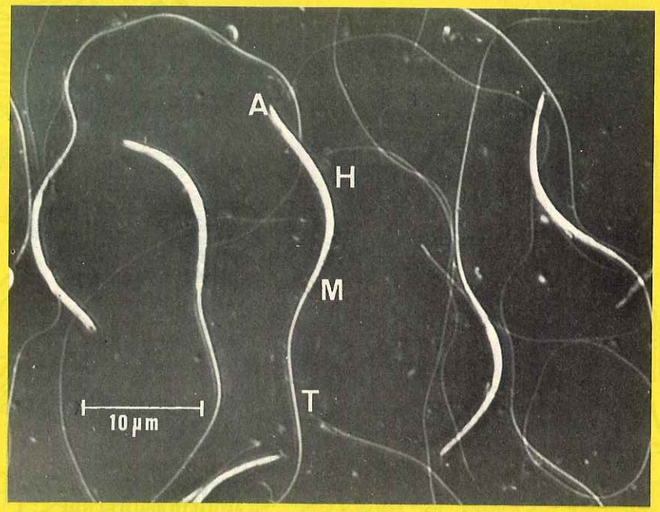
Is There A Future For AI With Broiler Breeders?



Cock spermatozoa in anilineblue-eosin stained smear. (Differential—interference contrast ×2230). A—Acrosome; H—Head; M—Mid-piece; T—End-piece of tail.

ARTIFICIAL INSEMINATION (AI) has a widespread application in the reproduction of both turkey and guinea fowl. In these species fertility results obtained after AI are much higher than those obtained with natural copulation, so AI is the only alternative.

In the domestic fowl hatchability of eggs set after natural copulation is relatively high. Hodgetts and Jones estimated that 81% hatchability is an average for the UK. This means, however, that in 1 in 5 of all eggs set fail to hatch. Thirty percent of the losses should be due to the lack of fertilisation. Thus fertility percentage should be at least 94.

Furthermore, Beer admits that 30% infertility is an overestimate of the problem and only 60% of the "apparent infertiles" should be truly infertile. This brings the final fertility level to at least 96%. This percentage has been confirmed in our experimental work with broiler breeders under conditions of natural mating.

After 19 days of incubation all clear and questionable eggs are broken out and fertility is determined by macroscopic examination. Average fertility is about 95%. Together with the pre-oviposital embryonic mortality true fertility should be close to 96%.

In contrast with the field results and depending on strain, average hatchability of eggs set is between 85 and 87% under experimental conditions. This is mainly due to a good selection of males, the use of small pens as replicates and the removal of non-hatchable eggs. Whatever the reason(s) a 4 to 6% increase in hatchability represents an enormous financial progress and therefore it is worthwhile to investigate the possibilities to increase the number of saleable chicks. An interesting point of discussion in this context are the possibilities and limitations of AI in the broiler industry. These are 3-fold:

1. Compared with natural mating what number of salesable chicks can be expected using AI?
2. What is the value of the offspring of breeders when they have been inseminated artifically?
3. What is the entire cost of the AI procedure compared with natural mating?

Breeding can be done very accurately with caged birds using AI, therefore this system is adopted by many breeders. The reproduction results following AI are comparable with those obtained after natural copulation and this gives us an idea among the possibilities of the AI technique under practical conditions. Our own experiments with broiler breeders have shown that it is possible to improve hatchability to 88-90% of eggs set following AI.

The key of this improvement is a severe macroscopic selection on semen quality. Males are trained to ejaculate and all those which produce a sufficient volume (+0.5 m) of thick, viscous and milky white semen were kept further.

The semen is expelled from the bulbous end of the vasa deferentia by a short but forcible pressure with the thumb and two forefingers of the operators left hand on the cloacal walls. Using this criterion approximately 35% of the males are rejected as unsuitable.

Two microscopic tests are performed to evaluate semen quality further. The first is the determination of the concentration of spermatozoa in the pooled semen. This is extremely high: between 7 and 8 × 10^9/ml. This is due to the absence of the so called transparent fluid, originating from the blood plasma. The next step is made by preparing smears of fresh undiluted semen from individual males. Very few selected males have more than 10% defective spermatozoa in their semen.

If semen so collected is used fresh, undiluted, 0.025 ml is inseminated per hen. This means that 175-200 × 10^6 of spermatozoa are deposited in the vagina. However, semen can be diluted and stored for short periods (6-24 hours). A storage medium has been developed in our laboratory and fertility and hatchability results obtained with stored (+2°C) semen are not significantly different from the undiluted control as long as the same number of spermatozoa are inseminated, the dilution rate is moderate and the storage period is no longer than 6 hours.

This is clearly illustrated in table 1 where the results are based on the number of eggs laid between the 2nd and 8th day inclusive after a single insemination. Can this figure be translated to the field?

A percentage of 85-87% should be possible if the whole procedure is carried out carefully. One major problem is the

Table 1

Per cent fertility and hatchability obtained with broiler breeders using fresh semen and semen stored for different times at different dilution rates.

Treatments	Undiluted fresh control	Diluted: 2 × 24 hours storage	Diluted: 2 × 6 hours storage	Diluted: 4 × 6 hours storage	Diluted: 4 × 6 hours storage	
Paremet studied	0.025 ml/hen and 200 × 10^6 sp	0.1 ml/hen and 400 × 10^6 sp	0.05 ml/hen and 200 × 10^6 sp	0.1 ml/hen and 200 × 10^6 sp	0.05 ml/hen and 100 × 10^6 sp	L.S.D.
Fertility/total eggs*	96.5** a	93.2 b	96.3 a	93.9 ab	90.1 c	2.95
Hatchability/total eggs	91 a	87 bc	89.6 ab	88.3 ab	84.7 c	3.2
Hatchability/fertile eggs	94.3 a	93.6 a	93 a	94.1 a	94.2 a	2.02

*Based on an average of 80 to 89 eggs per replicate and a total of 1604 to 1771 per treatment (20 replications).
**Percentages followed by a different letter are significantly different from each other.

possibility that hens have a hard shelled egg in the uterus. Fertility results with such hens are definitely lower even when insemination is performed very carefully. The number of hard shelled eggs is, however, very small when a proper lighting system is followed; most of the eggs are laid before insemination is started.

Mc Daniel obtained 67g more body weight gain per bird at 8 weeks for the offspring from males selected for AI as compared with the offspring from non-selected males used in natural matings. However, two separate factors are involved here.

The first factor is egg weight. When AI is used birds are kept in cages and it is known that eggs produced in cages are cleaner and heavier than those produced with the same feed on the floor. From several experiments it can be concluded that 1g higher egg weight results in 5-6g higher body weight at 7 weeks of age.

Our own experimental work has

Quali sono le possibilità della fecondazione artificiale per le riproduttrici da carne?

Riassunto—La riproduzione di ovaiole in gabbia é ben realizzabile con l'uso della fecondazione artificiale. I risultati della riproduzione con la FA sono comparabili ai risultati ottenuti dopo l'accoppiamento naturale. Questo ci dà un idea delle possibilità delle tecniche di FA sotto condizioni pratiche. I nostri propri esperimenti con riproduttrici da carne hanno mostrato che é possibile migliorare la schiusabilità fino a 88-90% di uova, ottenute con la FA.

La spiegazione per questo miglioramento é una seria selezione microscopica della qualità del seme. I maschi imparano ad eiaculare e tutti quelli che producono un volume sufficiente (circa 0.5 m) di seme bianco, spesso e viscido vengono mantenuti.

Vengono svolti due testi microscopici per esaminare la qualità del seme. Il primo test comprende l'esame della concentrazione degli spermatozoi nel seme prelevato. Questa é estremamente alta: tra 7 e 8 × 10^9/ml. e cio' é dovuto all'assenza del cosidetto fluido trasparente, derivante dal plasma del sangue. La fase seguente é la preparazione di campioni di seme fresco non diluito da maschi singoli. Pochissimi maschi selezionati hanno più di 10% di spermatozoi difettosi nel loro seme.

Se si usa il seme ottenuto cosi', Fresco, non diluito, si possono inseminare 0,025 ml per ovaiola. Cioé si introducono 175-200 × 10^6 spermatozoi nella vagina. Il seme puo' essere diluito e mantenuto per un corto periodo di 6-24 ore.

McDaniel ha ottenuto un aumento del peso corporeo di 67 gr. per soggetto a 8 settimane per i discendenti dei maschi selezionati per la FA, in confronto ai discendenti di maschi non selezionati usati in accoppiamento naturale.

Il primo fattore é il peso dell'uovo. Con la FA i soggetti vengono allevati in gabbia ed é cosa nota che le uova prodotte in gabbia sono più pulite e più pesanti di quelle prodotte con lo stesso mangime su terra. Da parecchi esperimenti si puo' concludere che un uovo che pesa 1 gr. di più dà un peso corporeo che supera i 5-6 gr. all'età di 7 settimane.

I nostri propri esperimenti hanno dimostrato che le uova da riproduttrici da carne in gabbia pesano 2 gr. di più di quelle delle loro sorelle su lettiera. Il peso dell'uovo fa quindi aumentare il peso finale del pollo da carne di 10-12 gr.

Da un maschio che produce 0.5 ml di seme per eiaculazione e che viene munto 3 volte per settimana, si ottengono 1.5 ml per settimana. Il seme viene diluito 3 volte (1ml + 2ml) e mantenuto da 6 a 8 ore. Con una concentrazione originaria di spermatozoi di 6.5 × 10^9/ml ad una dose di fecondazione di 0.1 ml (216 × 10^6 spermatozoi), occorre un maschio per 45 ovaiole la settimana. Questo significa una relazione tra maschio e femmina di 2:5

L'IA A-t'elle Un Avenir Avec Les Reproducteurs Chair?

Sommaire—On peut arriver à d'excellents résultats de reproduction avec des bêtes en cage en utilisant L'IA. Les résultats de reproduction obtenus avec l'IA sont comparables à ceux obtenus par copulation naturelle et ceci nous donne une idée des possibilités des techniques d'IA dans des conditions normales d'exploitation. Nos propres expériences avec des reproducteurs chair ont montré qu'il était possible d'arriver à un taux d'éclosion de 88-90% des oeufs incubés après IA.

La raison de cette amélioration est une sélection macroscopique sévere de la qualité du sperme. On entraîne les mâles à éjaculer et on garde tous ceux qui produisent un volume suffisant (+0, 5m) de sperme blanc laiteux, épais et visqueux.

On effectue deux tests au microscope pour évaluer la qualité du sperme. Le premier est la détermination de la concentration en spermatozoïdes du sperme obtenu globalement. Elle est très élevée: entre 7 et 8 × 10^9/ml. Ceci est dû à l'absence du fluide transparent originaire du plasma sanguin. L'étape suivante demande la préparation de frottis de sperme frais non dilué fourni individuellement par les mâles. Très peu de mâles sélectionnés ont plus de 10% de spermatozoïdes défectueux dans leur sperme.

Si le sperme collecté est utilisé frais, non dilué, on insémine 0,025ml par poule. Ceci signifie que 175-200 × 10^6 de spermatozoïdes sont déposés dans le vagin. Le sperme peut cependant être dilué et stocké pendant de brèves périodes (6-24 heures)

Mc Daniel a obtenu un gain de poids supplémentaire de 67g par bête à 8 semaines avec les descendants des mâles sélectionnés pour l'IA par rapport aux descendants des mâles non sélectionnés utilisés pour les accouplements naturels.

Le premier facteur est le poids des oeufs. Avec l'insémination artificielle, les bêtes sont gardées dans des cages et il est bien connu que les oeufs ainsi produits sont plus propres et plus lourds que ceux obtenus au sol avec la même nourriture. A la suite de plusieurs expériences on peut conclure qu'un oeuf pesant 1g de plus donne un supplément de poids de 5-6g à 7 semaines.

Notre propre travail expérimental a montré que les oeufs de reproductrices chair placées en cages pesaient approximativement 2g de plus que ceux pondus au sol par leurs soeurs. Grâce au poids des oeufs, le poids final du poulet de chair doit ainsi augmenter de 10-12g.

Si un mâle produit 0,5ml de sperme par éjaculation et qu'on le trait trois fois par semaine, on obtient 1,5ml par semaine. Le sperme est dilué 3 fois (1ml + 2ml) et stocké (6-8 heures). Avec une concentration originale en spermatozoïdes de 6,5 × 10^9/ml et une dose d'insémination de 0,1ml (216 × 10^6 spermatozoïdes) il faut un mâle pour 45 poules par semaine. C'est un ratio mâle-femelle de 2,5.

Gibt es in der Broilerelterntierhaltung eine Zukunft für KB?

Zusammenfassung—Wenn Elterntiere in Käfigen untergebracht sind, kann KB (künstliche Besamung) mit grosser Genauigkeit eingesetzt werden. Die darauf folgenden Reproduktionsleistungen entsprechen den mit natürlicher Besamung erreichten, was uns hinsichtlich der möglichen, praktisch einsetzbaren KB-Techniken zu einer Idee führt. Bei unseren eigenen Versuchen mit Broilerelterntieren hat es sich erwiesen, dass in Verbindung mit künstlicher Besamung die Schlupffähigkeit der eingelegten Eier auf einen Wert von bis zu 88-90% verbessert werden kann.

Der Schlüssel hierbei liegt in einer rigorosen makroskopischen Wertung der Spermaqualität. Die Hähne werden an das Absetzen eines Ejakulats gewöhnt, und diejenigen, die dickflüssiges, viskoses und milchigweisses Sperma in ausreichender Menge (0,5 ml +) produzieren, bleiben im Bestand.

Die Spermaqualität wird dann durch zwei mikroskopische Tests weiter begutachtet. 1. wird in gepoolten Spermaproben die Spermatozoenkonzentration bestimmt. Diese

(Bitte wenden)

demonstrated that eggs from caged broiler breeders are approximately 2gm higher in weight than those from their sisters on deep litter. Final broiler weight should thus be increased by 10-12g due to egg weight. The remaining 55-57g comes from the second factor: selection pressure. This can easily be done because only a small percentage of males are necessary when AI is applied. A complicating factor is the necessity of feed restriction of the breeder males during the rearing period.

Broilers are selected on early growth rate and ideally broiler breeder males should be selected for the AI programme at 6-7 weeks of age. A selection at sexual maturity can be misleading because the males are severely quantitatively restricted from 3-4 to 20-22 week of age; here other factors such as social order can mask final body weight.

Selection after 3 weeks of full feeding is perhaps too early because at that time the factor egg weight can still play an important role. We found a significant but rather low correlation co-efficient between body weights of breeder males at 3 and 20 weeks of age. Selection after 6-7 weeks is also disturbed by at least 3 weeks of feed restriction; perhaps a less severe restriction programme or a combination of qualitative and quantitative restriction from 3 to 6 weeks of age can be very helpful.

Important is the question if breeder males selected for fast growth have normal reproduction performances. Our experimental work with AI has shown no difference in fertility and hatchability between the heaviest males selected at 3 weeks of age and all males. Further experiments are necessary to find out the precise possibilities to improve body weight of broilers through selection of breeder males.

The data obtained in relation to the first two questions are used to answer the third question. As an example, we take a flock of 10 000 broiler hens which will be inseminated artificially. In order to make a complete financial analysis the reader has to multiply the different data with the currency of his own country.

If one male produces 0.5ml semen per ejaculate and is milked three times a week 1.5ml per week is obtained. The semen is diluted 3-fold (1ml + 2ml) and stored (6-8 hours). With an original spermatozoa concentration of 6.5×10^9/ml and an insemination does of 0.1ml (216×10^6 spermatozoa), one male is required for 45 hens per week. This is a male to female ratio of 2.5. Provided that 1200 (12%) males are delivered as one day old chicks and the birds are weighed at 5 weeks of age the obvious culls and the lightest birds can be removed to retain 7% of males.

At the age of 21-23 weeks the rest of the males are trained to ejaculate and if 35% are removed as unsuitable we have 4.55% to start the AI programme. If 2.5% of males are necessary for the flock 4% are needed at the beginning to compensate for dead and males with a declining semen picture. The labour cost for weighing the birds during rearing is offset by the saving of food of 5% males during 15 weeks. Using this method 86-87% hatchability can be obtained for the entire (89-94%) reproduction period.

Compared with the floor slightly more (2.5%) hatching eggs are produced in cages. These eggs are cleaner, heavier and have thicker shells. Furthermore the investment per hen is lower in cages and no litter and preventive medicaments against internal parasites are required.

A substantial feed saving and a very accurate distribution of the feed is possible in cages. Hens are separated from the males and at least 5g/hen/day can be saved. The 6% (600) fewer males consume 210g/day on the floor and in a flock of 10 000 birds and a 40 week reproduction period this accounts for a total feed saving of 35 280 (male) and 14 000 kg (female).

Because the exact body weight

muss extrem hoch liegen: zwischen 7 und 8×10^9/ml. Dieser hohe Wert resultiert aus der Abwesenheit der sogenannten Transparenzflüssigkeit, die ihren Ursprung im Blutplasma hat. Als nächstes werden Abstriche frischen, unverdünnten Spermas von einzelnen Hähnen untersucht. Nur sehr wenige der zur Probe genommenen Hähne fallen in eine Kategorie mit mehr als 10% defekter Spermatozoen.

Wenn das solcherart abgesammelte Sperma in frischem Zustand, unverdünnt, verwendet wird, liegt die Besamungsdosis bei 0,025 ml je Henne. D.h., dass 175-200 $\times 10^6$ Spermatozoen in die Vagina eingeführt werden. Das Sperma kann jedoch auch verdünnt und kurzfristig (6-24 Stunden) aufbewahrt werden.

Verglichen mit den Nachkommen nicht-selektierter Hähne und natürlicher Paarung, erzielte Mc Daniel 67 g Körper-Mehrgewicht in der 8. Lebenswoche bei den Nachkommen von Hähnen, die für das KB-Programm selektiert wurden.

Der erste Faktor hierbei ist das Eigewicht. Wenn KB eingesetzt wird, verbleiben die Tiere in den Käfigen und es ist allgemein bekannt, dass die in Käfigen produzierten Eier sauberer und schwerer sind als die unter gleichen Fütterungsverhältnissen in der Bodenhaltung anfallenden. Aus mehreren Versuchen lässt sich schlüssig darlegen, dass ein um 1 g gesteigertes Eigewicht das Körpergewicht der daraus geschlüpften Küken in der 7. Lebenswoche um 5-6 g steigert.

Unsere eigenen Versuche haben unter Beweis gestellt, dass die Eier von Broilerelterntierhennen in Käfighaltung ca. 2 g schwerer sind als die von den Schwestertieren in Bodenhaltung gelegten. Mithin sollten allein aufgrund des gesteigerten Gewichts der Bruteier die Broilerendgewichte um 10-12 g steigen.

Wenn man davon ausgeht, dass ein Hahn je Ejakulation 0,5 ml Sperma produziert und dreimal wöchentlich abgemolken werden kann, erhält man ein Spermavolumen von 1,5 ml je Hahn und Woche. Dieses Sperma wird dreifach verdünnt (1 ml + 2 ml) und 6-8 Stunden lang aufbewahrt. Bei einer ursprünglichen Spermatozoenkonzentration von $6,5 \times 10^9$/ml und einer Besamungsdosis von 0,1 ml (216×10^6 Spermatozoen) muss für den wöchentlichen Besamungsbedarf von 45 Hennen jeweils ein Hahn gehalten werden. Daraus resultiert für die Praxis ein äussert wirtschaftliches Hahnen: Hennenverhältnis.

Hay Un Futuro Para IA Con Reproductoras De Pollos de Asar?

Resumen—Se puede recriar con bastante exactitud en el caso de aves enjauladas, con IA. Los resultados de la reproducción después de la IA son comparables con los obtenidos después de la copulación natural y esto nos da una idea de las posibilidades que tiene el procedimiento de IA bajo condiciones prácticas. Nuestros propios experimentos con aves reproductoras de pollos de asar indican que es posible mejorar el índice de empolladura al 88-90% de los huevos incubados, después de la IA.

La clave de esta mejora es la selección macroscópica severa de la calidad del semen. Se entrenan los machos para eyacular, y todos aquellos que producen un volumen suficiente (+0.5 m) de semen lechoso espeso y viscoso, son conservados para uso ulterior.

Se efectúan dos pruebas microscópicas para valorar la calidad del semen. La primera es la determinación de la concentración de espermatozoides en el semen reunido, que es muy alta, entre 7 y 8×10^9/ml. Se debe esto a la ausencia del fluido transparente que origina el plasma sanguíneo. El siguiente paso es de preparar lotes de semen fresco y sin diluir de machos individuales. Son muy pocos los machos seleccionados que tienen más del 10% de espermatozoides defectuosos en el semen.

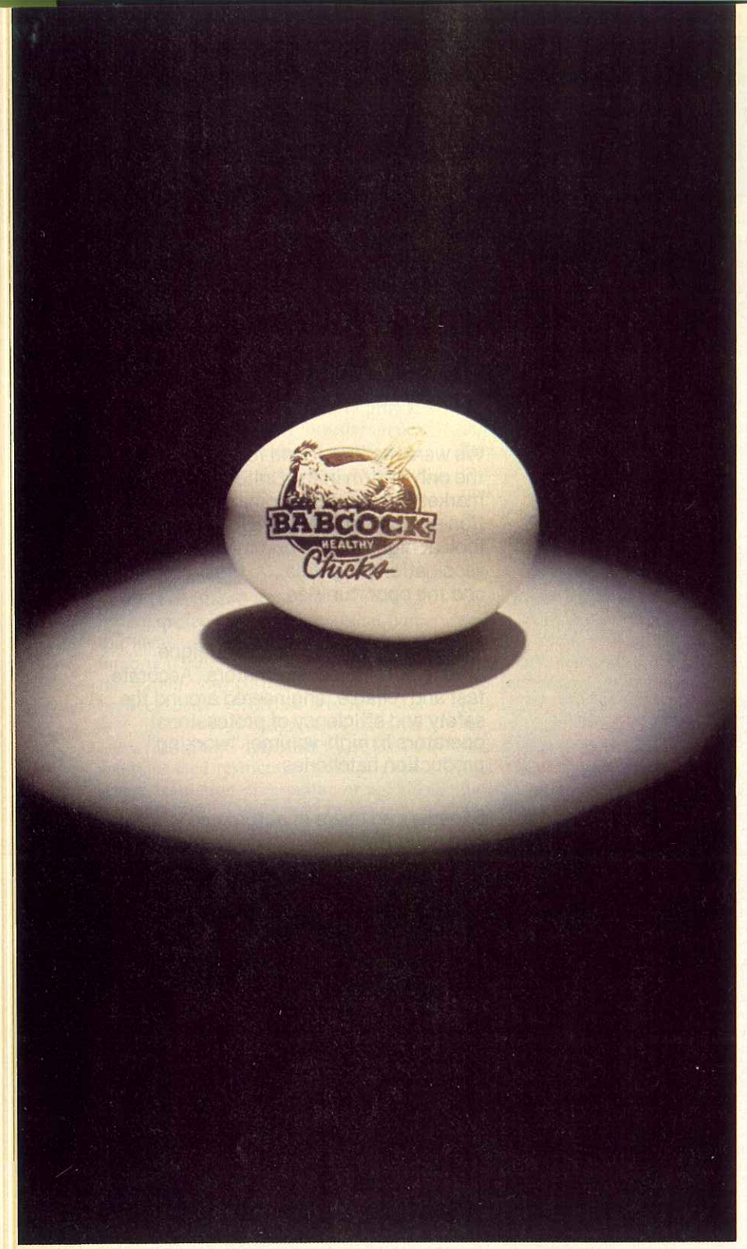
Si el semen así recogido es usado fresco y sin diluir, se insemina cada gallina con 0.025 ml. Esto significa que se depositan en la vagina 175-200 $\times 10^6$ de espermatozoides. Sin embargo, se puede diluir y almacenar el semen durante períodos breves de 6 a 24 horas.

Mc Daniel obtuvo 67 grs. más de engorde por ave a las 8 semanas para la progenie de machos seleccionados para IA, en comparación con la progenie de machos no seleccionados, usados en apareos naturales.

El primer factor es el peso del huevo. Cuando se usa la IA, se conservan las aves en jaulas y se sabe que los huevos producidos en jaula son más limpios y pesados que los producidos con la misma cantidad de pienso, pero sobre piso. Los resultados de varios experimentos permiten sacar en conclusión que los huevos 1 gramo más pesados resultan en un peso físico 5-6 gms. mayor a las 7 semanas de edad.

Nuestros propios trabajos experimentales han demostrado que los huevos de aves de recría de pollos de asar en jaula tienen un peso aproximadamente 2 gms mayor que sus hermanas criadas sobre yacija profunda. Por consiguiente, el peso final del pollo de asar podría ser aumentado en 10-12 gms. a causa del peso del huevo.

Si un macho produce 0.5 ml de semen por eyaculación y es "ordeñado" tres veces por semana, se obtienen 1.5 ml por semana de semen. Este semen es diluído tres veces (1 ml + 2 ml) y almacenado durante 6-8 horas. Con una concentración original de espermatozoides de 6.5×10^9/ml y una dosis inseminadora de 0.1 ml (216×10^6 espermatozoides), se requiere un macho por cada 45 gallinas por semana. Esta es una relación de machos-hembras de 2.5.



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increase is not yet known, 40g at 7 weeks is probably not over-estimated. This makes on a total of 155 hatching eggs/hen and a hatchability of 86.5% 134 chicks. The extra gain per hen is 5.36 kg.

The expenses for insemination material and diluent can be obtained from the dealer and are not very high. In addition after each insemination, fifteen minutes are required to clean the insemination material.

The greatest expense for AI and in most countries the greatest obstacle to change from floor to cage is labour. Thumin noted that 750-900 hens can be inseminated in one hour by a team of three men. The specially constructed two-tier cages have doors which slide open vertically and the hens are inseminated on the feed trough.

We think that the number cited by Thumin is too optimistic and that 400-500 birds/three men/hour including semen collection is an acceptable number. Here, the total labour per week for 10 000 birds is 66.6 hours for three men. Thus the weekly insemination can be done in three days.

Remarkable is the fact that the disadvantages of AI are restricted to the multiplication farm only while the advantages are spread over different steps of the broiler industry. This leads to the conclusion that only an integrated enterprise can benefit from the whole procedure.

An interesting point for the future of AI is the development of dwarf broiler hens. However, at this moment the performances of the hen (laying capacity) and of the offspring (broiler weight) are lower than those obtained with conventional breeders. With further improvement a lighter hen and a heavier male can bring us in the same position as the turkey industry.

—Dr F. van Wambeke

Vitamin E Important For Maternal Antibody

Parental antibody levels were significantly increased in 2 and 7-day-old chicks when the dams were fed 150 and 450 parts per million (ppm) vitamin E in their ration prior to being immunised with the bacterium, *Brucella abortus*, according to D.W. Jackson, G.R.J. Law and C.F. Nockels, Colorado State University, Fort Collins, USA.

When dams were fed 90, 300 or 900 ppm vitamin E, there was no increase in parental antibody titres in their chicks when compared with controls.

These results indicate that proper vitamin E supplemental levels fed to immunised hens could improve chick antibody titres and give them added protection.