID chips, as demonstrated with the use of sensors. Such nests, currently

being tested by breeding companies, would also allow the hen to exit the nest by herself after egg laying has been detected and associated to the hen RFID number. Thus, a lower number of nests would be used and the hen would remain a shorter period of time in the nest. Yet, buying such nests would require a significant investment.

3) Comparative ranking of sires of the fitness line with or without egg production data

a. Method

Within-sire selection was applied for the first two generations of the 'growth' line and 'fitness' line at ITELV breeding center. The purpose of the within-sire selection was to preserve the genetic diversity of all founder origins (see D7.4). Then, for the growth line, candidate sires were ranked on the within-sire-batch deviation for body weight at 12 weeks, irrespective of egg number of the dam, since no trap-nest was used in this line. For the fitness line, trap-nest were used, and candidate sires were taken from the dam family with the highest egg number during reproduction period, then they were ranked on the within-sire-batch deviation for body weight at 12 weeks within their dam family.

In order to assess the impact of using trap-nests for improving egg number, as a proxy of fitness, as well as growth, we compared the ranking of sires selected either on growth only (S1 scenario) or selected on dam egg number and on growth (S2 scenario). Calculations were done on the real data collected for dam egg number and body weight at 12 weeks in generations 1 (G1) and 2 (G2) of the fitness line at the Baba-Ali site of the ITELV breeding center.

b. Results

Consequences of applying scenario S1 or S2 for selecting sires are shown in Table 1, on male body weight at 12 weeks of age and dam egg number. Ignoring dam egg number for sire selection (S1) would have led to a higher selection differential on body weight (166 g instead of 111 g for a mean

body weight of 793 g) and a smaller selection differential on dam egg number (3 eggs instead of 6.5 eggs out for a mean egg number of 22). Thus, taking into account dam egg number (S2) led to higher selection pressure on egg number, still keeping a positive differential on body weight, representing a loss of 5% relatively to the mean body weight (difference (S2-S1) for body weight 1 at 12 weeks of age in Table 1).

Table 1- Comparison of male body weight at 12 weeks of age and dam egg number according to the selection scenario, S1 considering only body weight or S2 considering dam egg number and growth, using data from the fitness line selected in Baba-Ali site of ITELV.

generation 1	dam egg number during reproduction	BW 12 weeks (g)	S1: BW12 of sires selected on growth	dam egg number of S1 sires	S2: BW12 of sires selected on dam egg number and growth	dam egg number of S2 sires
number of recorded animals	58	182	12	12	12	12
mean	22.3	793	958	25.3	903	28.8
standard deviation (std)	8.1	155				
deviation from average			166	3.0	111	6.5
difference (S2-S1) in % of mean	0.16	-0.07				
difference (S2-S1) % of std	0.44	-0.36				
generation 2						
number of recorded animals	49	227	12	12	12	12
mean	22.67	891	1133	26.1	1085	32.5
standard deviation (std)	9.25	172				
deviation from average			242	3.43	194	9.83
difference (S2-S1) in % of mean	0.28	-0.05				
difference (S2-S1) % of std	0.69	-0.28				

These are theoretical results, assuming that all selected sires were indeed used to produce the next generation. In the real situation, scenario S2 was applied, but phenotypic trends on body weight and on egg number from G1 to G2 did not show any improvement in egg number, whereas average performance of candidate males showed an increase in body weight at 123 weeks of age, from 793 g (G1) to 891g (G2).

This lack of improvement of egg number may have two reasons:

- some sires had to be replaced, mainly because of mortality, so that the realized selection differential differed from the values calculated in Table 1.

- Egg number is generally less heritable than body weight, so that selection response will be slow, in spite of a selection differential representing 0.8 phenotypic standard deviation.

Egg number was also observed as being positively correlated with number of chicks, as expected for a fitness trait

c. Conclusion

Using trap-nests in the selection process of the fitness line makes it possible to increase the selection differential on egg number, with some loss on selection differential of body weight which still remains positive. Thus, current results are encouraging on the possibility to improve egg number without a marked degradation of body weight in the fitness line.

After generation 2, we may remove the constraint of within-sire selection, considering that initial founder origins have been sufficiently mixed. This would make it possible to increase selection pressure, using an optimization method to maintain diversity while increasing selection intensity.

4) Perspectives

Results from D6.2 on landscape phenomics led to recommend the addition of shank-diameter in the selection process, as a proxy for climate adaptation. This trait has been added to the phenotyping process at generation 2.

Results from sensors on body temperature variation will be interesting to consider, particularly to look at possible phenotypic correlations with egg number and body weight on the subset of tested hens.

Selection signatures are being currently analyzed on local chickens of Algeria, which may open the possibility to include additional information from molecular markers. Yet, this would require systematic blood sampling, DNA extraction and array genotyping at each generation to set up a meaningful reference population. Additional budget will be necessary if ITELV plans to continue in this direction.

5) Conclusions

ITELV has successfully tested sensors for body temperature and has developed a trap-nesting device which makes it possible to take into account egg number in the selection process. This represented a great effort and manpower dedication. New innovations are expected to be produced as a result of studies initiated by SCALA-MEDI, but a continuous effort will be needed to benefit from these.