Mapping traditional poultry hatcheries in Egypt

AHBL • Promoting strategies for prevention and control of HPAI
Mapping traditional poultry hatcheries in Egypt

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## Contents

**PHOTOS** ........................................................................................................................................... 1  
**TABLES** ........................................................................................................................................ 2  
**FIGURES** ....................................................................................................................................... 2  
**ACRONYMS** ................................................................................................................................. 2  
**ACKNOWLEDGEMENTS** ............................................................................................................... 3  
**SUMMARY** ................................................................................................................................... 4  
**ARABIC SUMMARY** ..................................................................................................................... 5  
**INTRODUCTION** ............................................................................................................................. 6  
**METHODOLOGY** ............................................................................................................................ 8  
**FINDINGS** ................................................................................................................................... 10  
  - Overview of the Traditional Hatchery .......................................................................................... 10  
  - Transport Management of Eggs and DOBs .................................................................................. 15  
  - Eggs Transport .............................................................................................................................. 15  
  - Dob Transport .............................................................................................................................. 15  
  - Control Hatcheries ......................................................................................................................... 16  
  - Baladi Ck and Dk Movement Network ......................................................................................... 17  
  - Gharbia Governorate THS .......................................................................................................... 19  
  - Fayoum Governorate THS ........................................................................................................... 22  
  - Sohag Governorate THS .............................................................................................................. 24  
  - Performance of THS ..................................................................................................................... 26  
  - Disease Risk Factors .................................................................................................................... 27  
  - Genetic relationships among different H5N1 isolates ................................................................. 33  
**LIMITATIONS TO THE SURVEY** ................................................................................................. 36  
  - Time of survey ............................................................................................................................. 36  
  - Information Feedback ................................................................................................................... 36  
**DISCUSSION AND RECOMMENDATIONS** .............................................................................. 38  
**REFERENCES** ................................................................................................................................. 41  
**ANNEXES** ................................................................................................................................... 43  
  - Annex 1: Survey Questionnaire for Traditional Hatcheries .......................................................... 43  
  - Annex 2: BLAST 2 Sequences results ............................................................................................ 47  

### Photos

**Photo 1** (A) Dome shaped, Interior Capture, (B) Mid-Passage in-between Egg-Houses. ................................. 10  
**Photo 2** Upper unit of Egg House, notice Central Manhole to the Lower Unit, Feathers and Egg Racks. .......................................................... 11  
**Photo 3** Ventilating Holes in (A) Egg House, (B) Mid-Passage. ............................................................. 11  
**Photo 4** Recently built TH (hatched DOBs in Qasaba –Left) ....................................................................... 12  
**Photo 5** Modified or Semi Hatchery (A) control unit, (B) Hygrometer, (C) Hatching Stage, (D) Egg Turning. ................................................................................................................................. 13  
**Photo 6** (A) Measuring egg temperature, (B) Egg Candling (C) Egg Turning, (D) Warming eggs. .................................................................................. 14  
**Photo 7** Transportation of egg (A) AND Day Old Chicks (B) ................................................................... 16  
**Photo 8** Door to door distributors. ........................................................................................................ 16  
**Photo 9** Strict traffic cleaning and Disinfection .................................................................................... 17  
**Photo 10** Pure Fayoumi breed raised by Exthar Eldawagen Project. ......................................................... 37
Tables

TABLE 1 ACCESSION NUMBERS, NAMES, HOSTS, LOCATIONS AND TIMES OF COLLECTION OF SELECTED H5N1 ISOLATE SAMPLES ..........9
TABLE 2 ORIGIN OF EGGS FOR INCUBATION (PERCENTAGE) AND TOTAL WEEKLY NUMBER OF EGGS HATCHED BY THE 84 SELECTED HATCHERIES IN THREE GOVERNORATES ......................................................18
TABLE 3 DESTINATION FOR DAY OLD BIRDS (PERCENTAGE) AND TOTAL WEEKLY NUMBER OF DOB DISTRIBUTED BY THE 84 SELECTED HATCHERIES IN THREE GOVERNORATES ..................................................................................18
TABLE 4 COMPARISON OF ESTIMATED HATCHABILITY (%) BETWEEN TRADITIONAL AND MODERN HATCHERIES .....................26
TABLE 5 WEEKLY ECONOMIC LOSSES OF THS COMPARED WITH MODERN HATCHERIES .................................................27
TABLE 6 DISTANCE OF 84 SELECTED TRADITIONAL HATCHERIES TO OTHER FACILITIES (IN PERCENT OF OCCURRENCE) ............28
TABLE 7 NUMBERS OF THS INCUBATING SINGLE OR MIXED EGG SPECIES ...........................................................................28
TABLE 8 CIRCULATION OF RACKS BETWEEN THS AND EGG PRODUCING FARMS .................................................................28
TABLE 9 LITTER REMOVAL FREQUENCY ..................................................................................................................................29
TABLE 10 SANITATION OF VEHICLES USED TO TRANSPORT EGGS AND DOBS .......................................................................29
TABLE 11 SANITATION OF DOB BASKETS. ..................................................................................................................................30
TABLE 12 SANITATION PRODUCTS USED .................................................................................................................................30
TABLE 13 DISPOSAL OF HATCHERY WASTE. ..............................................................................................................................30
TABLE 14 USE OF VETERINARY SERVICES ...............................................................................................................................31
TABLE 15 ADVICE TO DOB PURCHASERS AND FEEDBACK TO EGG PRODUCERS .................................................................31
TABLE 16 VACCINATION AND TREATMENT OF DOBs ...............................................................................................................31
TABLE 17 REARING OF BIRDS BY THE THS ..............................................................................................................................32

Figures

FIGURE 1 MAP OF EGYPT WITH THE SURVEYED GOVERNORATES .........................................................................................7
FIGURE 2 THE CONTRIBUTION OF EACH GOVERNORATE WITH BALADI EGGS ...........................................................................18
FIGURE 3 THE CONTRIBUTION OF EACH GOVERNORATE PURCHASING DOB ..............................................................................19
FIGURE 4 SURVEYED 32 THS IN GHARBIA GOVERNORATE .........................................................................................................20
FIGURE 5 LOCATIONS OF EGG SUPPLIERS TO AND DOB PURCHASER FROM GHARBIA THS ........................................................21
FIGURE 6 SURVEYED 30 THS IN FAYOUM GOVERNORATE ...........................................................................................................22
FIGURE 7 LOCATIONS OF EGG SUPPLIER TO AND DOB PURCHASER FROM FAYOUM THS ..............................................................23
FIGURE 8 SURVEYED 22 THS IN SOHAG GOVERNATE ................................................................................................................24
FIGURE 9 LOCATIONS OF EGG SUPPLIER AND DOB PURCHASER FROM SOHAG THS .................................................................25
FIGURE 10 PHYLOGENETIC ANALYSIS OF HAEMAGGLUTININ GENE OF SELECTED EGYPTIAN H5N1 ISOLATES .........................34
FIGURE 11 GEOGRAPHICAL DISTRIBUTION OF SELECTED H5N1 VIRUSES ISOLATED IN EGYPT FROM 2006 TO 2008. THE TWO PRE-PANDEMIC STRAINS ARE SURROUNDED BY RED CIRCLES. THE ABV24031 VIRUS IS NOT SHOWN AS ITS GEOGRAPHICAL LOCATION IS NOT KNOWN ..................................................................................................................35

Acronyms

AGAP Livestock Production Service Of The Animal Production And Health Division
AI vac Inactivated Avian Influenza Vaccine
CK Chick
CLEVB Central Laboratory For Evaluation Of Veterinary Biologics
DHV Duck Virus Hepatitis Virus
DK Duck
DOB One Day Old Birds (Either Chick Or Duckling)
DOC Day Old Chick
DOD One Day Old Duck
ECTAD FAO Emergency Centre For Transboundary Animal Diseases
FAO Food And Agriculture Organization Of The United Nations
GOVS Egyptian General Organization Of Veterinary Services
HO Hatchery Owner
LE Egyptian Pound (one LE=0.185 US dollar at the period of study).
OIE World Organization Of Animal Health
SPF Specific Pathogen Free
TH Traditional Hatchery
TOR Terms Of Reference
WHO World Health Organization
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Summary

This study was carried out in response to periodic reoccurrence of highly pathogenic avian influenza (HPAI) in Egypt, especially in backyard birds and humans and despite significant control efforts. Its objective was to develop a database of traditional hatcheries (THs) in Egypt and identifying their role in supplying genetic stock to the rural sector. A total of 84 THs were surveyed in the governorates of Gharbia (32 THs), Faiyoum (30) and Sohag (22) in July and August 2008. Nearly all the surveyed THs incubate Baladi chicken (CK) eggs, from improved breeds resulting from the crossing of native with exotic breeds, and/or pure Peking or hybrid duck (DK) eggs. About 510 000 day-old chicks (DOCs) and 192 300 day-old ducklings (DODs) were produced weekly during the study period.

There is clear seasonality in TH productivity, with high operating capacity in the winter season (January to April) along with significantly increased hatchability resulting in periods of intense rearing of growing birds. The main source of the CK eggs incubated in the surveyed THs is Qalyubia governorate (supplying 69.7 percent) followed by Faiyoum (24.3 percent) and Gharbia governorates (3.0 percent). DK eggs come from Gharbia (38.5 percent), Beheira (26.7 percent), Sharqia (14.6 percent) and Qalyubia (11.9 percent) governorates. Of the total DOCs produced, 40 percent are nursed in Faiyoum governorate, 30 percent in Sohag and 10 percent in Quena; 32 percent of the total DODs produced are nursed in Gharbia, 30 percent in Faiyoum and 13 percent in Beheira. In the surveyed THs, the hatchability percentages of both types of egg are significantly lower than those in modern hatcheries incubating the same types of egg, in both the winter and summer seasons. Hatchability decreases significantly in summer for both egg species in the THs. Weekly losses due to decreased hatchability are estimated at 66 810 DOCs and 32 499 DODs.

Regarding disease risk factors, none of the THs are organized for a one-way flow of products, workers, air and traffic from clean to dirty zones. The sun-dried mud bricks used to build most of the THs allow disinfection by fumigation only. Of the THs surveyed, about 21 percent are located within 500 m of water canals, 32 percent within 500 m of poultry farms, 75 percent within 500 m of poultry hatcheries, and 83 percent within 500 m of paved roads. About 20 percent incubate both CK and DK eggs at the same time. The turning of eggs with unprotected hands, the circulation of egg racks among THs and egg producing farms, and the lack of disinfection of the vehicles used to transport both eggs and day-old birds (DOBs) facilitate the transmission and dissemination of infectious agents across virtually all the locations involved in producing chickens and ducks. This was confirmed by the 100 percent similarity of the haemagglutinin genes of H5N1 viruses isolated simultaneously from north and south Egypt.
الخسارة المعيشية

نظرًا لانتشار مرض أنفلونزا الطيور المعدى في مصر وتكرار حدوث الإصابة في الطيور المنزلية كتلك الإصابات البشرية في العامين المنكبين، تم دراسة عدد 84 مزرعة بلدي تمثل 22 مزرعة مجمعية سوهاج. ووجد أن هذه المفخاخات تنتج كالة دجاج محلية في غرب مصر بين المساكن المحيطة، وكذلك تنتج بط بكيني نقي أو هجين بين البكيني والكاميل. ويلعب أنتاج هذه المفخاخات نحو نصف مليون كوكب.

دجاج بوم و92 ألف بط بيضاء أُنتجت يوم أسبوعي أثناء فترة الدراسة في شهر يوليو واستمرت لمدة 73.9 ألف كوكب دجاج بط بوم على التوالي أسبوعًا أثناء فترة الدراسة. أوضحت الدراسة أن محافظة القليوبية تعتبر المصدر الرئيسي لبعض الفترات تاريخ دجاج البيض في المفخاخات تحت الدراسة وذلك بنسبة 69.7% منهامحافظة الفيوم والغربية بنسبة 13.4% و3% على التوالي. بالنسبة لبيض التنجاع الغربي بنسبة 38.5% بينما محافظة البحرية الشرقية والغربية تنتج 26.7% ، 14.6% ، 11.9% من البيض المحلى الم المصدر المفخاخ الصغيرة الميادة 100% و40% ، 30% ، 10% من كالتكرات دجاج المفخاخ من هذه المفخاخات يتم تزويدها في محافظات القليوبية، الفيوم، وقنا على التوالي. بينما 32% و13% من بط بوم المنتج يتم تزويدها في محافظات البحرية الشرقية والغربية.

وقد دراسة عوامل مخاطر الأمراض في المفخاخات البلدية وجد أن تصميم كل هذه المفخاخات لا يعتمد من المحكم، العمال، الزود أو البيانات في أنجاب واحد من المنطقة المحلية (منطقة تضمين البيض) إلى الأماكن الفيما (أنتاج الكتكوت). الطيور المصنوع من المحمي المستخدم في بناء معظم المفخاخ لا يسمح إن بتطبيق عن طريق النبض. نحو 23% ، 32% و83% من هذه المفخاخات تقع على مساحة أقل من 500 متراً من قوات بانية. مزروع دجاج، مفخاخ البلدية طريق مهده على المواصل. أيضًا من مصدر أنقاص الأمراض تقارب 3% من المفخاخات. ودار أنتاج البيض بين المفخاخات و massa A نافذ بانكوت بواسطة مركب من الفيما عبر النافذة، من الجهاز المخلو في أنتاج البط والدجاج البلدي والاستمرار في المناخة. إذا هذه المفخاخ المتوسطة الحالة خلال هذه الفترات النظرية، العلاقة بين أنفلونزا الطيور طفيفة ولكن في الأمراض الأخرى كتلك هذه الأمراض في المواضع المتنوعة المختلفة والمشاركة في تزويج هذه الأمراض من الطيور. وما يعكس هذا النشر التأريخي تقرير من شمال وجنوب البلاد، تناسب نسبة 100% ، 10% كتلك عدات تمرينة كروم أنفلونزا الطيور H5N1 في نفس التاريخ تقريبًا من شمال وجنوب البلاد، وتمتيك حالة 1% قد وجدت عدات عيزون مصنعة من فروس أنفلونزا الطيور. أظهرت الدراسة أن المفخاخات البلدية في احتجاج لتحسين وتغیر التصميم وإدارة مراحل العملية الإنتاجية ليس فقط لزيادة الإنتاج ولكن تمثل فرد أنشاء أمراض الطيور وأهمها أنفلونزا الطيور.
Introduction

Highly pathogenic avian influenza (HPAI) subtype H5N1 is an important infection for the poultry industry in many countries. The disease was first reported in Egypt in February 2006, when at least four outbreaks in poultry were reported in different governorates. Afterwards, massive outbreaks occurred simultaneously in different governorates, with great losses to the poultry industry.

H5N1 virus is of great concern to public health because of its ability to cross species and infect humans; of 51 cases of human infection reported in Egypt, 23 were confirmed deadly (WHO, 2009). The majority of these human infections is due to direct and close contact with household poultry.

The endemic situation of HPAI H5N1 in Egypt (OIE, 2008) affects not only the commercial flocks of sectors 1, 2 and 3, but also rural households throughout most governorates.

This study aimed to develop a database of traditional hatcheries (THs) in the three Egyptian governorates of Gharbia, Faiyoum and Sohag (Figure 1), focusing on the THs’ role in supplying genetic stock to the rural sector and representing central nodes in the network among egg producing farms, day-old bird (DOB) purchasers and the rural sector. The study identifies the THs’ capacity, seasons of operation, types and sources of breeds, and sanitary measures during the hatching and marketing of DOBs. Its Terms of Reference (TOR) are given in Annex 1.
Figure 1 Map of Egypt with the surveyed governorates
Methodology

A seven-page questionnaire with 55 questions was designed by the national coordinator and the national consultant to identify the capacity, operating seasons, sources and types of Baladi breeds, and sanitary practices of THs in the three governorates. The questionnaire is reproduced in Annex 1.

In July and August 2008, a survey with the questionnaire was conducted at 84 THs in the three targeted governorates: 32 hatcheries in Gharbia, 30 in Faiyoun, and 22 in Sohag. The methodology involved the participation of hatchery workers and owners to collect information about hatchery practices. Data collection allowed the exchange of technical knowledge between interviewers and hatchery workers and owners.

As well as the 84 THs, 12 commercial modern hatcheries incubating improved Baladi breeds and one government hatchery producing pure Baladi breeds were also analysed. One specific pathogen-free (SPF) farm and two hatcheries owned by large integrated poultry companies were included as positive controls for evaluating the THs’ sanitary measures.

Informal interviews were carried out with the owners of parent stock flocks producing Baladi hatching eggs (chickens and ducks), Baladi breed growers and nurseries, intermediaries and door-to-door distributors (Sarih) to gather technical information about their roles in the supply of genetic stock and the distribution of chicks and ducklings.

Data gathered from the survey were entered into a database file. SPSS analytical software version 16 (SPSS Inc.) was used to analyse the data. Simple descriptive analyses were carried out, followed by analysis of variance (ANOVA) to determine the F value and significance at $P \geq 0.05$.

The percentage contribution of each governorate as an egg producer or DOB purchaser was calculated according to the number of DOBs produced weekly by the THs at the time of data collection. The data were aggregated from the primary data.

To find the relationship among the different geographical locations involved in Baladi breed trading as egg producers, egg purchasers (THs) and DOB growers and the role of rural birds in disease transmission, a study was carried out on the genetic relationships of about 37 HPAI H5N1 viruses, selected on the basis of differences in geographical location, time of isolation and host, in addition to the two World Health Organization (WHO) recommended pre-pandemic vaccine strains. The sequences of haemagglutinin gene (surface glycoprotein) were collected from the United States National Centre for Biotechnology Information (NCBI) Influenza Virus Resource. The similarity percentage was calculated using the Blast 2 sequence (Annex 2). A multiple alignment and distance-based neighbour joining phylogenetic tree was generated using the Molecular Evolutionary Genetic Analyses (MEGA) software version 4 (Tamura et al., 2007). The accession numbers, virus names, hosts and dates of collection of selected viruses are shown in Table 1.
Table 1 Accession numbers, names, hosts, locations and times of collection of selected H5N1 isolate samples

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Findings

Overview of the traditional hatchery
In order to understand the role and efficiency and manage the risks of Egyptian traditional poultry hatcheries as producers and suppliers of DOBs for the rural sector, it is important to describe and refer to the hatchery structure, operations and workers, the eggs incubated and the management of both egg and DOB transport.

TH structure
Most THs are dome-shaped structures. The foundations are of red bricks, while the rest of the building is of sun-dried mud bricks, which assist isolation and temperature regulation. The hatchery is divided longitudinally into two sections of egg houses (or ovens) with a mid-passage (called the Qasaba) between them (Photo 1). The Qasaba floor is concrete, to facilitate cleaning and disinfection, and is covered with a layer of wood shavings where the hatched birds are left until dispatch to dry and fluff out. The shavings minimize leg deformities resulting from the birds slipping.

Photo 1 (A) Dome shaped, interior capture, (B) mid-passage in-between egg-houses.

On each side of the Qasaba, there are three to 13 egg houses, each approximately 3.5 m wide and long, and 3 m high. Each egg house (bait or oven) is divided into two levels (upper and lower units) by a wooden platform.
Each unit has a separate entrance (called the Moadem), and a trap door (the Friz) between the upper and lower units that allows workers to slip from one unit to the other to set and turn the eggs (Photo 2). The floor of each unit is covered with a layer of wood shavings and either straw or a plastic carpet (called the Iasa). These protect the eggs from damage during the turning process and prevent the hatched birds from slipping.

The roof of each egg house is humped in shape with a central hole (called the Razona) for ventilation and heat regulation (Photo 3). Two or three rooms connected to the hatchery provide workers’ rest rooms and storage.

Recently built THs are made of red bricks, with walls lined on both sides with gypsum that act as a heat isolator; the ceilings are flat and made of wood. All other features and dimensions are the same as for older THs (Photo 4).
Photo 4 Recently built TH (hatched DOBs in Qasaba –left)

Modified or Semi-automatic hatcheries
Owing to limited financial resources and the high cost of modern hatcheries, which ranges from 200,000 to 650,000 LE for machines with capacity for 115,000 chicken (CK) eggs, some hatchery owners in Berma village, Gharbia governorate have converted the TH rest and storage rooms into egg setting and hatching units similar to those in modern hatcheries.

These rooms are made of red brick. Eggs are set on metal trolleys, each carrying about 5,000 CK eggs. Depending on the size of the room, it may contain four or more trolleys. All the eggs on one trolley are turned manually at the same time, using a metal bar (Photo 5d). Heat is generated by flaming petrol gas and temperatures are controlled by a thermostat, which activates the flaming petrol gas in suboptimal temperatures or operates a suction fan when the temperature gets too high. Relative humidity is measured by a hygrometer (photo 5B). The hatching stage takes place in a separate room, to which eggs are transferred in plastic or metal baskets three days before hatching (Photo 5c).

TH operations
THs usually operate throughout most of the year, with a break of one to three months for rest, thorough cleaning and disinfection, usually starting in September or December.

Before starting incubation, the egg house is warmed with electric lamps, as in all the surveyed hatcheries in Sohag governorate, or petrol lamps, as in Gharbia and Faiyum governorates. Petrol lamps are preferred in these governorates because they are cheaper to run, easier to adjust for temperature control, movable to the coldest areas inside egg houses, and not at risk from the frequent power cuts that effect the electricity supply.

Each hatchery contains eggs and birds at different stages of production, with one of its egg houses starting a new production cycle every three days or more. The capacity of each lower or upper unit is 4,000 to 5,000 CK eggs or 2,000 to 2,500 duck (DK) eggs.

Hatching of all the eggs starts in the upper unit (Photo 2) then either all are incubated in the lower unit or divided equally between both units. The units are warmed for 12 or 14 days for CK or DK eggs respectively (Photos 2 and 6D). Warming is stopped when the embryos’ organs are complete and the embryos are producing enough of their own internal heat to continue the incubation process (Wilson, 2008; Berry, no date).
The hatchery worker judges when the egg has reached the proper temperature by placing it in his/her eye socket (Photo 6A). Excessive egg temperature is reduced by spraying the eggs with warmed water from a perforated plastic bottle or the mouth. DK eggs of 14 days or more are routinely sprayed two to four times a day until they hatch, because they produce more internal heat than CK eggs, especially when there is an abnormal increase in the size of the air sac. No instruments are used to measure either temperature or humidity.

The eggs are turned by hand two to four times a day, until two to three days before hatching (Photo 6C). The process of candling is used to identify infertile and/or dead eggs at five to seven days of incubation, using a simple wooden box – the candler (Photo 6B) – with an electric lamp inside and a small hole in one side to emit light. Working in the dark, the hatchery worker holds each of the eggs up to the light of the candler to observe its contents. Hatched birds are transferred to the mid-passage (Qasaba) to dry and await dispatch (Photo 1B).
TH worker

In Arabic, the word for hatchery worker is Bermawy, which means “man from Berma village”. A large hatchery of at least eight egg houses needs two workers, and a smaller hatchery needs a chief worker and an assistant. Most hatchery workers have obtained no or only a low level of education.

It was noticed that all the surveyed THs in Faiyum and Sohag governorates are operated by workers from Sanabu or Kamboha, two small villages in the Dairot district of Asyut governorate. All the hatchery workers in Gharbia are from Berma village, where skilful incubation has long been the specialty of a group of old families who mastered and guarded the techniques of their profession, passing them from one generation to the next.

TH owners

All the TH owners hope to switch to automatic incubation methods owing to the higher percentage of hatchability, better quality of DOBs and higher price for DOBs that these methods allow. Owners attributed the low hatchability of eggs and the poor quality of DOBs mainly to the low quality of eggs purchased or the carelessness of hatchery workers. Owing to their limited awareness of hygiene measures and the lack of veterinary consultancy, owners invest in expenditures that bring direct returns, rather than those whose returns are less immediate, such as disease prevention or control.
Breeds incubated by TH
None of the surveyed THs incubate geese or turkey eggs. They incubate only DK and/or Baladi CK eggs.

CKs incubated by TH
All the surveyed THs incubate the improved native breeds that have been developed since the mid-1940s from crossbreeding the native breeds Faiyoumi, Baladi, Dandarawy and Saini with the exotic breeds White Leghorn, Rhode Island Red, Plymouth and Isabrown (Hosny, 2006). Owing to the continuous and uncontrolled crossbreeding among the resultant improved breeds (Dokki 4, Mandarh, Baheig, Matrouh, El-Salam, Golden Montazh and Silver Montazh) by the producers of eggs for hatching there are no clear definitions of different types of these breeds, which are all referred to as improved Baladi or meshaarre.

CKs incubated by modern hatcheries
Most of the surveyed modern hatcheries incubate either the improved Baladi breeds that are used in egg production in the rural sector, or the first generation Shamort type used for meat production. This hybrid is a result of crossbreeding between the improved Baladi breed and exotic Sasso and/or Shaver breeds. Most first-generation CKs are raised in farms in sector 3, with a few raised in sector 2. The Shamort CK is similar in shape to the Baladi CK, but weighs 1.6 to 2 kg after about two months of fattening.

DK incubated
All traditional and modern hatcheries incubate either pure Peking ducks or a hybrid resulting from crossbreeding between Peking and Khaki Campbell. This hybrid is called Peking when the hatched ducks are white or Baladi when they are mottled with black patches. The latter is similar in shape to the native Sudani breed but has better egg production and food conversion rates. Some THs in Gharbia governorate incubate Muscovy and mallard breeds.

Transport management of Eggs and DOBs

Eggs transport
The eggs for hatching are transported at night from the parent flock farms to the hatcheries on the back of open pickup trucks. Each truck carries up to 30 000 CK or 15 000 DK eggs (Photo 8A), which are protected with a waterproof cover. The distance to the TH may be as long as 700 km or more (for example, between Qalyubia and Sohag governorates) and the journey may last more than ten hours. Inexperienced or unmotivated drivers, poorly ventilated egg trucks and rough roads may result in poorer-quality eggs for incubation. It was noticed that some egg transporting vehicles are contaminated with debris, feathers, litter shavings and faecal matter.

DOB transport
DOB s are collected in plastic baskets or boxes by unprotected hands. Each basket may carry up to 100 day-old chicks (DOCs) or 50 day-old ducklings (DODs). The baskets of DOBs are transported in open pickup trucks, protected by a water-proof cover (Photo 8B).
Each truck may carry up to 14,000 DOCs or 6,000 DODs. Apart from the 1 or 2 percent that may be sold directly to villagers in neighbouring houses, all the DOBs produced are transported to poultry growing or nursery farms, where CKs are raised until they weigh either 150 g (in 15 to 20 days) or 325 g (in 40 to 45 days). DKs are raised until they weigh 400 to 600, in ten to 15 days. The birds are then sold by weight to direct buyers (by a door-to-door distributor), intermediaries or traders. Door-to-door distributors usually use palm-branch crates (Photos 9A and B) or open carts (Photo 9C), and trade the birds in numbers, mainly on credit to village women, who usually choose their CKs and/or DKs on the basis of good body size, healthy appearance and colours of feather.

Photo 8 Door to door distributors.

Control hatcheries
The following observations were made during visits to the three control hatcheries used as a positive control for the study:

- A hatchery sanitation plan is part of the integrated quality control system. One of the three hatcheries is certified by the International Organization for Standardization (ISO) and has well-defined standard operating procedures and working instruction programmes. There is clear implementation and control of hygiene.

- The hatchery layout considers: 1. No mixing of eggs and birds; 2. The workers’ flow from the clean zone (egg setter) to the dirty zone (hatching unit), with foot dips at the entry, hand-washing facilities, showers and protective clothing facilities; 3. Positive pressure airflow in the clean zone where an air intake is near a dirty zone exhaust; the SPF farm passes the air through six filters, the last of which is a high-efficiency particulate air filter;
• All vehicles entering the hatchery pass through a disinfectant wheel wash and a vehicle spray using a disinfectant solution; the wheel wash is topped up regularly to avoid contamination and dilution; one commercial hatchery carries out a preliminary truck wash at a car-washing station 5 km from the hatchery with a special traffic film remover (Photo 10), and drivers are not allowed to leave their vehicles’ cabins while in the hatchery.

• Personnel are all well-trained and qualified. The SPF farm does not allow workers to eat poultry products while on the farm to avoid infection or carrying of poultry pathogens. Workers are regularly examined for microbial infections.

• There is routine microbiological monitoring of hatchery sanitation programmes. An effective rodent control programme is in place. Hatchery waste products are properly treated before disposal.

**Photo 9 Strict traffic cleaning and disinfection.**

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**Baladi Ck and Dk movement network**

There is clear seasonality in the maximum operating capacity of all surveyed THs, with the winter months of January to April having the highest hatchability, as demonstrated by the THs’ intense DOB production in these months.

Field investigations with a rural distributor and a hatchery owner in Sohag governorate revealed that DOCs are more marketable than DODs in this and neighbouring governorates. CKs are preferred because they need less feed and space to raise than DKs do. It is worth noting that nearly all the DKs raised in Sohag are bought in Asyut governorate.

Overall, Qalyubia governorate is the main producer of CK eggs for THs (with 69.7 percent of the total), followed by Faiyoum (24.39 percent) (Table 2 and Figure 2). The nucleus for DK egg production is Gharbia (38.5 percent of the total), followed by Beheira (26.7 percent), Sharqia (14.6 percent) and Qalyubia (11.9 percent).

Of all the DOCs produced by the THs surveyed, 40 percent were reared in Faiyoum governorate, followed by 30 percent in Sohag and 10 percent in Quena. Of the DODs, 32 percent were reared in Gharbia, followed by 30 percent in Faiyoum and 13 percent in Beheira (Table 3 and Figure 3).
Table 2 Origin of eggs for incubation (percentage) and total weekly number of eggs hatched by the 84 selected hatcheries in three governorates

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Number Eggs: 68 000 131 500 203 000 57 800 239 000 3 000 510 000 192 300

Figure 2 The contribution of each governorate with Baladi eggs

Table 3 Destination for Day Old Birds (percentage) and total weekly number of DOB distributed by the 84 selected hatcheries in three governorates

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Number DOB: 68 000 131 500 203 000 57 800 239 000 3 000 510 000 192 300
Figure 3 The contribution of each governorate purchasing DOB

Gharbia governorate THs
The 32 THs surveyed in Gharbia governorate (Figure 4) produced during data collection in July and August 2008 about 68 000 DOCs and 131 500 DODs a week. In order of importance, they depend on Qalyubia, Gharbia and Beheira governorates as sources of CK eggs, and on Gharbia, Beheira, Qalyubia and Kafr El-Sheikh for DK eggs (Figure 5). The purchasers of DOBs are located in 11 governorates, and intermediaries and traders also come to the TH locations to purchase (Figure 5).
### Total number of surveyed TH incubating different egg species (Capacity of thousands)

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<th>Capacity</th>
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**Figure 4 Surveyed 32 THs in Gharbia governorate.**
Figure 5 Locations of egg suppliers to and DOB purchaser from Gharbia THS
Fayoum governorate THs

The 30 THs surveyed in Faïyoum governorate (Figure 6) produced about 203,000 DOCs and 57,800 DODs a week in July and August 2008. They depend mainly on farms in Faïyoum as a source of Baladi CK eggs, followed by those in Qalyubia. Most duck eggs come from Sharqia and Qalyubia. Nearly all the DOBs are sold in Faïyoum (Figure 7).

Total number of surveyed TH incubating different egg species (in thousands)

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Figure 6 Surveyed 30 THs in Faïyoum governorate.
Figure 7 Locations of egg supplier to and DOB purchaser from Fayoum THs
Sohag governorate THs
The 22 THs in Sohag (Figure 8) produced about 239,000 DOCs and 3,000 DODs a week in July and August 2008. They purchase nearly all their CK eggs from Qalyubia. Their clients for DOBs are located in Sohag, Quena and Asyut governorates (Figure 9).

Figure 8 Surveyed 22 THs in Sohag Governorate

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<td>121-180</td>
<td>0</td>
<td>▲</td>
<td>81-100</td>
</tr>
<tr>
<td>121-180</td>
<td>1</td>
<td>⭐️</td>
<td></td>
<td>181-240</td>
<td>0</td>
<td>▲</td>
<td>101-120</td>
</tr>
</tbody>
</table>
Figure 9 Locations of egg supplier and DOB purchaser from Sohag THs
Performance of THs
The performance of the THs as producing units was measured by estimating the egg hatchability percentage compared with that of modern hatcheries incubating the same breeds. The hatchability percentage depends on many factors, such as the age, health and nutrition status of the producing flock, the egg storage conditions, egg transportation management, hatchery operating techniques (egg turning process, temperature and humidity control) and hatchery sanitary measure. However, the hatchability percentages of THs were significantly lower than those of modern hatcheries incubating Baladi CK or DK eggs, in both incubation seasons (summer and winter) (Table 4). In addition, the hatchability of both types of egg was significantly higher in winter than summer in the THs (Table 4). The lower hatchability in THs could be attributed to poor or irregular temperature and humidity control, inefficient turning and limited sanitary measures. The difference in percentage hatchability between the two seasons could be attributed to Egypt’s high summer temperatures (which may exceed 40 °C) affecting the productivity of the parent flock (nearly all egg producing flocks are kept in naturally ventilated buildings), the quality of eggs, egg storage, egg transportation, and temperature control in hatcheries.

Egg hatchability in Sohag THs was significantly lower, at p >0.05, than that in Gharbia and Faiyoum THs (Table 4). This could be attributed to the long distances between egg producing farms in Qalyubia and Sohag governorates, where the journey may last more than ten hours in poorly ventilated trucks and on rough roads. Another factor could be that egg houses in Sohag THs are warmed by electric lamps fixed to the walls and without fans, which may result in uneven temperature distribution.

The economic losses resulting from the lower hatchability percentages in THs compared with modern hatcheries can be estimated from the total production by THs in the period under study (Table 4).

Table 4 Comparison of estimated hatchability (%) between traditional and modern hatcheries

<table>
<thead>
<tr>
<th>Egg type</th>
<th>Season</th>
<th>Hatchery</th>
<th>No</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken</td>
<td>Winter</td>
<td>Modern</td>
<td>13</td>
<td>86.3</td>
<td>75</td>
<td>90</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traditional</td>
<td>55</td>
<td>77.3</td>
<td>65</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>Modern</td>
<td>13</td>
<td>81.7</td>
<td>70</td>
<td>85</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traditional</td>
<td>55</td>
<td>68.6</td>
<td>50</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gharbia</td>
<td>Traditional</td>
<td>7</td>
<td>75.1</td>
<td>65</td>
<td>82</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Faiyoum</td>
<td>Traditional</td>
<td>25</td>
<td>72.8</td>
<td>50</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sohag</td>
<td>Traditional</td>
<td>21</td>
<td>71.4</td>
<td>50</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Duck</td>
<td>Winter</td>
<td>Modern</td>
<td>3</td>
<td>86.3</td>
<td>85</td>
<td>89</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traditional</td>
<td>45</td>
<td>74.6</td>
<td>60</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>Modern</td>
<td>3</td>
<td>81.7</td>
<td>80</td>
<td>85</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traditional</td>
<td>45</td>
<td>64.8</td>
<td>50</td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

DOB derived from THs show more dehydration and higher mortality rates during the first week of life than modern hatchery birds. The prices of DOBs produced by THs are therefore lower than those for birds from modern or modified hatcheries.
Table 5 Weekly economic losses of THs compared with modern hatcheries

<table>
<thead>
<tr>
<th>Weekly loss of all surveyed TH incubating CK:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean difference (Table 4) between modern and TH (13.1%) X</td>
<td></td>
</tr>
<tr>
<td>Total DOC production by THs (510 x 10^3) = 66.810 X</td>
<td></td>
</tr>
<tr>
<td>Price of DOC at time of survey (1.2 LE) = 80 172 LE</td>
<td></td>
</tr>
</tbody>
</table>

All surveyed TH incubating DK:

| Mean difference (table 4) between modern and TH (16.9%) X |  |
| Total DOD production by THs (192 x 10^3) = 32.499 X |  |
| Price of DOD at time of survey (2.2 LE) = 71 497 LE |  |

Disease risk factors

Structure
The mud bricks used to build most THs allow disinfection by smoke or fumigation only. None of the TH layouts consider the one-way flow of products, workers, air and trucks from clean to dirty zones. They have no facilities for washing and disinfecting vehicles.

Distance from nearest water canal
Distance from nearest water canal
About 9.5 percent of the surveyed THs are located less than 50 m (very close) from a water canal; 78.6 percent are more than 500 m (far) away from one, and the rest are between 50 and 500 m away (close) (Table 6).

Distance from nearest paved road
About 29.8 percent of the surveyed THs are very close to, 53.6 percent are close to and 16.7 percent are far from the nearest paved road (Table 6).

Distance from nearest poultry farm
The majority of THs (67.9 percent) are more than 500 m from the nearest poultry farm; 13.1 percent are very close and 19.8 percent are close (Table 6).

Distance from nearest poultry hatchery
Of the surveyed THs, 41.7 are very close to the nearest poultry hatchery, 33.3 percent are close and 25 percent are more than 500 m away (Table 6). Nearly all the THs are surrounded by village houses, so they are very close to backyard and household birds.

Turning eggs
In all but the modified THs, eggs are turned by hand. Hatchery workers do not use protective gloves.
Table 6 Distance of 84 selected traditional hatcheries to other facilities (in percent of occurrence)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Distance*</th>
<th>Gharbia</th>
<th>Faiyoum</th>
<th>Sohag</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Canal</td>
<td>Very Close</td>
<td>6.3</td>
<td>20.0</td>
<td>0.0</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>18.8</td>
<td>3.3</td>
<td>13.6</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>75.0</td>
<td>67.7</td>
<td>86.4</td>
<td>78.6</td>
</tr>
<tr>
<td></td>
<td>Very Close</td>
<td>31.3</td>
<td>33.3</td>
<td>22.7</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>50.0</td>
<td>60.0</td>
<td>50.0</td>
<td>53.6</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>18.8</td>
<td>6.7</td>
<td>27.3</td>
<td>16.7</td>
</tr>
<tr>
<td>Paved Road</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very Close</td>
<td>31.3</td>
<td>93.3</td>
<td>86.4</td>
<td>67.9</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>40.6</td>
<td>23.3</td>
<td>36.4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>0.0</td>
<td>43.3</td>
<td>36.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Poultry Farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very Close</td>
<td>28.1</td>
<td>3.3</td>
<td>4.5</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>40.6</td>
<td>3.3</td>
<td>9.1</td>
<td>19.0</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>31.3</td>
<td>93.3</td>
<td>86.4</td>
<td>67.9</td>
</tr>
<tr>
<td>Poultry Hatchery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very Close</td>
<td>59.4</td>
<td>33.3</td>
<td>27.3</td>
<td>41.7</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>40.6</td>
<td>23.3</td>
<td>36.4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>0.0</td>
<td>43.3</td>
<td>36.4</td>
<td>25.0</td>
</tr>
</tbody>
</table>

* very close< 50m, close=50-500m, distant> 500m

Egg spraying
All the THs spray water on the eggs to control their temperature.

Mixing species
Some 36.6 percent of the surveyed THs in Faiyoum and 18.75 percent of those in Gharbia incubate both DK and CK eggs at the same time (Table 7).

Table 7 Numbers of THs incubating single or mixed egg species

<table>
<thead>
<tr>
<th>Type of eggs</th>
<th>Faiyoum No.</th>
<th>Faiyoum %</th>
<th>Gharbia No.</th>
<th>Gharbia %</th>
<th>Sohag No.</th>
<th>Sohag %</th>
<th>Total No.</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>14</td>
<td>46.6</td>
<td>3</td>
<td>9.4</td>
<td>21</td>
<td>95.5</td>
<td>38</td>
<td>45.2</td>
</tr>
<tr>
<td>DK</td>
<td>5</td>
<td>16.6</td>
<td>23</td>
<td>71.9</td>
<td>1</td>
<td>4.5</td>
<td>29</td>
<td>34.5</td>
</tr>
<tr>
<td>Both</td>
<td>11</td>
<td>36.6</td>
<td>6</td>
<td>18.7</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>20.3</td>
</tr>
</tbody>
</table>

Footwear disinfecting at entrance
No TH has a footbath at its entrance

Circulation of egg racks
Racks are routinely circulated between the TH and egg producing farms by 63.09 percent of the THs, and sometimes circulated by 16.7 percent (Table 8).

Table 8 Circulation of racks between THs and egg producing farms

<table>
<thead>
<tr>
<th>Circulation of racks</th>
<th>Faiyoum Number</th>
<th>Faiyoum %</th>
<th>Gharbia Number</th>
<th>Gharbia %</th>
<th>Sohag Number</th>
<th>Sohag %</th>
<th>Total Number</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routinely</td>
<td>22</td>
<td>73.3</td>
<td>22</td>
<td>68.7</td>
<td>9</td>
<td>40.9</td>
<td>53</td>
<td>63.1</td>
</tr>
<tr>
<td>Irregularly</td>
<td>7</td>
<td>23.3</td>
<td>4</td>
<td>12.5</td>
<td>3</td>
<td>13.6</td>
<td>14</td>
<td>16.7</td>
</tr>
<tr>
<td>Never</td>
<td>1</td>
<td>3.3</td>
<td>6</td>
<td>18.7</td>
<td>10</td>
<td>45.4</td>
<td>17</td>
<td>20.2</td>
</tr>
</tbody>
</table>

Litter removal
Wood shaving litter should be removed from the mid-passage regularly at every hatch, but only 21.4 percent of the surveyed THs do so (Table 9).
Table 9 Litter removal Frequency

<table>
<thead>
<tr>
<th>Removal of litter</th>
<th>TH Fayoum</th>
<th>TH Gharbia</th>
<th>TH Sohag</th>
<th>Total No.</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular removal</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>18</td>
<td>21.42</td>
</tr>
<tr>
<td>irregular</td>
<td>26</td>
<td>21</td>
<td>19</td>
<td>66</td>
<td>78.57</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>32</td>
<td>22</td>
<td>84</td>
<td></td>
</tr>
</tbody>
</table>

Use of rotational disinfection program
Only four of the 84 THs disinfect the hatcheries using different disinfectants in a rotation.

Presence of retail poultry equipments
About 10.7 percent of the surveyed THs retain equipment used to distribute birds.

Microbial monitoring
None of the surveyed THs monitor the implementation of sanitary measures.

Sanitation of transport vehicles
About 15 percent of the surveyed THs do not sanitize the vehicles used to transport DOBs; 10.7 percent do so after every delivery; and 71.4 percent at irregular intervals (Table 10).

Table 10 Sanitation of vehicles used to transport eggs and DOBs

<table>
<thead>
<tr>
<th>THs</th>
<th>Sanitation of egg transport</th>
<th>Sanitation of DOB transport</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Every delivery</td>
</tr>
<tr>
<td>Gharbia</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Fayoum</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Sohag</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>Percentage</td>
<td>32.1</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Egg transporting vehicles are sanitized after every delivery by 8.3 percent of the surveyed THs, weekly by 1.2 percent and irregularly by 58.3 percent (Table 10). None of the surveyed THs uses disinfectant to sanitize the vehicles, but only detergents (Table 12).

It was noticed that two or three hatchery owners in Bardis, Balina district, Sohag governorate purchase CK eggs from the same egg producer, and use the same vehicles, to minimize transport costs. This sharing of an egg source allows them to judge both the quality of the eggs purchased and the skill of the hatchery workers.

Sanitation of DOB baskets
About 1.2 percent of the surveyed THs do not sanitize their DOB baskets (Table 11); 21.7 percent do so regularly after every delivery and the rest at irregular intervals. Only 2.4 percent of the THs use disinfectants in the sanitation process (Table 12).
Table 11 Sanitation of DOB baskets

<table>
<thead>
<tr>
<th>THs</th>
<th>Sanitation of DOB baskets</th>
<th>Frequency of sanitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Gharbia</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Faiyoum</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>Sohag</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>1</td>
</tr>
<tr>
<td>Percentage</td>
<td>91.7</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Table 12 Sanitation products used

<table>
<thead>
<tr>
<th>THs</th>
<th>DOB basket sanitation with</th>
<th>Vehicle sanitation with</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Detergent</td>
</tr>
<tr>
<td>Gharbia</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>Faiyoum</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Sohag</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>51</td>
</tr>
<tr>
<td>Percentage</td>
<td>20.5</td>
<td>61.4</td>
</tr>
</tbody>
</table>

Disposal of TH waste

In Sohag governorate, the THs can depend on daily garbage collections for the disposal of hatchery waste products (egg debris, dead embryos and litter). In contrast, more than half of the THs surveyed in Faiyoum simply dump these materials on the roads outside the villages where their egg suppliers are located. The garbage collector in Berma village, Gharbia collects hatchery waste twice a week, but may simply dispose of the waste from more than 200 THs into water canals. Some duck growers in Gharbia use unhatched eggs that have been boiled and mixed with wheat bran or crushed maize as a feed for ducklings over seven days of age (Table 13).

Table 13 Disposal of hatchery waste

<table>
<thead>
<tr>
<th>THs</th>
<th>Disposal of egg debris</th>
<th>Disposal of litter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Garbage collection</td>
<td>Water canal</td>
</tr>
<tr>
<td>Gharbia</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>Faiyoum</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Sohag</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>18</td>
</tr>
<tr>
<td>Percentage</td>
<td>53.6</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Use of veterinary services

Some 89.3 percent of the surveyed THs do not consult veterinary services about good practices (Table 14), and only 10.7 percent consult private veterinarians – none of them use official (government) services. The THs consulting veterinarians do so for diagnosis of the causes of lowered hatchability percentages and/or low-quality DOBs, to find out whether the egg producing farms or practices at the hatchery are to blame, and how to improve the performance of other incubated eggs from the same source.
Table 14 Use of veterinary services

<table>
<thead>
<tr>
<th>THs</th>
<th>No</th>
<th>Private</th>
<th>Yes</th>
<th>Official</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gharbia</td>
<td>24</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Fayoum</td>
<td>29</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Sohag</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>84</td>
</tr>
<tr>
<td>Percentage</td>
<td>89.3</td>
<td>10.7</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Advice to DOB purchaser

About 69 percent of the surveyed THs do not advise the DOB purchasers about the best conditions for rearing the birds they supply, but they do allow purchasers to select good birds (Table 15).

Feed back to egg supplier with low-quality egg.

Slightly more than 7 percent of the surveyed THs do not provide feedback to egg suppliers with low-quality eggs; instead, they change the source of eggs. The other THs inform suppliers about any quality problems, to encourage them to improve and, mainly, for compensation purposes (Table 15).

Table 15 Advice to DOB purchasers and feedback to egg producers

<table>
<thead>
<tr>
<th>THs</th>
<th>Advice to DOB purchasers</th>
<th>Feedback to egg producers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Gharbia</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>Fayoum</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Sohag</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>58</td>
</tr>
<tr>
<td>Percentage</td>
<td>16.7</td>
<td>69.0</td>
</tr>
</tbody>
</table>

Vaccination of DOBs

About 73 percent of surveyed THs vaccinate DOBs with inactivated avian influenza (AI) vaccines that are provided free of charge by Egypt’s General Organization of Veterinary Services (GOVS) (Table 16). They vaccinate DOBs with 0.2 ml of vaccine by subcutaneous inoculation. Two types of vaccines are used: the Chinese vaccine H5N1 (reassortant vaccine, prepared from A/goose/Guangdong/1/1996 HPAI H5N1 by reverse genetics); and H5N2 vaccine (prepared from A/Dk/Potsdam1402-6/1986, H5N2 low pathogenic virus strain).

Table 16 Vaccination and treatment of DOBs

<table>
<thead>
<tr>
<th>THs</th>
<th>Frequency of vaccination</th>
<th>Type of Treatment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Sometimes</td>
<td>Yes</td>
</tr>
<tr>
<td>Gharbia</td>
<td>4</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>Fayoum</td>
<td>4</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Sohag</td>
<td>14</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>Percentage</td>
<td>26.2</td>
<td>60.7</td>
<td>13.1</td>
</tr>
</tbody>
</table>

* Inactivated AI vaccine. # Antibiotic
About 10.7 percent of the surveyed THs treat DOBs with subcutaneous inoculation of antibiotics, mainly gentamycin sulfate, to minimize and control mortalities in the first week of life.

A few hatchery owners provide DOD growers with duck eggs from duck breeder flock that has recently been vaccinated with duck hepatitis vaccine, so that the growers can use the egg yolks in addition to the antibiotics for emergency control in case of duck virus hepatitis infection. THs vaccinate DOCs with Marek’s disease vaccine only if the birds are to be raised as breeders and the purchaser has requested it.

Rearing of the DOBs by the THs

Nearly 68 percent of hatchery owners that produce DOBs do not raise the young birds; 11.9 percent raise birds on farms adjacent to their THs, and 19.1 percent on the roofs of their THs. One TH owner raises chicks on a separate farm (Table17).

Table 17 Rearing of birds by the THs

<table>
<thead>
<tr>
<th>THs</th>
<th>No</th>
<th>Close to TH</th>
<th>Yes</th>
<th>On roof of TH</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gharbia</td>
<td>18</td>
<td>5</td>
<td>9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Faiyoum</td>
<td>19</td>
<td>4</td>
<td>7</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sohag</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>10</td>
<td>16</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>67.9</td>
<td>11.9</td>
<td>19.1</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

Assessment of risk factors

Because different types of DOBs are produced, the assessment of disease risk factors at THs compared with those at positive controls was done by the chi-square test based on field observations only. The expectation by chi-square was similar to the observation (data not shown). The positive control hatcheries were considered to be at low disease risk as they carry out both bio-exclusion (to prevent the introduction and spread of new infection agents into the hatchery) and biocontainment measures (to prevent the spread of current and existing pathogens within the hatchery, or their release from the hatchery; Thieme, 2007). On the traffic light system illustrated below, the control cases can be placed in the green light or safe zone.

None of the surveyed THs practised either bio-exclusion or biocontainment measures, so they can be categorized in the high-risk or red light zone.

With the partial or insufficient application of bio-exclusion and biocontainment practices by the modern and modified hatcheries (incubating Baladi eggs), they are ranked in the red or warning yellow light zones.
Genetic relationships among different H5N1 isolates

The low sanitary measures and unhygienic practices found throughout the production network motivated an investigation of the relations among different locations involved in trading Baladi breeds. This investigation was based on the different HPAI H5N1 viruses isolated in the survey locations, referring to the time of sample collection and the host of the isolates responsible for most of the human cases caused by contact with backyard birds (Saad et al., 2008).

The phylogenetic tree of the haemagglutinin gene of selected isolates (Figure 10) confirmed that there is a close genetic relationships evolving from one introduction. It showed that all the clusters of the tree contain a mixture of isolates from different geographical locations (marked with coloured symbols on the left of the isolate name). In addition to the three clusters of the Nile Delta (green diagonals), Lower Egypt (yellow squares) and Upper Egypt (dark green triangles) regions (Saad et al., 2008), a new cluster containing variant strains has evolved from the Nile Delta region (red circles). In late 2007, this new cluster also contained isolates from Quena governorate among the Nile Delta governorates, as well as two World Health Organization (WHO) recommended pre-pandemic vaccine strains.

To trace the time and location of H5N1 virus emergence and spread within the selected areas, the geographical location of each selected virus was plotted on a map of Egypt and linked to full identical viruses (Figure 11). The evolved variant virus labelled with a red circle was first detected on 3 November 2007 in Sharqia governorate, then on 18, 19 and 30 December 2007 in Qalyubia, Quena and Beheira governorates respectively. Comparing the haemagglutinin gene amino acid sequences of these four isolates showed that they are 100 percent identical (Annex 3). In spite of the long distance between Qalyubia and Quena governorates, of more than 700 km, the same virus was isolated at nearly the same time, confirming the previous finding that the viruses move freely and rapidly in the production chain.

In addition, the same 100 percent identities of haemagglutinin gene sequence were found among human isolates in Faiyoum and poultry isolates in Gharbia, Beheira, Alexandria and Giza governorates (green diagonals in Figure 10, and Annex 3). The same observation occurred in the cluster labelled with green triangles: human isolates in Sohag (which purchases 99.8 percent of its CK eggs from Qalyubia governorate), Quena (which raises 21 percent of the DOCs produced by Sohag THs) and Qalyubia (which is the main CK egg-producing governorate, Table 2) are identical. (The strain names, accession numbers, hosts, collection locations and times of collection of each isolate symbol are listed in Table 1.)
Figure 10 Phylogenetic analysis of haemagglutinin gene of selected Egyptian H5N1 isolates
Figure 11 Geographical distribution of selected H5N1 viruses isolated in Egypt from 2006 to 2008. The two pre-pandemic strains are surrounded by red circles. The ABV24031 virus is not shown as its geographical location is not known.

Figure 12 Occurrence of H5N1 outbreaks in a six-month period (higher frequency in January 2008 in different geographical locations in Egypt)

Limitations to the survey

Time of survey
July and August are considered the low season for DOB production by THs owing to hot weather, decreased egg hatchability percentages and lower DOB quality. It would have been better to carry out the survey in winter, the maximum production season.

Governorates surveyed
During the field visit to Sohag governorate, hatchery owners and distributors reported that Asyut governorate is the main supplier of ducklings for Upper Egypt governorates. There are more than 100 THs in the Dairot district of Asyut alone.

Price of poultry feed
In July 2008, there was a sharp increase in the price of formulated poultry feed, from LE 2 200 to LE 3 200 per tonne. This resulted in a situation similar to that of the February 2006 HPAI outbreak, where there was no demand for DOBs. In addition, villagers were preparing for the sacred month of Ramadan, and many owners had closed their hatcheries.

Hatchery owners
Owners are not always willing to share information about their businesses, and the advantages of participating in this survey were not often evident to them. During the 2006 HPAI outbreak, most incubated eggs and hatched birds were condemned owing to market paralysis. Hatchery owners were not compensated in the way that poultry growers and nurseries were, so they are now less willing to cooperate with authorities. The data collected were the result of knowledge exchange between the hatchery owners and the research consultant.

Hatchery records
THs’ records of egg suppliers and DOB purchasers tend to be poor. Survey results regarding the egg and DOB network should therefore be interpreted with great caution.

When the TH survey began, the ECTAD team leader in Egypt (Dr Rob de Rooij) was on annual leave. The national coordinator (Dr Zahra Ahmed) also had a three-week gap between contracts (although she followed activities over the phone) which resulted in a lack of guidance and planning at the start of the study.

Information feedback
In their 2007 report, Pagani and Kilany mention that egg houses may be divided into two or three levels. None of the THs surveyed for this study had egg houses or ovens on three levels. The same authors report that there are water containers inside the ovens to keep the humidity level high, but the researchers in this study found that the water is kept in the mid-passage, not the ovens, and is just warm. Each TH has only one water container, for wetting eggs in cases of elevated egg temperature. Hatchery workers do not have equipment for measuring relative humidity. Pagani and Kilany claim that the petrol lamp is the only heat source for warming egg ovens, but in nearly all the THs in Sohag governorate surveyed for this study electric lamps are used instead of petrol ones.

Pagani and Kilany mention that veterinary vaccines are taxed at a high rate of about 25 percent, but vaccine importers in Egypt confirmed that vaccines are exempt from tax, except for the less than 3 percent tax charged on recently registered vaccines. The same authors reported a shortage of poultry vaccines on the market, and waiting periods of several months before orders are received. In fact, there is aggressive competition among the more than 15...
companies and offices of international vaccine producers to supply vaccines to distributors and/or poultry farms directly. Therefore, most of the time, several vaccine strains for a disease are available. Occasionally, however, poultry producers face a shortage of a specific strain produced by a specific manufacturer because the market demand for that strain is higher than expected by the vaccine importer, or because of a disease outbreak either in Egypt or worldwide.

During field visit to Sohag governorate, the researchers visited the Ekthar Eldawagen Project, which raises, maintains and produces CKs of the pure Fayoumi breed. Eng Naser, the Chairperson of this project, reported that the farm had not been exposed to infection with HPAI H5N1 virus since the 2006 outbreak. This is additional information to the report prepared by Hosny (2006).

**Photo 10 Pure Fayoumi breed raised by Ekthar Eldawagen Project.**
Discussion and recommendations

Aristotle, writing in 400 BC, reported that the ancient Egyptians artificially incubated poultry eggs on a large scale in dung heaps (Nesheim Malden, Austic and Card, 1979; Parkhurst and Mountney, 1987; Grimes and Pardue, 1996; Berry, no date). The skill of incubation has been passed down the generations up to the present day (Asker, 1927; El-Ibiary, 1946; Taylor, 1949; Landauer, 1951).

All the THs surveyed in this study incubate improved CK hybrid breeds, most of which are raised by growers for two or six weeks before being sold to village women. Village households raise the CKs as a source of eggs and meat or small income. All the DK eggs incubated by THs are hybrids of crossed Peking and Khaki Campbell breeds. DKs are raised for two weeks in nurseries, before being distributed to villagers. Of the 32 THs surveyed in Gharbia governorate, 71.9 percent incubate DK eggs, 9.4 percent CK eggs and 18.7 percent both. Of the 30 Faiyoum THs, 46.6 percent incubate CK eggs, 16.6 percent DK eggs and 36.6 percent both types. In Sohag, 95.5 percent of the 22 THs surveyed incubate CK eggs and 4.5 percent DK eggs.

The network of movements of Baladi eggs to and DOBs from THs has important implications for disease invasion and spread, and studying it can provide scientific support for preventive and control measures. Qalyubia governorate provides 69.8 percent of the CK eggs used by the 84 surveyed THs, followed by 24.4 percent from Faiyoum governorate, and 3 percent from Gharbia governorate. The main source of DK eggs is Gharbia, supplying 38.6 percent, followed by Beheira governorate with 26.7 percent, and Qalyubia governorate with 12 percent.

The highest percentages of DOC growers are located in Faiyoum, with 39.8 percent, followed by 30 percent in Sohag, 10.1 percent in Quena and 6.7 percent in Asyut governorates. Gharbia governorate accounts for 32.3 percent of total DOD purchases, followed by 13.4 percent in Beheira and 4.5 percent in Qalyubia governorates.

DOBs from the THs show more dehydration and higher mortality rates in the first week of life. This reduced vitality could be attributed to inhomogeneous temperatures and relative humidity control, in addition to higher microbial load stresses resulting from a lack of sanitary practices. In the period of the study (summer 2008), the estimated losses of the 84 surveyed THs resulting from significantly decreased hatchability compared with modern hatcheries were about 66,810 DOCs and 32,499 DODs a week. In addition, the prices of DOBs produced by modern hatcheries may be 0.10 to 0.25 LE/bird higher than those for THs’ DOBs.

It is recommended that a similar study be carried out in the winter season, when HPAI incidence is higher, to estimate the maximum DOB production, and the contribution of each geographical location to the trade in Baladi birds. It is also important to survey Asyut governorate, which contains more than 100 THs and is considered the main source of ducklings for Upper Egypt governorates.

Regarding disease risk factors, the mud bricks used in building the THs permit disinfection with fumigation only. The location of THs among village houses puts them at high risk from neighbouring backyard and household birds. Gentry, Mitrovic and Bubach (1962) found that hatcheries with poor floor design and faulty traffic patterns were highly contaminated compared with those with one-way flows. It is therefore important to relocate hatcheries outside villages, away from sources of poultry pathogens, and to build them out of water-proof materials with a layout that prevents the crossing of eggs and DOBs and allows a one-way flow of products, workers and vehicles.

Turning eggs by hand without gloves is considered a risk factor, as damage of thin-shelled eggs leads to the spread of embryo material to the surrounding eggs, favouring the
growth of micro-organisms. Egg turning in this manner also facilitates the transmission of food-borne disease organisms from eggs to workers, and vice versa.

Egg wetting with sanitized or unsanitized water to control temperature can result in contamination. Any moisture on warm eggshells evaporates, thus cooling the eggs, but lowering the internal pressure, which drives contaminants through the pores into the eggs (Hubbard, 2002).

In the Gharbia and Faiyoum THs that incubate CK and DK eggs at the same time, there is the risk that one species is resistant to or silently infected by a disease and could therefore act as a reservoir or carrier of the infection to the other susceptible species.

The circulation of egg racks among THs and poultry farms opens the way for disease transmission between the two nodes.

The lack of strict disinfection of DOB baskets and vehicles at TH entry gates facilitates disease circulation along the production chain.

The disposal of egg debris and dead eggs without treatment, in water canals or along roads leading to poultry farms may lead to water pollution and/or scavenging by wild birds resulting in disease outbreaks and endemics. Daily collection of waste products and their proper disposal by local authorities is an important matter.

The irregular removal of litter from the mid-passages of hatcheries, along with the lack of microbial monitoring, is likely to result in persistent and continuous infection of THs. Gentry, Mitrovic and Bubach (1962) described how, as CKs hatch, the exposed embryo fluids collect bacteria from contaminated shells and ventilation air. This combination of nutritious fluids and warm temperature provides an excellent environment for bacteria to multiply very rapidly.

The study concluded that the Baladi breed production network is liable to disseminate not only HPAI but also other disease agents (e.g., food-borne diseases) across Egypt, and could provide the infectious seeds for virtually all regional epidemic foci.

Most of the THs vaccinate DOCs with inactivated AI vaccine supplied free of charge by GOVS. The vaccination of DOBs with suboptimal doses masks or obscures the symptoms of HPAI infection. Taha et al. (2008) isolated two escape mutant H5N1 viruses responsible for the HPAI wave in late 2007 and early 2008 in the Nile Delta region, and attributed the mutations to weak vaccine pressure. Revaccination with a full dose at two weeks of age is therefore essential.

Very few THs vaccinate DOCs with Marek’s disease vaccine, other than DOCs to be raised as breeders by egg producing farms. Such vaccination is important for minimizing the immunosuppressive effect of the disease and to provide immune-competent CKs to the rural sector.

There is a lack of awareness about the basic principles of disease prevention among hatchery owners and workers. THs are usually successful when markets are favourable, but cannot compete with modern or modified hatcheries when profit margins are very small, such as during the summer season.

There is clear seasonality, with high operating capacity in the winter season (January to April) along with significantly increased hatchability, demonstrated by periods of intense rearing and growing birds. Given the poor sanitary measures found, an epidemic that starts during this period has the potential to reach many poultry farms and to damage the rural network by seeding endemic foci. This was confirmed by the high incidence of H5N1 AI during winter 2008 (Figure 12) and the full identity of haemagglutinin gene sequences of H5N1 viruses isolated in Upper Egypt governorates (which are completely dependent on Nile Delta governorates as sources of hatching eggs) with Nile Delta region strains, indicating the direct transmission of such viruses from Nile Delta governorates to southern Egypt. Although Egyptian strains are categorized into three main geographical clusters – Nile Delta, Lower
Egypt and Upper Egypt (Saad et al., 2008) – the phylogenetic tree and blast 2 results generated by this study demonstrate that each cluster contains mixtures of identical isolates from other geographical regions. Particularly noteworthy among these is the newly evolved cluster (labelled with red circles), which contains a fully identical isolate from Quena governorate in Upper Egypt among variant strains from Qalyubia, Beheira and Sharqia governorates in the Nile Delta region, confirming that viruses can move freely and rapidly in all directions to reach all the nodes of the poultry production network. Stevens et al. (2008) highlight the increased propensity of HPAI H5N1 clade 2.2 viruses to acquire human receptor specificity. Taha et al. (2008) and WHO/OIE/FAO (2008) mention that the Egyptian strains belong to clade 2.2. Enhanced biosecurity and surveillance during the winter period of increased HPAI virus activity is therefore likely to benefit disease control.

Although THs succeed in incubating hatching eggs, neither their structures nor their practices provide either bio-exclusion or biocontainment. Planning and support for the relocation and redesign of THs, after proper consultation, should be considered and funded by non-governmental organizations (NGOs) and government authorities. Educational conferences on health goals to raise hatchery staff’s knowledge of biosecurity and improved practices would help increase awareness.
References


**WHO.** 7 Jan. 2009. Cumulative number of confirmed human cases of avian influenza/H5N1 reported to WHO. [www.who.int/csr/disease/avian_influenza/country/cases_table_2](http://www.who.int/csr/disease/avian_influenza/country/cases_table_2)


**WHO.** September 2008. Antigenic and genetic characteristics of H5N1 viruses and candidate H5N1 vaccine viruses developed for potential use in human vaccines.


Annexes

Annex 1 Survey questionnaire for traditional hatcheries.

| Governorate: ________________________________ | Village: ________________________________ |
| Name of the hatcheries owner: __________________ | Tel: ________________________________ |
| Name of the respondent: __________________ | Job of the respondent: __________________ |
| Interviewer: __________________ | Date: __________________ |

**A- Location:**

1- GPS Coordinates ________________________________

**B- Type of hatchery:**

□ 1- Manual (traditional) □ 2- Semi □ 3- Automatic (modern)

**C- Capacity and type and season of operation:**

C-1- Does your hatchery work permanently. □ 1- Yes □ 2- No

C-2- What is maximum capacity of this hatchery? ---------------

C-3- What is the operational capacity of this hatchery? ---------------

C-4- Does the working capacity of your hatchery change with the season?

□ 1- Yes □ 2- No

C-5- Do you keep record of the hatchability?

□ 1- Yes □ 2- No

C-6- What is the season of the year with the highest hatchability?

□ 1- summer □ 2- winter

C-7- What is the percentage of hatchability?

□ 1- summer ...... □ 2- winter .......

C-8- Do you use veterinary services for your hatchery?

□ 1- Yes □ 2- No

C-9- If the answer is yes, what type of veterinary services do you use?

□ 1- Official Vet services □ 2- Private Vet services

C-10- Do you vaccinate or treat your 1-day old chick and/or duckling?

□ 1yes □ 2- No □ 3- Sometimes

C-11- If yes, for which diseases do you vaccinate your birds?

□ 1- Marek vac □ 2- AI vacc. □ 3- DVH vac □ 4- Antibiotic □ 5- Other specify

C-12- Do you inform the chick/duckling purchaser for best condition for starting birds?

□ 1yes □ 2- No □ 3- Sometimes
13- Do you feed back egg supplier with abnormal egg hatchability %?
□1yes □2- No □ 3-Sometimes

D- source/type of eggs used for incubation and main suppliers of Baladi type eggs for hatching:

D-1- What is the type of hatched Egg?
□1- Baladi type Chicken □2- Baladi type Ducks □3- Chicken □4- Ducks □5- Mixed type □6- Others (specify)

D-2- What are the source of the hatched eggs?
□1- own production □2- purchased from the farm directly □3- Market □4- purchased from middleman □5- Both □ 6-Others (specify)

D- 3 - Source of your eggs:

D- 3 -1- Source of your chicken eggs?
□1- the same governorate □2- other governorate, specify

D- 3 -1-1 – If other, where and percentage?
□□1 □□2 □□3 □□4

D- 3 -2 – Source of duck eggs?
□1- the same governorate □2- other governorate, specify

D- 3 -2-1 – If other, where and percentage?
□□1 □□2 □□3 □□4

E- sanitary measures:

E.A- Constant measures:

E.A-1- Distance from water canal?
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-2- Distance from paved road?
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-3- Distance from nearest poultry farm
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-4- Distance from nearest poultry hatchery
□1-Very close (m) □2-Close (m) □3-Far (m)

E.B- Variable measures:-

E.B.1- Do you use footbath in you hatchery?
□1- Yes □2- No

E.B.2 - Is there ventilation in the hatchery?
□1- Yes □2- No

E.B.3- If the answer is yes, what is the type of ventilation?
□1- Natural □2- Artificial

E.B.4- Are pets allowed to roam on the hatchery?
□1- Yes □2- No
E.B.5 - Are insects controlled?
- 1- Yes
- 2- No

E.B.6 - If the answer is yes, how it applied?
- 1- Insecticides powder
- 2- Spray

E.B.7 - Are rodent controlled?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.8 - If the answer is yes, how rodent control is practiced?
- 1- Rodent proof door
- 2- Rodent trap
- 3- Chemical poisons
- 4- Both

E.B.9 - Do you use disinfectants?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.10 - If the answer is yes, describe the mode of disinfection?
- 1- By fixed type
- 2- By rotating between disinfectants
- 3- Other specify

E.B.11 - Do the hatchery men wash their hands before egg handling/turning?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.12 - Do the hatchery men are working in more than one hatchery at the same time?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.13 - Do you use clean and disinfected water to spray/condition the hatching eggs?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.14 - Do you sanitize the eggs before hatching?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.15 - If the answer is yes, what is the type of the used sanitizer?
- 1- Disinfectants
- 2- Clean Water
- 3- Rotating between water and disinfectants
- 4- Other (specify)

E.B.16 - How do you dispose Egg / debris/ dead chicks?
- 1- Garbage collector
- 2- Incineration
- 3- Sell
- 4- Other specify

E.B.17 - Do you disinfect one- day old bird boxes?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.18 - If the answer is yes, using what:
- 1- Water
- 2- Detergent
- 3- Disinfectant
- 4- Both

E.B.19 - Frequency of bird boxes sanitation.
- 1- Every hatch
- 2- Every 2 weeks
- 3- Monthly

E.B.20 - Circulation of egg racks?
- 1- Yes
- 2- No
- 3- Sometimes

E.B.21 - Do you disinfect egg traffics?
- 1- Yes
- 2- No
E.B.22- If the answer is yes, when?
☐ 1- Every delivery  ☐ 2- weekly  ☐ 3- Irregularly

E.B.23- What type of traffic disinfectants?
☐ 1- Clean water  ☐ 2- detergent.  ☐ 3- Disinfectant  ☐ 4- Both

E.B.24- do you disinfect one-day old traffics?
☐ 1- Yes  ☐ 2- No

E.B.25- If the answer is yes, when?
☐ 1- Every delivery  ☐ 2- weekly  ☐ 3- Irregularly

E.B.26- Microbial monitoring of the hatchery?
☐ 1- Yes  ☐ 2- No

E.B.27- Removal of litter ?
☐ 1- Every hatch.  ☐ 2- Weekly  ☐ 3- Every 2 weeks  ☐ 4- Monthly

E.B.28- Disposale of litter?
☐ 1- Sell  ☐ 2- Garbage collector  ☐ 3- Fertilizer

E.B.29- Presence of retail equipments?
☐ 1- Yes  ☐ 2- No

F.A. marketing:

F-1- Do you sell the produced chicks and/or duckling?
☐ 1- Yes  ☐ 2- No

F-2- If yes, where?

F.2.1. Chicks
☐ 1- To neighbours in the same area
☐ 2- To poultry grower in the same Governorate
☐ 3- To poultry grower in the neighbouring Governorate, specifies:  ☐ 4- To traders that come to the village, Specify  ☐ 5- other (specify)

F.2.2. Ducklings
☐ 1- To neighbours in the same area
☐ 2- To poultry grower in the same Governorate
☐ 3- To poultry grower in the neighbouring Governorate, specifies:  ☐ 4- To traders that come to the village, Specify  ☐ 5- other (specify)

F-3- Do you nurse your own produced chicks and/or duckling?
☐ 1- yes  ☐ 2- no

F-4- If yes where?
☐ 1- In back yard / at roof
☐ 2- Close to the hatchery
☐ 3- In nurseries owned by the hatchery
☐ 4- other (specify)
Annex 2: Blast 2 Sequences results

**Sequence 1: ACA29672**
Length = 568 (1..568)

**Quena isolate** (A/Ck/Egypt/07202-NLQP/2007 (H5N1))

**Sequence 2: ACA29680**
Length = 553 (1..553)

**Behira isolate** (A/Ck/Egypt/07701-NLQP/2007 (H5N1))

NOTE: Bitscore and expect value are calculated based on the size of the nr database.

Score = 1146 bits (2964), Expect = 0.0
Identities = 553/553 (100%), Positives = 553/553 (100%), Gaps = 0/553 (0%)
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<td>548</td>
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CPU time: 0.04 user secs. 0.03 sys. secs 0.07 total secs.
**Blast 2 Sequences results**

**BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]**

**Sequence 1:** ACA29672  
Length = 568 (1..568)

**Sequence 2:** ACA29671  
Length = 552 (1..552)

**Score = 1144 bits (2960), Expect = 8.0**  
**Identities = 552/552 (100%), Positives = 552/552 (100%), Gaps = 0/552 (0%)**

**Query 17**  
DQICIGYAHNISTEVDKVTMENVNSTVTHAQGILEKTNKILCCLDLGVEPVLILLRGCGVAGM  76

**Subject 1**  
DQICIGYAHNISTEVDKVTMENVNSTVTHAQGILEKTNKILCCLDLGVEPVLILLRGCGVAGM  60

**Query 77**  
LLGNFNDCEPLMEVSFQYSNFYVYRLLHLLHLGRINRFEIQIPKES  136

**Subject 61**  
LLGNFNDCEPLMEVSFQYSNFYVYRLLHLLHLGRINRFEIQIPKES  120

**Query 137**  
SWFDBHAEGSSASACPYQGQSFFYHWNLIEKDNAYPTIKESCYHNTHQGRLLVGLGIHHR  196

**Subject 121**  
SWFDBHAEGSSASACPYQGQSFFYHWNLIEKDNAYPTIKESCYHNTHQGRLLVGLGIHHR  180

**Query 197**  
PNDABQTRLQFVTIYSVGSTLRNLQVLPIATRSEVNQSGVGEFFNTILESNDAIN  256

**Subject 181**  
PNDABQTRLQFVTIYSVGSTLRNLQVLPIATRSEVNQSGVGEFFNTILESNDAIN  240

**Query 257**  
FENGNIAPSNAYKVGKDFSTINKSELEYCNKTCQGTPIGAINSSHMPFHNIIPLTIG  316

**Subject 241**  
FENGNIAPSNAYKVGKDFSTINKSELEYCNKTCQGTPIGAINSSHMPFHNIIPLTIG  300

**Query 317**  
ECFYKLYNSNLVATLCLSNPGQERRRERKCLGLPACAGFPTEQEGSNVQGTVENQVYHSNIEQ  376

**Subject 301**  
ECFYKLYNSNLVATLCLSNPGQERRRERKCLGLPACAGFPTEQEGSNVQGTVENQVYHSNIEQ  360

**Query 377**  
GSGYADKEFSTQRAIDOVYNKSVNNSSCHNHTQPEAVGREFHNFHRLERIHLHKRMEDGFLD  428

**GSGYADKEFSTQRAIDOVYNKSVNNSSCHNHTQPEAVGREFHNFHRLERIHLHKRMEDGFLD**

**NOTE:** BitScore and expect value are calculated based on the size of the nr database.
Mapping the Traditional Poultry Hatcheries - Egypt

Animal Health, Breeds and Livelihoods

Subject 361: GSGYADKESIQKAIDGTYMKVHSIDHRMTQFEAVGREFHNLERRIEHLNKIMEDQFLD 420
Query 437: VNTYNELVLVMEKRTLDFTHDSNYKHLYDKVRLQLEHAELGNGCREFYHEDNECME 496
Subject 421: VNTYNELVLVMEKRTLDFTHDSNYKHLYDKVRLQLEHAELGNGCREFYHEDNECME 480
Query 497: SYRGTIDTPYSEQEARKREEISGWLESIGTQILSISTVTASSLALAMVAAGLFLAM 556
Subject 481: SYRGTIDTPYSEQEARKREEISGWLESIGTQILSISTVTASSLALAMVAAGLFLAM 540
Query 557: CSNSSLQCRICI 568
Subject 541: CSNSSLQCRICI 552

CPU time: 0.05 user secs. 0.03 sys. secs 0.08 total secs.
Mapping the Traditional Poultry Hatcheries-Egypt

Blast 2 Sequences results

BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gaps open: 11 gap extension: 1
mismatch character option X for protein, N for nucleotide
Masking color option: Black
Show CDS translation: Align

Sequence 1: ACP80054
Length: 540 (1-540)

Qosna Human 2007

Sequence 2: AFB139070
Length: 537 (1-537)

Katobia Human 2007

NOTE: Bit score and expect value are calculated based on the size of the nr database.

Score = 1688 bits (2008), Expect = 0.6
Identities = 548/549 (100%), Positives = 548/549 (100%), Gaps = 0/549 (0%)
Mapping the Traditional Poultry Hatcheries-Egypt

Animal Health, Breeds and Livelihoods
Mapping the Traditional Poultry Hatcheries - Egypt

Blast 2 Sequences results

**BLAST 2 SEQUENCES RESULTS VERSION BLAST 2.2.10 (Mar-02-2005)**

Matrix: BLOSUM62  gap open: 11  gap extension: 1
x_dropoff: 0  expect: 10,000  wordsize: 3  Filter  View option: Standard
Masking character option: X for protein, n for nucleotide  Masking color option: Black
Show CDS translation
Align

Sequence 1: ABO64687
Length = 568 (1..568)

Gharbia- Ch- 2006

Sequence 2: ACA29668
Length = 568 (1..568)

Alexandria- quail- 03/02/2007

Score = 1169 bits (15.3), Expect = 2.6
Identifiers: 568/568 (100 %), Positives: 568/568 (100 %), Gaps: 0/568 (0 %)

Query 1  | MERSYLLAYVSPVSDQIYGVYQHANSTQEQYCTEMSNVVRSZAQIELTHENKSCOL 60
Object 1 | MERSYLLAYVSPVSDQIYGVYQHANSTQEQYCTEMSNVVRSZAQIELTHENKSCOL 60
Query 61  | DVYNFRLLRSDVGWLSLDNMYCQGETQVKEKINPANDLCTFSPKSNVEELKSL 120
Object 61 | DVYNFRLLRSDVGWLSLDNMYCQGETQVKEKINPANDLCTFSPKSNVEELKSL 120
Query 122 | LARIYHFEHQIQIIPKSMWQCREAISGSSAYCPQGRSSEPRWVMLIKKDKAFTEKXS 180
Object 122 | LARIYHFEHQIQIIPKSMWQCREAISGSSAYCPQGRSSEPRWVMLIKKDKAFTEKXS 180
Query 191 | NHHQEDDLLLAHIHPNNAAATYRKLQKYDCTQVSGTSTLQVBIIARSSVNVGGG 240
Object 191 | NHHQEDDLLLAHIHPNNAAATYRKLQKYDCTQVSGTSTLQVBIIARSSVNVGGG 240
Query 241 | RIEFFWTILKSDNAIFENARIAPENAKYKVISHDSTIKESLGYHKNKNTQTFJGA 300
Object 241 | RIEFFWTILKSDNAIFENARIAPENAKYKVISHDSTIKESLGYHKNKNTQTFJGA 300
Query 301 | ZGSGNFTPHKKLSISCPYKCSWNVLATGNLNPGSERRKQLRP6LAAAGFSEGWW 360
Object 301 | ZGSGNFTPHKKLSISCPYKCSWNVLATGNLNPGSERRKQLRP6LAAAGFSEGWW 360
Query 361 | QGMDTWGNYHKSSMNQDGSSGADQAGNRTQNAIDGSVENKWISSLIIXNNTQFAWGSF8NLSE 420

NOTE: Bitscore and expect value are calculated based on the size of the nr database.
Mapping the Traditional Poultry Hatcheries-Egypt

Blast 2 Sequences results

**BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.13 [Mar-02-2008]**

- **Sequence 1:** ABU53668
  - Length: 548 (1...548)

- **Sequence 2:** ABU53670
  - Length: 548 (1...548)

**Sohag Human - 2007**

**Kaliobia Human - 2007**

**NOTE:** Bit score and expect value are calculated based on the size of the nr database.
Mapping the Traditional Poultry Hatcheries—Egypt

Animal Health, Breeds and Livelihoods

CPU time: 0.05 user secs. 0.06 sys. secs 0.11 total secs.
Mapping the Traditional Poultry Hatcheries-Egypt

**Blast 2 Sequences results**

**BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]**

- **Matrix:** BLOSUM62
- **gap open:** 11
- **gap extension:** 1
- **x_dropoff:** 0
- **expect:** 10.000
- **wordsize:** 3
- **Masking character option:** X for protein, n for nucleotide
- **Masking color option:** Black

**Sequence 1:** ABP96846
**Length:** 568 (1..568)

**Fayoum-Human-2007**

**Sequence 2:** ABN70709
**Length:** 568 (1..568)

**Gharbia-Ck-2006**

*NOTE: Bitscore and expect values are calculated based on the size of the nr database.*

**Scores:** 1289 bits (70%), **Expect:** 0.0

**Identities:** 568/568 (100%) / **Percent:** 568/568 (100%) / **Gap:** 0/568 (0%)

- **Query 1:** MEFVIVALLAVAVSVLAACQDDQGGEQQYHANGIAGQEVQIMEKCVTQEASQDIELEKRMKSDKLCLL 66
- **Subject 1:** MEFVIVALLAVAVSVLAACQDDQGGEQQYHANGIAGQEVQIMEKCVTQEASQDIELEKRMKSDKLCLL 66
- **Query 2:** QVYKFLILAKCDQAVAQQWLLQGMPQCTMLNPFWYIVLIVERINPANDCQYPGHFNOYELMRHL 120
- **Subject 2:** QVYKFLILAKCDQAVAQQWLLQGMPQCTMLNPFWYIVLIVERINPANDCQYPGHFNOYELMRHL 120
- **Query 3:** L3R15R3FQSQQIRPR35SSHAA350VSAAPYQGRSSFRHNVWKLHINCOLYPTPRSV 118
- **Subject 3:** L3R15R3FQSQQIRPR35SSHAA350VSAAPYQGRSSFRHNVWKLHINCOLYPTPRSV 118
- **Query 4:** NNTQNDLLVLWGLWQRHFAAQGTQNYQPTTY3VQTSLQLQPLVPHAIATRSKVNNQGQ 248
- **Subject 4:** NNTQNDLLVLWGLWQRHFAAQGTQNYQPTTY3VQTSLQLQPLVPHAIATRSKVNNQGQ 248
- **Query 5:** RIEFWEILKMNIAFNSFHAHIPAYVXKWARNIKITMKSUENOYKQCTPFGA 300
- **Subject 5:** RIEFWEILKMNIAFNSFHAHIPAYVXKWARNIKITMKSUENOYKQCTPFGA 300
- **Query 6:** ZHO3SFTNHFLRTI3CPVXHMVRILVATURNNSQERREKRKRG1GATASFIQGG 300
- **Subject 6:** ZHO3SFTNHFLRTI3CPVXHMVRILVATURNNSQERREKRKRG1GATASFIQGG 300
- **Query 7:** QMVWQESYERHNNKNSQ5G5NQADHKTSTQI1AD0TVKNNWQ21BNHNTFAVEFGRFNLQ 420
- **Subject 7:** QMVWQESYERHNNKNSQ5G5NQADHKTSTQI1AD0TVKNNWQ21BNHNTFAVEFGRFNLQ 420