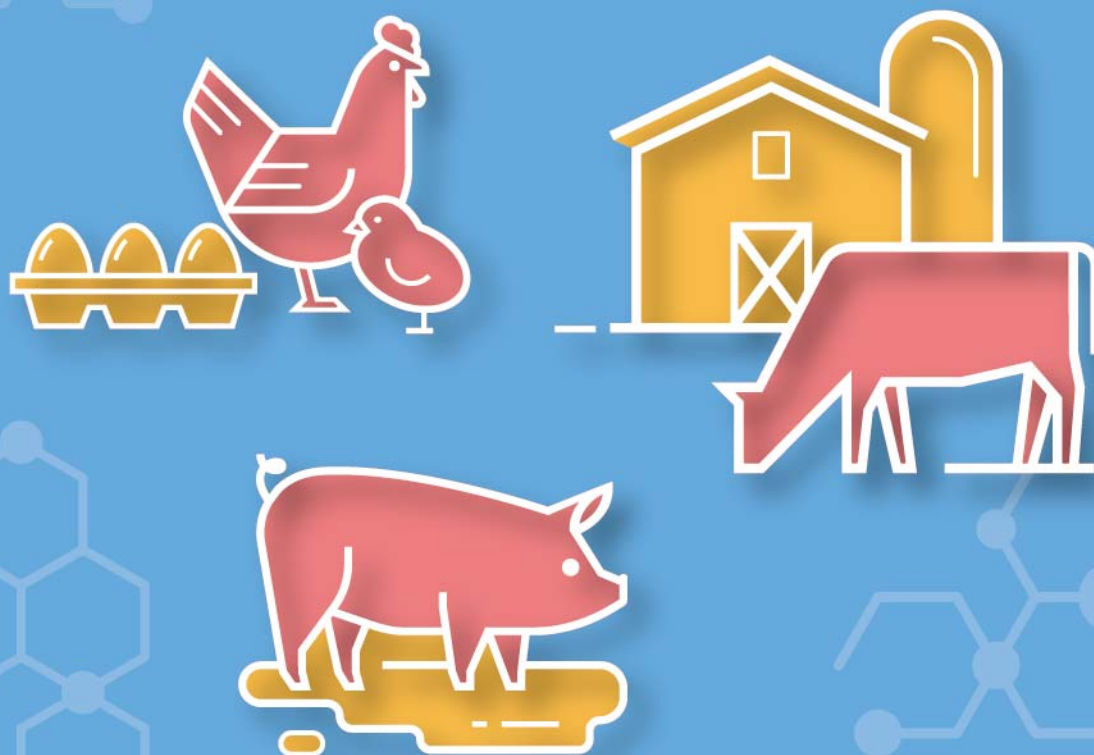


Taiwan Livestock Research Institute

Ministry of Agriculture

Biennial Report
2022-2023



Published by Taiwan Livestock Research Institute, Ministry of Agriculture

Foreword



The Taiwan Livestock Research Institute is an animal research and development unit under the Ministry of Agriculture. The Institute is responsible for the establishment of animal resource, industrial technology and practical research. A total of 279 research projects have been carried out in 2022 and 2023. The Taiwan Livestock Research Institute has made outstanding progress through these projects. The projects of this research were fundamentals, animal industry upgrading, commercialization, and sustainable management. The results of the research projects were divided into five fields: animal genetics and physiology, animal nutrition, forage crops, livestock management, and processing of animal products. These research results have been published and are listed in the published papers. In addition, the biennial report showed that the activities of the researchers such as scientists sent abroad, training courses, seminars, and symposia. This biennial report was the culmination of work completed in 2022 and 2023. Your comments and suggestions would be greatly appreciated.

Taiwan Livestock Research Institute, Ministry of Agriculture,
Director General

Dr. *Jeng-Fang Huang*

November, 2024

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01

Research and Development

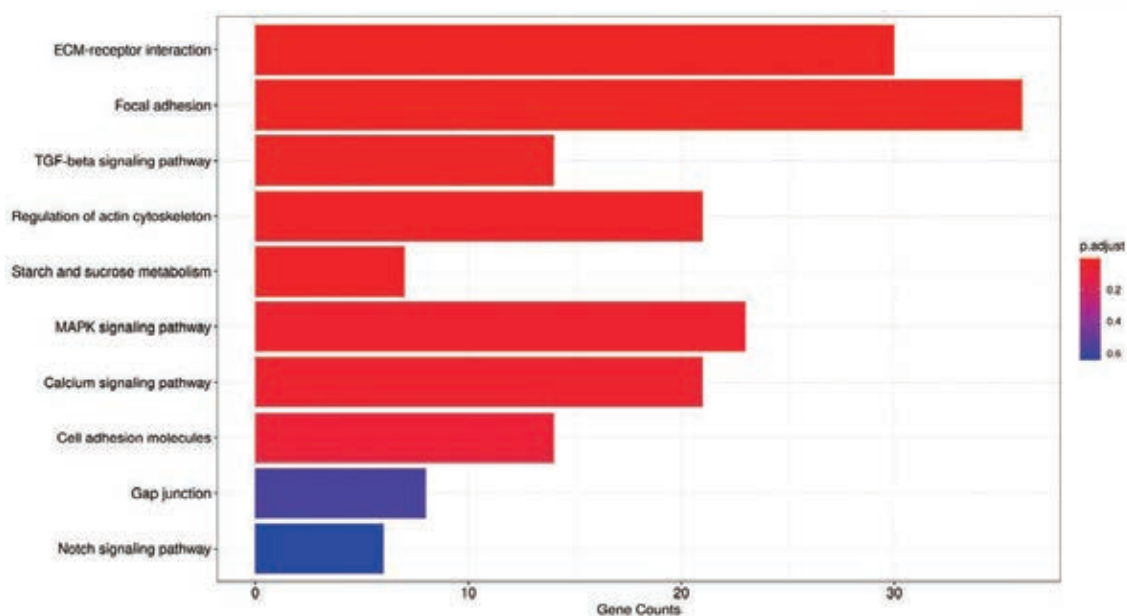
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Study on RNA expression of egg production tissues in the silkie chicken

The purpose of this study was to compare the differences in the transcriptomes of the egg production tissue of silkie chickens with relatively high and low egg production rates and screen candidate genes for egg production rate. Illumina RNA seq was used to analyze the gene expression of the egg production tissue of silky chickens with high egg production rate (H group) and low egg production rate (L group). The results showed that 680 differentially expressed genes (DEG) were identified between H and L groups, including 315 down-regulated and 365 up-regulated in the H group. Gene Ontology analysis showed that the most DEG were related to biological processes, which mainly related to cell development processes, cell differentiation and morphology

for up-regulated genes, and posttranscriptional regulation and negative metabolic regulation for down-regulated genes. Kyoto Encyclopedia of Genes and Genomes analysis showed that up-regulated DEGs were mainly related to ECM receptor, cell cytoskeleton, and starch and sucrose metabolism, and the downregulated DEG were mainly related to Neuroactive ligand-receptor, beta-Alanine and nitrogen metabolism, and progesterone-mediated oocyte maturation. In conclusion, intercellular signaling pathways, metabolic pathways, and estrogen signaling pathways may play an important role in regulating egg production.

(H. Y. Kuo)



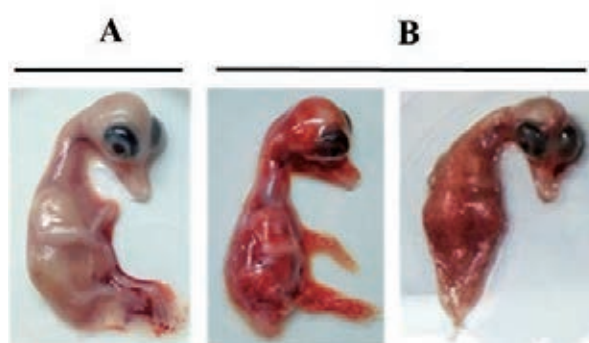
The top ten KEGG pathway information on the up-regulated genes in silkie chicken

Study on the application of waterfowl iPSC cell line in vaccine production

Currently, waterfowl parvovirus vaccines are produced by using Muscovy duck embryonated eggs. When a nationwide endemic situation occurs, large amounts of clean fertilized duck eggs will be seriously demanded. However, once an outbreak of avian influenza occurs, the Muscovy duck will also be attacked and largely impair the source of the embryonated eggs. Therefore, an alternative matrix for vaccine production becomes a top priority. The purpose of this study was to establish Muscovy duck induced pluripotent stem cell (diPSC) lines, and evaluate their potential for vaccine productions. The results showed that the diPSC successful domestication can be cultured in DMDM + 2% FCS have been maintained in vitro for more than 65 passages. The cells were recovered after virus infection and detected by polymerase chain reaction (PCR). The results were positive, which confirmed the host cells of waterfowl parvovirus. The titers of TCID₅₀ and

EID₅₀ of the recovered virus were 10-5.42 / 0.1 mL and 10-4.77 / 0.2 mL, respectively. In the future, we will evaluate the potential of this cell line for vaccine production.

(J. F. Liou)



Effect on Muscovy duck embryos of Muscovy duck parvovirus inoculated at 14 days of age.

A: Uninoculated control.

B: Five to six days after infection, the embryos were slightly stunted and severely hemorrhage over their whole body.

Research and application of frozen semen technology in breeding goose

In order to help the goose breeders preserve the genetic material of the breeding stock, delay inbreeding depression and gene loss of the breeding goose, this study continues to improve the quality of gander frozen semen by optimizing the frozen semen technology. In 2023, the frozen semen (added 9% dimethyl acetamide (DMA), 12% DMA or 9% dimethyl sulfoxide (DMSO) as the antifreeze), which sperm motility was more than 20% and sperm survival rate was more than 45% after thawing, were selected to thaw and artificially inseminated. Among them, eggs from the 12% DMA group had the best fertilization



Semen collection of goose

rate; while the eggs in the 9% DMSO group had the worst. Statistical analysis was conducted on the semen quality after thawing of the above three types of frozen semen. The results showed that the semen quality analysis values of the 9% DMSO group were not significantly different from those

of the other two groups. Therefore, the reason why the 0% egg fertilization rate found in the 9% DMSO group should be further confirmed.

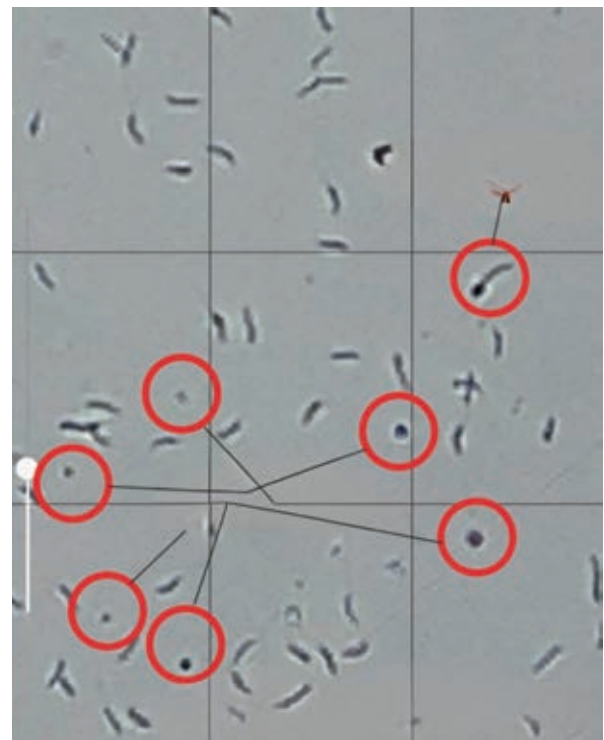
(T. W. Chuang, C. H. Cheng, M. J. Lin and S. D. Wang)

Maintenance and utilization of diversity in Chinese geese

Chinese geese (*Anser cygnoides domesticus*) were divided into brown and white according to their feather color, and were mainly used for meat in Taiwan. Compared to the White Roman geese, the Chinese geese were inferior in terms of economic traits such as growth and reproductive performance, and the market share in Taiwan's goose industry is only about 3%. This study aimed at maintaining the characteristics of Beidou White goose LRI 2 and Beidou Brown Goose LRI-1, and continuously breed the purebred breeds then update the pedigree. This year, a total of 317 offspring of Beidou White goose LRI 2 and Beidou Brown Goose LRI-1 were reserved, whereas a total of 49 doses of somatic cell and frozen semen were cryopreserved. After investigating the breeding situation of Beidou White goose LRI 2 and Beidou Brown Goose LRI-1 in breeding season (2023), it was found that the fertilization rate of eggs of flat-fed geese were higher than those of cage-fed geese. The cage-fed Beidou Brown Goose LRI-1 had the significantly lowest egg fertilization rate ($P < 0.05$), while the hatching rate of fertilized eggs had no significant difference between breeds and feeding methods. In addition, the semen volume, sperm concentration and sperm aberration rate of Beidou White goose LRI 2 ganders significantly impacts its semen quality in different breeding season.

Except for the sperm deformity rate, the semen quality of Beidou Brown Goose LRI-1 ganders was related to the semen quality. A significant positive correlation between spermatozoa and age ($P < 0.05$).

(T. W. Chuang, C. H. Cheng, C. Y. Lien and S. D. Wang)



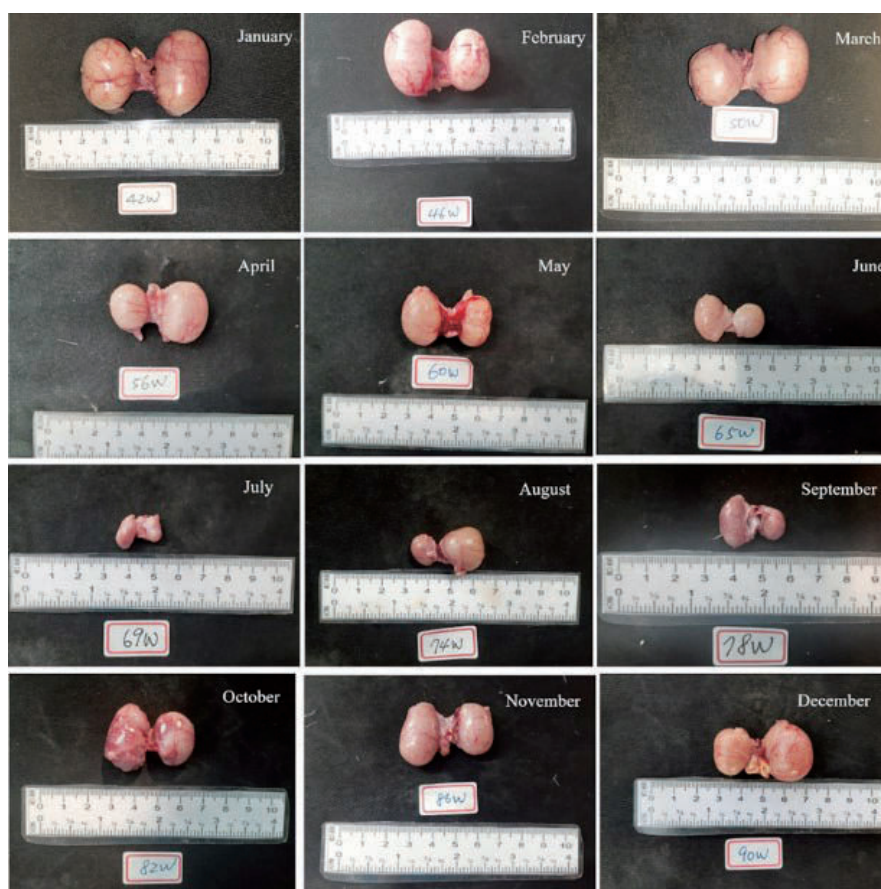
Goose semen quality analysis: The red circled part was abnormal sperm

Investigation on testicular morphology and semen quality of White Roman ganders in cool and hot seasons

This study aimed to establish data on semen quality and testicular morphology for White Roman ganders. Forty-six 40-week-old White Roman ganders were utilized. The cloacal temperatures of 10 ganders were collected every month from January to December, and 3 ganders were sacrificed monthly to record testicular weights and analyze testicular morphology. The temperature and humidity in the goose house were recorded during the test period. In addition, semen was collected from 10 ganders per month from January to June, and semen volume, semen concentration and sperm motility were recorded.

The results showed that temperature and humidity index (THI) in the goose house was higher from July to September, and the cloacal temperature of White Roman ganders were higher during July to September and November. The testicular weight of mature White Roman ganders was heaviest in February and lightest in June. The diameters and shapes of testicles were smaller in June and July. Semen volume was largest in February, and the sperm motility was higher in February, March and April.

(S. H. Chuang, T. W. Chuang, C. M. Lin and S. D. Wang)



Variation of testicular morphology of White Roman ganders in different months

Comparison of the effects using different ultrasonic guidance probes on oocyte collection in culled cows

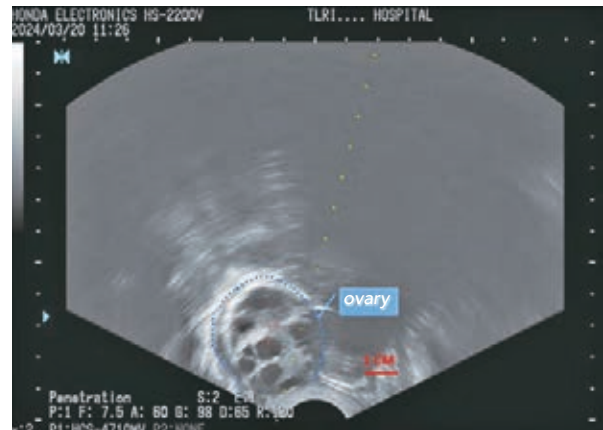
An OPU system consists of 3 major components: an ultrasonographic scanner with an appropriate transducer (probe), an aspiration pump, and a needle guidance system connected to an oocyte collecting tube. The aim of this study was the comparison of the effects using different ultrasonic guidance probes and needles on oocyte collection in culled cows. The result shows that oocytes recovery rate guided by France and Japanese probes were 45% and 54%. Rate of recovery oocytes with intact cumulus cell were

75% and 85%. On Average, about 3.5 of oocytes were collected on each culled cow. In summary, given the importance of an intact cumulus cell investment for oocyte maturation and future developmental capacity, any damage to the COC caused by the aspiration procedure has to be assessed for a given system so that preventive procedures can be taken.

(T. Y. Kuo, L. H. Hung, F. H. Chu, C. X. Lee, C. L. Lee, S. S. Liang, G. J. Fan and J. R. Yang)



Ovum-pick up



Ultrasonographic scanner to vision the ovary and follicles

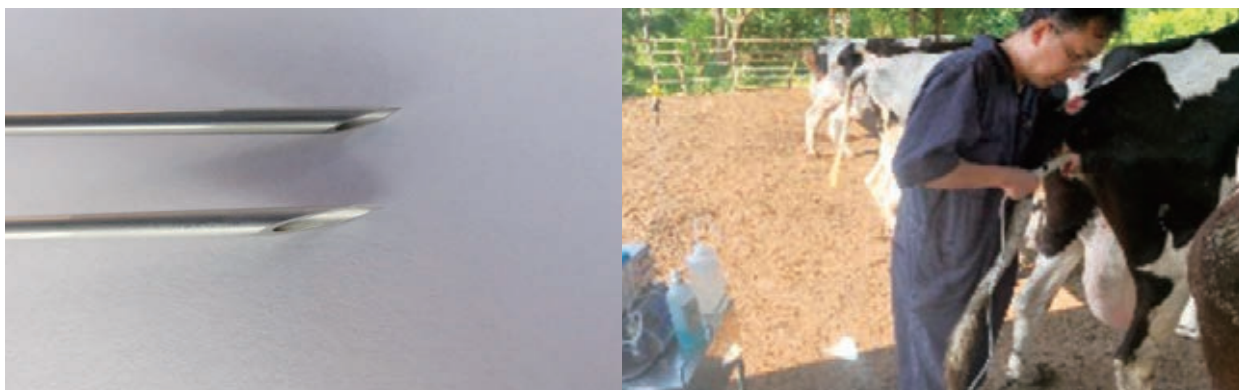
Improved efficiency of oocytes collection from dairy cattle

The application of artificial reproductive technologies aimed to improve the economic benefits of livestock. Among these technological applications, *in vitro* embryo production (IVEP) has attracted attention, and its application in the livestock industry continues to increase. The number of bovine embryo transfers worldwide has increased tenfold in the past decade (200,000 to 2 million/year), of which oocytes collection combined with *in vitro* embryo production (OPU-IVP) accounts for the majority (reaching more

than 68% in 2022), which has become The key research and development direction was to improve the efficiency of cattle breeding and increase unit output. The purpose of this study was to evaluate the effectiveness of Ovum Pick Up in collecting oocytes from dairy cattle. The ovaries were fixed in the rectal veterinary examination method and the oocytes in the ovarian follicles were aspirated using an ultrasonic imaging probe combined with an oocyte collection probe. In this way, the operation process requires skilled skills

to achieve a recovery rate of more than 60%. The surface-coated probe can effectively improve the development effect on the ultrasonic display

screen, and can increase the recovery rate by an average of 7% compared with traditional probes. (F. H. Chu, T. Y. Kuo, Y. H. Chen and J. R. Lee)



Comparison of the cutting angle of the COVA coated oocytes collection probe (top) compared with the traditional probe. The operation of ovum pick up from dairy cows (right)

Investigation on birth weight uniformity of KHAPS black pig

The poor weight uniformity would cause feeding and management problems and increase the cost of pork production. It was necessary to collect the basic information and the performance record of breeding stock for genetic evaluation. We analyzed the farrowing data from 46 KHAPS black pig sows by recording the birth weight of piglets and evaluating the birth weight uniformity. The birth weight of KHAPS black piglets was 1.15 ± 0.27 kg, the litter size was 12.67 ± 3.39 , and the number of piglets born alive was 10.63 ± 2.92 . The within-litter birth weight ranged from 0.85 to 1.64 kg, and the within-litter birth weight standard deviation ranges from 0.08 to 0.44 kg. The parity was divided into 5 groups including 1st, 2nd, 3rd, 4th and 5-6th parity for comparison. The results showed that the 2nd and 3rd parity of sows had higher litter size and number of piglets born alive than the first parity sows. When comparing the different groups of within-litter birth weight standard deviation or coefficient of variation, it was found that the poor weight uniformity at birth was accompanied by the poor weight uniformity

at weaning. The performance of weight uniformity was affected by many factors such as genetics, environment, feeding and management. We were going to get more information on the sow's reproductive performance and establish breeding strategy. Final goal was to improve the uniformity of birth and market weight of black pigs.

(L. L. Peng, H. S. Wang, S. C. Chang, H. J. Huang, H. M. Liang, L. H. Chen, C. W. Chou and J. R. Yang)



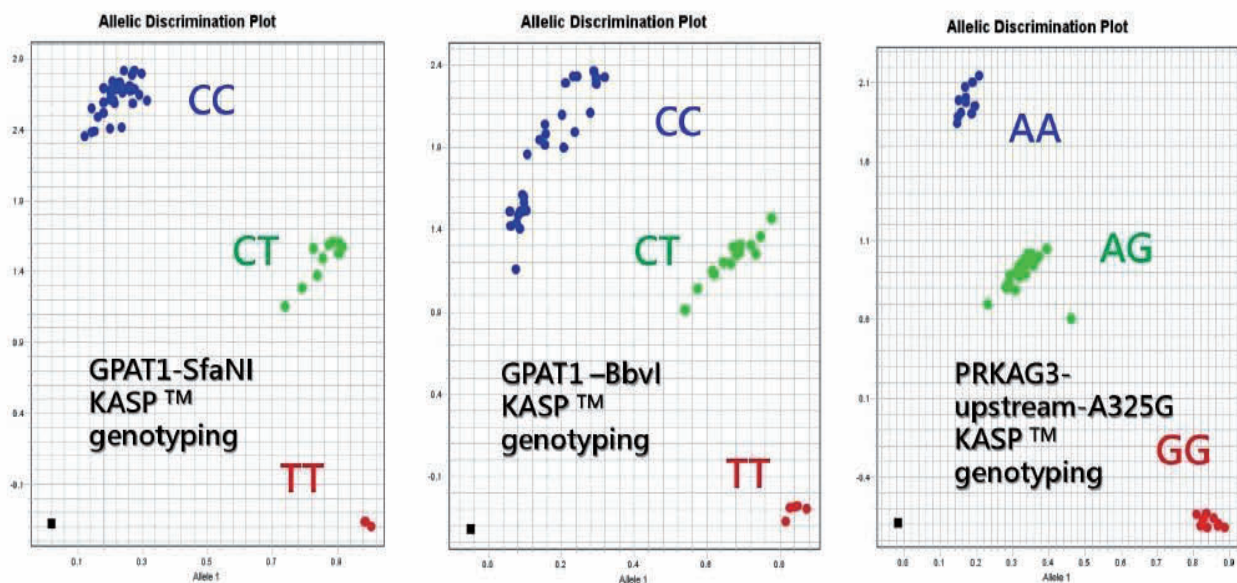
Collection of piglet birth weight data

Genotypic analysis of single nucleotide polymorphism on GPAT1 and PRKAG3 genes in commercial pigs

Intramuscular fat (IMF) content is one of the key factors affecting pork tenderness, juiciness, odor, and flavor. The literature indicated that GPAT1 (Glycerol-3-phosphate acyltransferase 1) and PRKAG3 (protein kinase AMP-activated non-catalytic subunit gamma 3) genes significantly affect the IMF content and pH value of the *longissimus dorsi* muscle in pig. This study aimed to develop a genotyping method in pig breeds using real-time PCR technology. Thirteen Duroc, thirteen Landrace, eight Yorkshire, and thirteen black pigs were randomly sampled for genotyping. Preliminary results showed that the CC genotype frequencies of the above breeds

at the GPAT1- SfaNI site were 31, 100, 100, and 62%, respectively; the GPAT1-BbvI site were 39, 39, 63 and 100%, respectively. However, the AA genotype frequencies for PRKAG3-A325G were 46, 23, 75, and 23%, respectively. In the future, we will further analyze the correlation between the above GPAT1 and PRKAG3 gene mutations and the IMF content of pig *longissimus dorsi* muscle to clarify their impact.

(C. T. Chu, D. Y. Lin, Y. Y. Lai, M. C. Wu and H. L. Chan)



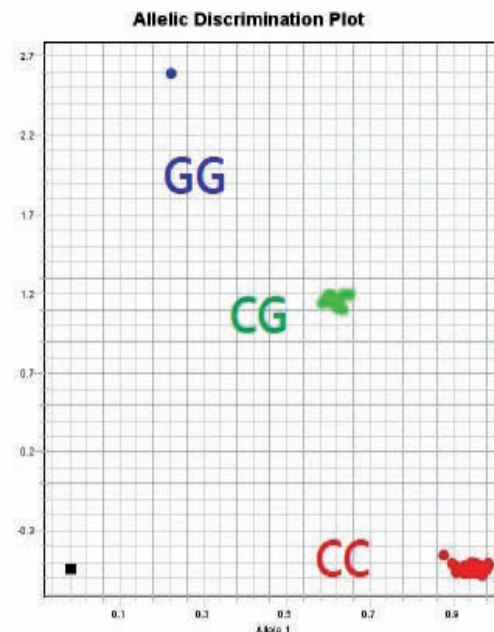
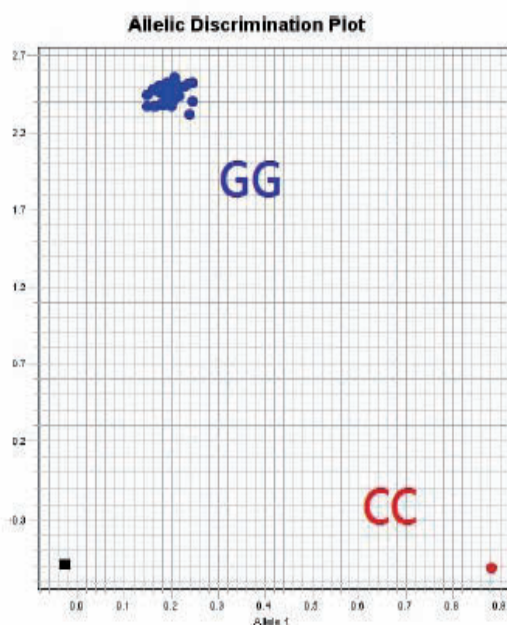
Genotyping cluster plots of GPAT1 and PRKAG3 genes by the kompetitive allele-specific PCR (KASP™) assay

Genotypic analysis of single nucleotide polymorphism on OC-116 gene in commercial native chicken and layer by real-time PCR platform

The hatchability is one of the key factors affecting the supply of market chicks and economic benefits, and it is significantly influenced by the eggshell thickness. The aim of this study was to develop a genotyping method for SNP of ovocleidin-116 in commercial native chicken and layer by using real-time PCR technology labeled with kompetitive allele-specific polymerase chain reaction (KASP). Commercial red feather native chicken, silkie, and Lohmann layers were randomly sampled for DNA extraction and

genotyping with 50 birds per breed. Preliminary results indicated that the allelic frequency of cytosine in commercial red feather native chicken, silkie, and Lohmann layers were 0.85, 0.2, and 1, respectively. The effect of OC-116-C1336G on eggshell thickness and hatchability will be further investigated to confirm the essential influence.

(C. T. Chu, D. Y. Lin, Y. Y. Lai, M. C. Wu and H. L. Chan)

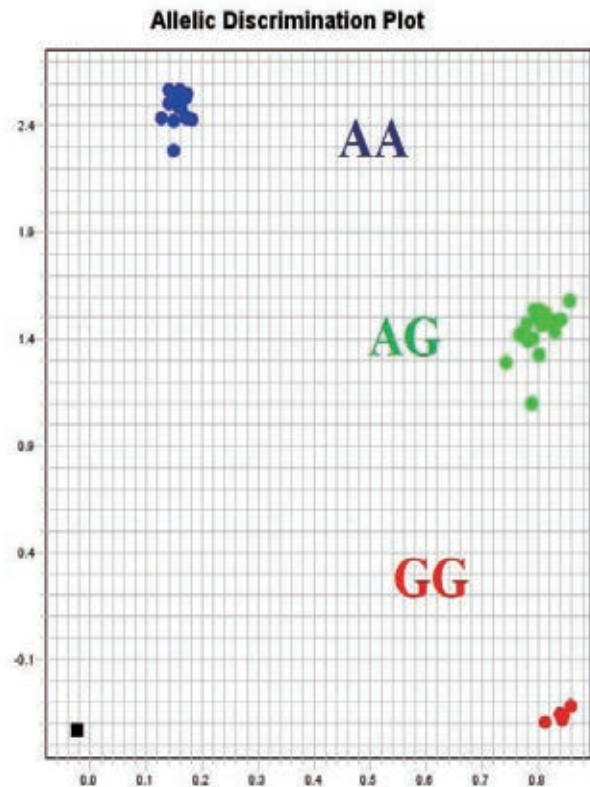


Genotyping cluster plots of OC-116 gene by the kompetitive allele-specific PCR (KASPTM) assay. The genotyped samples marked blue were GG homozygotes; those marked red were CC homozygotes; those marked green were CG heterozygous. Black was the control sample.

Genotypic analysis of single nucleotide polymorphism on UBE3C gene in commercial pigs by Real-time PCR platform

Intramuscular fat content (IMF, %) is one of the key factors relating to pork tenderness, juiciness, odor, and flavor. Research reported that significantly higher IMF (%) of the longissimus dorsi muscle (LD) was found in Duroc pigs with AA genotype than those of AG type (5.963 ± 0.339 vs. $4.169 \pm 0.555\%$, $P < 0.05$). The aim of this study was to develop a genotyping method for SNP of UBR3C-intron6 in commercial pig breeds using real-time PCR technology labeled with fluorescent primers (FAM/HEX-labeled Primer). The 72 Duroc, 44 Landrace, 17 Yorkshire, and 47 black pigs were randomly sampled for g.1586399A>G genotyping and IMF (%) measured. Preliminary results showed no polymorphisms in the three international commercial breeds were observed. The paternal breed, Duroc, was dominated by the wild-type allele A with a frequency of 0.95, while no wild-type allele was found in samples from the maternal breeds, Landrace, and Yorkshire. However, in the black pig samples, the frequency of the wild-type allele A was 0.65. The relationship between the point mutation genotype of UBE3C gene and the IMF content of LD in black pigs remains to be further elucidated.

(C. T. Chu, D. Y. Lin, Y. Y. Lai, M. C. Wu and H. L. Chan)

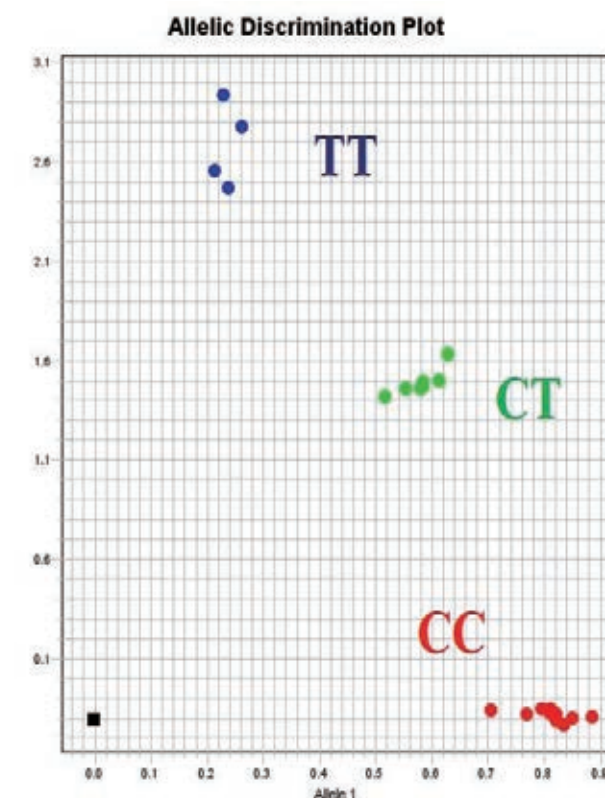


Genotyping cluster plots of UBE3C gene by the competitive allele-specific PCR (KASP™) assay. The genotyped samples marked blue were AA homozygotes; those marked red were GG homozygotes; those marked green were AG heterozygotes. Black was the control sample.

Preliminary study on SNP genotyping with real-time PCR for OCX-32-exon4 in native broiler and layer

Hatchability is of economic importance to the poultry industry due to its significant impact on chick yield and the supply of chicken to the market, which is related to the thickness of the eggshell of hatching eggs. Ovocalyxin-32 gene was mapped on chromosome 9 of chicken. QTL analysis showed that SNPs of ovocalyxin-32 family genes were associated with egg production traits. The objectives of the present study were to detect OCX-32-exon4 point mutation by developing real-time PCR method, and to investigate the association between this SNP and egg production traits, eggshell thickness and hatchability, in commercial native chicken and layer. Commercial pedigreed Red Feather Native chicken, Silkie and Lohmann layers were randomly sampled for DNA extraction and genotyping with 50 birds per breed. Preliminary results indicated that only red-feather native chickens showed g.6144T>C polymorphisms with allelic frequency of C being 0.67. The effect of this mutation point on eggshell thickness and hatchability will be further investigated to confirm the potential application on early selection programs.

(C. T. Chu, D. Y. Lin, Y. Y. Lai, M. C. Wu and H. L. Chan)



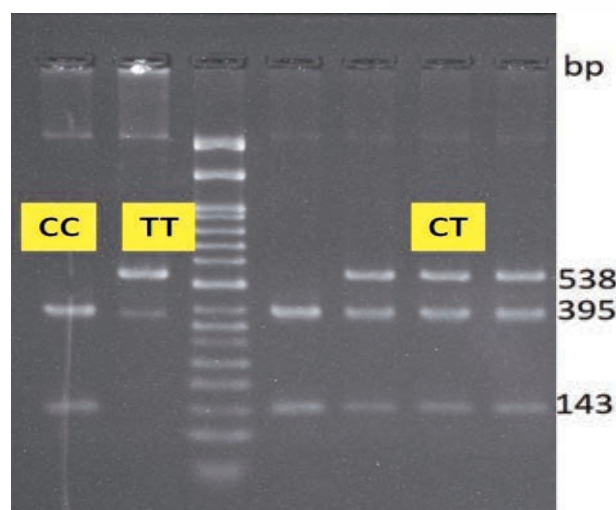
Genotyping cluster plots of OCX-32-exon4 by the kompetitive allele-specific PCR (KASP™) assay. The genotyped samples marked blue were TT homozygotes; those marked red were CC homozygotes; those marked green were CT heterozygous. Black was the control sample.

Frequency analysis of a litter size trait candidate marker EXOC4 in stock pigs

The EXOC4 genetic marker is one of the candidate markers for pig litter size traits. The purpose of this study was to screen the EXOC4 genotypes of stock pigs in breeding farms to understand the frequency of favorable genotypes or allele indicated in the literature, and to further evaluate the markers for industrial applicability. DNA samples were collected from 942 pigs of 9 breeding farms, including 371 Duroc, 414 Landrace and 157 Yorkshire. The analysis results show that the percentages of CC, CT and TT genotypes in all tested pigs were 66.35, 28.13 and 5.52%, respectively; the CC, CT and TT genotype percentages of individual breeds of Duroc, Landrace and Yorkshire pigs were 50.67, 38.54, 10.78% vs. 70.53, 27.05, 2.42% vs. 92.36, 6.37, 1.27%, respectively. Analyzing the genotypes of 109 sows with litter size traits, the percentages of CC, CT and TT genotypes were 77.06, 18.35 and 4.59% respectively. In addition, preliminary analysis of the association between genotypes and litter size traits show that the Duroc and Landrace sows with CT genotype had higher mean litter

size than CC and TT ones. However, this part still needs to continue to collect, analyze, and verify data on litter size traits in order to evaluate the applicability of EXOC4 as a breeding marker for pigs.

(R. B. Liaw, S. Y. Wang, Y. S. Yu, J. C. Chen, Y. Y. Lai, K. J. Liu and M. P. Cheng)



Genotyping of EXOC4 gene by PCR-RFLP/Mbil

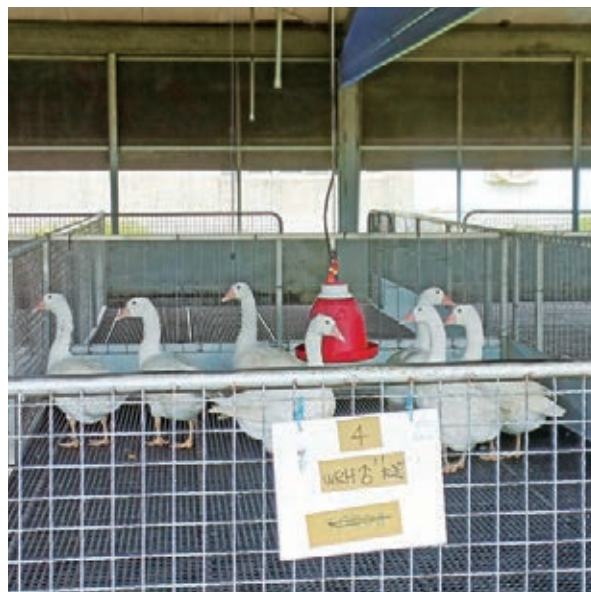
Investigation of growth performance and blood biochemistry in White Roman geese and microclimate of rooftop-type solar photovoltaic house

The aim of the study was to investigate the growth performance and blood biochemistry of White Roman geese and the microclimatic observation in rooftop-type solar photovoltaic goose houses. A total of one hundred forty-four geese at 6 weeks of age were randomly divided into the control and the treatment groups, with 6 males and 6 females per pen (6 replicates). Geese body weights were recorded every two weeks and the blood samples

were collected at 14 weeks of age. Additionally, the microclimatic observations of rooftop-type solar photovoltaic houses were monitored. The results showed that there was no significant difference between the control and treatment groups in geese body weight. However, the concentration of glutamic-pyruvic transaminase and triglycerides in geese reared in the rooftop-type solar photovoltaic houses were significantly

higher than those reared in the indoor rearing house ($P < 0.05$). Moreover, the concentrations of total cholesterol and high-density lipoprotein in plasma were significantly lower in the rooftop-type solar photovoltaic house ($P < 0.05$). The average environmental temperature inside and outside the rooftop-type solar photovoltaic house was about 31°C and 34°C, respectively, which was 1-3°C lower than the control group. In conclusion, geese reared in the rooftop-type solar photovoltaic house did not show the better growth performance. However, it had positive impacts on geese blood biochemistry and environmental temperature of geese houses, which could be adopted in the goose industry.

(C. C. Hsiao, C. Y. Lien and S. D. Wang)



The geese feeding

Genetic diversity analysis of registered goat through microsatellite markers- Nubian goat population

Nubian goats exhibit excellent performance in growth and kidding rate; also, their milk fat content is superior to other dairy goat breeds. Their dual-purpose characteristics for both milk and meat have led to their widespread use in Taiwan's goat farming industry. Since the initiation of goat registration in 1995, Nubian goats have been included, with a systematized breeding system established through records of appearance, pedigree, and performance. In recent years, the application of biotechnologies has not only helped goat farmers eliminate the adverse G6S gene but has also enabled further understanding of the genetic diversity within Taiwan's Nubian goat population. This study analyzed the genetic diversity of 212 registered Nubian goats from two farms in southern Taiwan using microsatellite genetic markers. The analysis of 16 microsatellite markers, including MAF065, MCM527, TCRVB6, SRCRSP9, OarFCB48,

CSRD247, SRCRSP23, INRA063, OarAE54, ILSTS005, SPS113, SRCRSP8, ILSTS087, INRABERN172, ILSTS029, and DRBP1, revealed 188 alleles with an average of 11.75 alleles per locus. The expected heterozygosity ranged from 0.019 to 0.780 with an average of 0.641, observed heterozygosity ranged from 0.019 to 0.750 with an average of 0.608, and polymorphic information content ranged from 0.019 to 0.750 with an average of 0.599. Among these markers, 14 displayed high polymorphic information content ($PIC > 0.5$). Thus, these 14 microsatellite markers could be used as a basis for monitoring the genetic diversity of the Nubian goat population, understanding their genetic structure and kinship, and providing a foundation for the future selection and preservation of goat genetic resources in Taiwan.

(C. J. Hsieh, J. C. Chen and D. Y. Lin)

Results of microsatellite marker analysis for the Nubian goat population

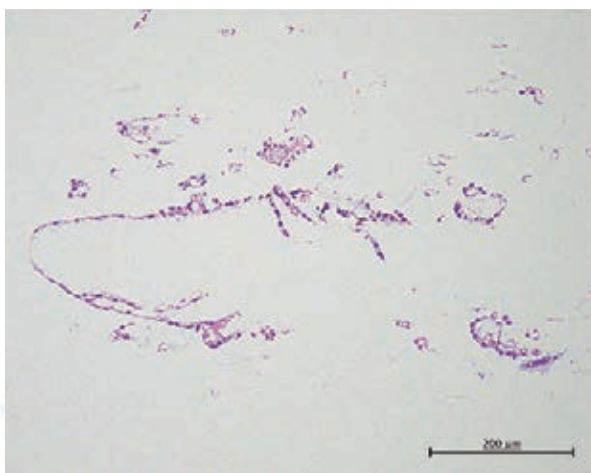
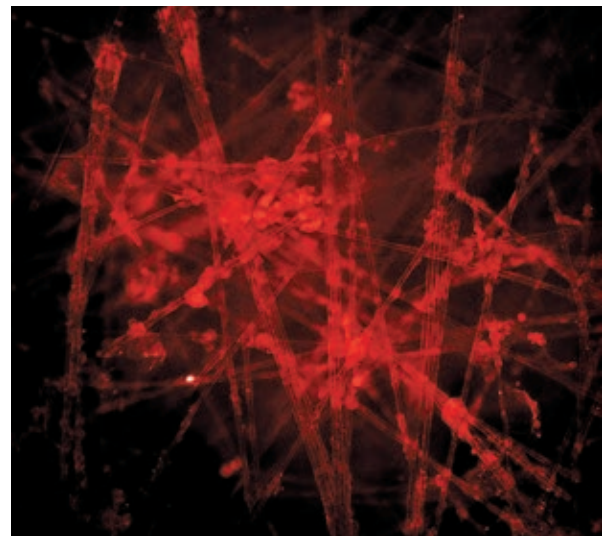
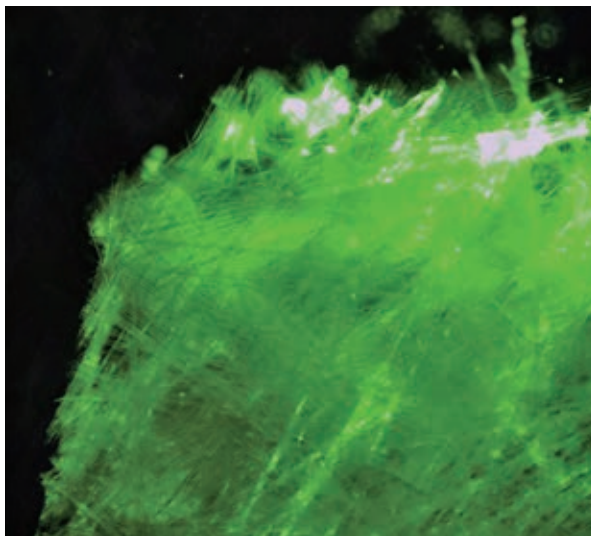
Marker	Number of alleles	Expected heterozygosities	Observed heterozygosities	PIC values	Observed fragment sizes (bp)
MAF065	14	0.665	0.660	0.645	112-138
MCM527	7	0.555	0.547	0.511	153-171
TCRVB6	17	0.737	0.750	0.698	222-264
SRCRSP9	15	0.726	0.722	0.681	102-132
OarFCB48	10	0.655	0.660	0.613	150-168
CSRD247	12	0.780	0.741	0.750	218-242
SRCRSP23	17	0.614	0.656	0.573	83-109
INRA063	8	0.641	0.660	0.576	162-180
OarAE54	13	0.729	0.689	0.694	118-134
ILSTS005	4	0.019	0.019	0.019	176-188
SPS113	13	0.780	0.731	0.745	136-154
SRCRSP8	15	0.698	0.613	0.653	227-247
ILSTS087	9	0.739	0.613	0.697	141-155
INRABERN172	7	0.669	0.651	0.614	233-245
ILSTS029	10	0.540	0.571	0.462	142-164
DRBP1	17	0.705	0.453	0.656	102-134
Mean	11.75	0.641	0.608	0.599	

Growth technology of porcine induced pluripotent stem cells on scaffolds

Currently, there is no research on the growth of porcine induced pluripotent stem cells (piPSCs) on artificial scaffolds. To understand their growth behavior for subsequent tissue engineering research, this study induced the differentiation of piPSCs into endothelial cells (ECs) and then cultured them on SeedEZ 3D membranes to observe their growth, thereby establishing the technology for piPSC growth on artificial scaffolds. The results showed that after one month of culture on SeedEZ 3D membranes, the differentiated ECs still expressed EC antigens such as CD31 and vWF, indicating that the cells maintained EC characteristics. Further

observation of the SeedEZ 3D membrane tissue sections revealed that the cells interconnected to form strip-like structures and tube-like formations. Although Masson's trichrome staining did not show blue connective tissue structures, red EC tissue was observed. Future efforts will continue to improve culture conditions to optimize cell coverage and utilize this as a material for the production of tissue-engineered vascular grafts (TEVGs), aiming to eliminate the use of animal-derived vascular scaffolds and fulfill the 3Rs principle of replacement, reduction, and refinement in animal experimentation.

(Y. J. Liao and J. R. Yang)



The piPSCs grew on SeedEZ 3D membranes. The ECs derived from GFP expressing piPSCs can grow on SeedEZ 3D membranes. They exhibited green fluorescence (left) and expressed CD31 antigen (middle). Additionally, tissue sections revealed that cells tightly interconnected in a tube-like formation (right).

Analysis on the uniformity of body weight of breeding roosters and their offsprings in Taiwan native chicken Taizhu No. 1 inbred lines

Uniformity of body weight is a very important management tool and an important economic trait in the chicken industry. In order to explore the impact of the body weight of breeding roosters on the uniformity of the marketing body weight of their offspring, this study used the 16-week-old body weights of 266 breeder chickens of the G14 generation and 2,017 growing chickens of the G15 generation of four inbred lines of Taiwan native chicken Taizhu No. 1 to conduct uniformity analysis. The 16-week-old body weight of male and female chickens of each line was divided into high-weight group, medium-weight group (M) and low-weight group. We analyze the 16-week-old body weight of the offspring between the medium body weight group and all breeding roosters group (AL), and compare their coefficients of variation. The results showed that there were significant differences in body weight at 16 weeks of age between strains and genders ($P < 0.001$), but there was no significant difference between groups. The standard deviation of body weight at 16 weeks of age was significantly different between genders ($P < 0.001$), but there was no significant difference between strains and groups. There was a significant difference in the variation coefficient of body weight at 16 weeks of age between groups (P

< 0.05), but there was no significant difference between strains and genders. The offspring of roosters in the medium weight group have lower The coefficient of variation reflects better uniformity. This study used a small population of native chicken breeders and their offspring to conduct uniformity analysis at 16 weeks of age. The results showed that the offspring of the medium-weight group of roosters had a lower variation coefficient than the offspring of the all-breeding rooster group, reflecting better uniformity. This degree can be used as a reference for chicken breeders to select breeding roosters for producing broiler chicks.

(D. Y. Lin, S. J. Tzeng, Y. Y. Lai, C. M. Hung, M. Y. Tsai and C. T. Chu)



Rooster and hen of Taiwan native chicken Taizhu No. 1 inbred line L7

Analysis of sperm quality in roosters of Taiwan native chicken Taizhu No. 1 inbred lines

The fertility and hatchability of breeders are important economic traits of chickens, and the sperm quality of roosters directly affects the fertility and hatchability of eggs. In order to investigate the sperm quality of roosters in four inbred lines (L7, L9, L11 and L12) of Taiwan native chicken Taizhu No. 1, computer-assisted sperm analysis (CASA) and flow cytometer were used in this study to analyze semen of the four lines candidate roosters (28, 32, 24 and 30, respectively) for sperm quality. The average sperm concentrations ($10^9/\text{mL}$) of the four inbred line L7, L9, L11 and L12 candidate roosters were 4.269, 4.291, 3.341 and 3.340, respectively, and the sperm motility was 85.5%, 79.3%, 87.3% and 87.3%, the sperm progressive motility were 50.7%, 48.2%, 55.6% and 55.6%, respectively, and the sperm viability were 83.6%, 86.0%, 82.0% and 82.0%. The candidate roosters with sperm concentration greater than $3.0 \times 10^9/\text{mL}$, sperm motility greater than 70%, sperm progressive motility greater than 30% and sperm viability greater than 60% were selected for breeding with 6 hens of the same line for each, and hatching eggs of 20 days were hatched. The fertility of the four inbred lines L7, L9, L11 and L12 were 93.8, 90.0, 94.6 and 92.6%, respectively, the hatchability (chicks/hatching eggs) was 82.6, 69.9, 84.7 and 83.6%, and fertilized egg hatchability (chicks/fertilized eggs) were 88.0, 77.6, 89.6 and 90.3%, respectively.

The results obtained in this study can be used as the information for breeding and promotion of the four inbred lines, and can also provide a reference for pedigree breeding population of native chickens.

(D. Y. Lin, S. J. Tzeng, Y. Y. Lai, C. M. Hung, H. L. Liu, M. Y. Tsai, C. T. Chu and M. C. Wu)



Rooster of Taiwan native chicken Taizhu No. 1 inbred line L12

The effect of temperature-humidity index on semen production of male New Zealand rabbits

The purpose of this study was to compare the effects of temperature-humidity index (THI) on the semen production of New Zealand bucks, as an indicator of rabbit heat stress. The average THI of rabbit houses in our institute during the cool season from November to April was 20.3 ± 2.5 , and the average THI in the hot season from May to October was 27.6 ± 3.6 . Analysis shows that when THI is higher than 27.8, rabbits suffer heat stress 37.6% of the time. The weaning weight of bucks in the cool season was 1001.3 ± 80.5 g, which was significantly higher than that of 777.4 ± 109.0 g in the hot season ($P < 0.05$). And the frequency of mating behavior in the cool season was $100.0 \pm 0.0\%$, which was significantly higher than the $85.7 \pm 7.6\%$ in the hot season ($P < 0.05$).

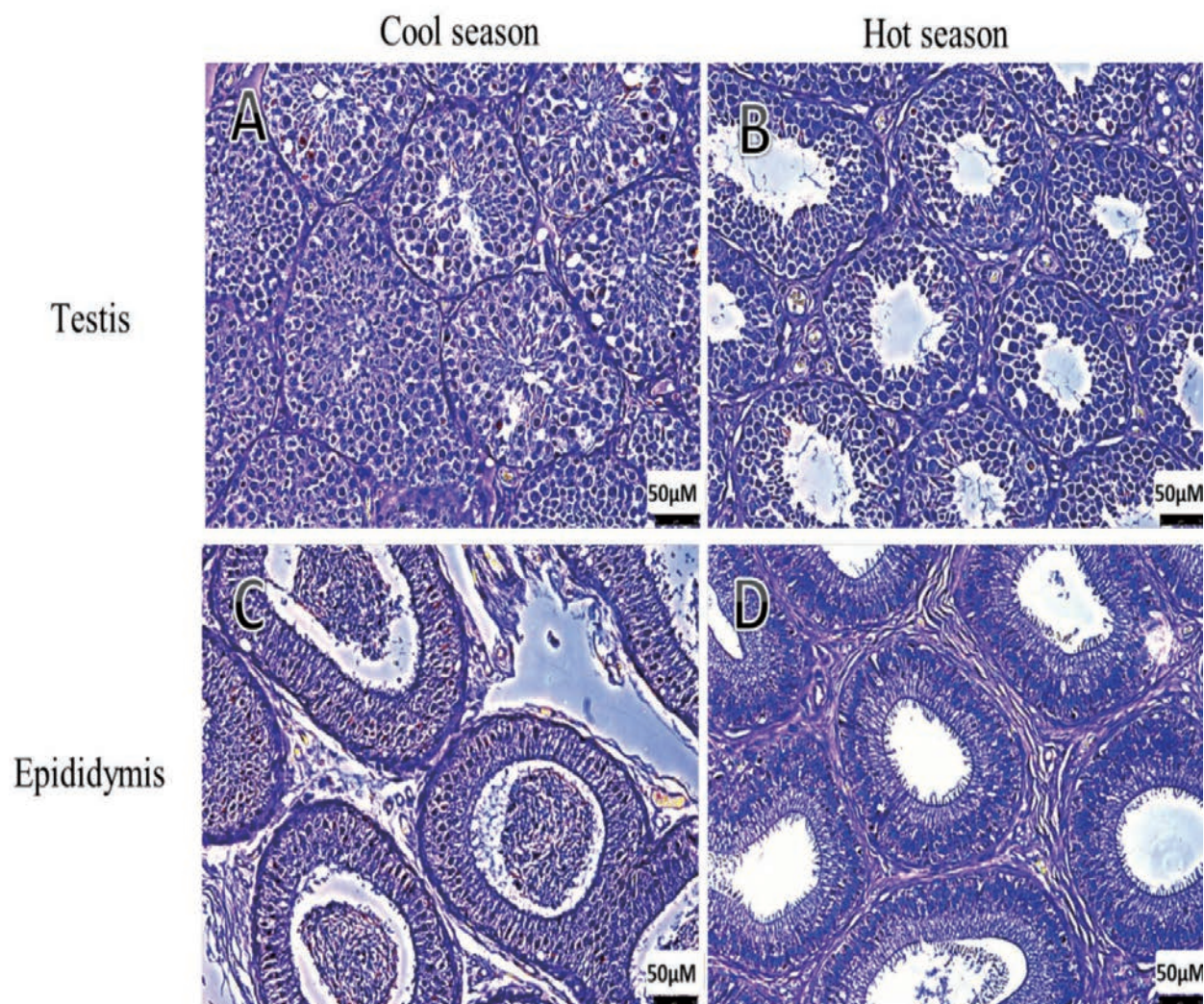
Examining the semen traits of New Zealand male rabbits in the cool season and hot season, there was no significant difference in the parameters of semen volume, sperm concentration, vitality and progressive motility, but the sperm motility during the cool season was $69.3 \pm 10.5\%$, which was significantly better than that in the hot season ($46.5 \pm 13.6\%$) ($P < 0.05$). The comparison of testicular tissue sections showed that the continuous high temperature in the environment led to a serious reduction in spermatogenesis in hot season male rabbits, which was also the reason for the decrease in male rabbit fertility in summer.

(P. C. Tsai and T. C. Kang)

Compared the semen quality of male rabbits during cool and hot season (mean \pm SD)

Items	Cool season (Nov-Apr)	Hot season (May-Oct)
No. of trials	39	77
Semen volume (mL)	1.1 ± 0.2	0.8 ± 0.2
Semen conc. (10^6 sperm / mL)	882.3 ± 342.4	914.0 ± 144.1
Motility (%)	69.3 ± 10.5^a	46.5 ± 13.6^b
Vitality (%)	67.4 ± 11.1	62.6 ± 8.0
Progressive motility (%)	33.4 ± 9.4	24.4 ± 11.5

^{a, b} Means within the same row without the same superscripts differ significantly ($P < 0.05$)

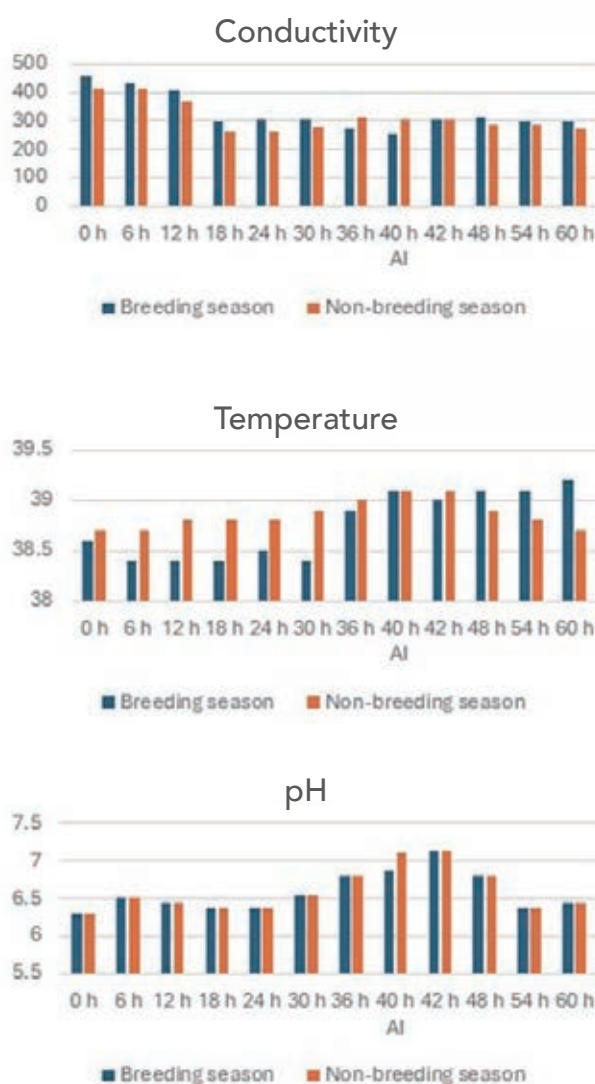


Immunohistochemistry staining of 1 year-aged rabbit testis and epididymis in cool and hot season. There were different developing stage of spermatocytes (round and elongating spermatids or mature sperm) within the lumina of seminiferous tubules of cool season male testis (A), but were not in the seminiferous tubules of hot season male testis (B). Epididymis of hot season buck showing presence of large numbers of mature sperm (C) which contracts with lack of mature sperm in epididymis of hot season testis (D). (Bar = 50 µM)

The variation in vaginal mucus conductivity, pH and temperature treated with estrus synchronization during breeding and non-breeding seasons of Albain does

During both breeding and non-breeding seasons, the variation in vaginal mucus conductivity, pH, and temperature of 283 Alpina goats were recorded following synchronization treatments. Measurements were taken every 6 hours starting from removal of the Controlled Internal Drug Release (CIDR) device at 0 hours and continued for 60 hours. Artificial insemination was conducted on all goats at 42 hours post CIDR removal, and the conductivity, pH, and temperature of vaginal mucus were recorded at this time to understand the normal values during artificial insemination. The recorded values of successfully pregnant goats after artificial insemination were analyzed for both breeding and non-breeding seasons, providing reference values for artificial insemination procedures. Results showed that at 42 hours after CIDR removal, the conductivity of vaginal mucus in pregnant goats during breeding season was 313.0 ± 7.0 mS/cm compared to 254.0 ± 13.0 mS/cm in non-breeding season, with pH values of 7.32 ± 0.05 versus 7.16 ± 0.08 , and temperatures of $39.10 \pm 0.09^\circ\text{C}$ versus $39.10 \pm 0.05^\circ\text{C}$ respectively. Except for temperature, conductivity and pH values were higher in pregnant goats during the breeding season. The changes in conductivity and pH exhibited similar waveforms in pregnant goats during both breeding and non-breeding seasons, but consistently showed higher values starting from CIDR removal (0 hours), with pregnant goats during the breeding season consistently higher than those in the non-breeding season throughout the 60-hour monitoring period. Overall, the differences in vaginal mucus conductivity between successfully pregnant goats during breeding and non-breeding seasons were 59 ± 8.4 mS/cm, pH differences were 0.16 ± 0.06 , and temperature remained constant at

39°C . Significant differences in conductivity and pH were observed in pregnant goats during breeding or non-breeding seasons, indicating that these data were capable of serving as references for synchronization treatments and subsequent applications in female reproductive management. (T. C. Kang and K. F. Tseng)



The variation of vaginal mucus conductivity, pH, and temperature in pregnant Alpine goats in breeding and non-breeding season.

The correlation between HSP70 in semen and semen performance of dairy goats

This study analyzed the heat shock protein 70 (HSP70) content and semen performance of Alpine goats. Five sexually mature dairy male goats with an average age of 18 months were used for artificial vaginal semen collection during the breeding season. The semen collection frequency was once a week and collected continuously for 15 weeks. After the fresh semen was collected, the semen characteristics were recorded and centrifuge, wash, and then analyze the HSP70 content in the sperm was. The results showed that sperm motility, acrosomal integrity, and mitochondrial depolarization performance were significant differences ($P < 0.05$). Sperm were divided into high-motility and low-motility groups

based on their motility. There were also significant differences in sperm motility, acrosomal integrity, and mitochondrial depolarization between the two groups. Comparing the characteristics of semen, the performance of HSP70 was highly positively correlated (0.9) with goat sperm motility and irrelevant to the degree of mitochondrial damage. In summary, the characteristics of HSP70 expression in sperm that were highly correlated with sperm motility and can be used as a reference for subsequent related research and development. (K. F. Tseng, T. C. Kang, C. J. Hsieh and C. C. Chu)

Motility, acrosome integrity and mitochondrial depolarized of goats sperm

Semen samples	Sperm motility (%)	Acrosome integrity (%)	Mitochondrial depolarized (%)
1	42.1±0.1 ^c	52.6±4.1 ^b	26.3±1.1 ^a
2	40.9±0.4 ^c	33.2±1.8 ^d	45.1±2.9 ^c
3	57.7±2.1 ^b	40.1±0.9 ^c	34.6±1.9 ^b
4	31.7±0.4 ^d	50.7±0.6 ^b	33.4±3.3 ^b
5	65.0±2.1 ^a	61.6±1.1 ^a	24.6±2.3 ^a

Different superscript letters (a–d) in the same column represents a significance difference at $P < 0.05$.

Correlation between HSP70 expression and different parameters for evaluating quality of goat sperm

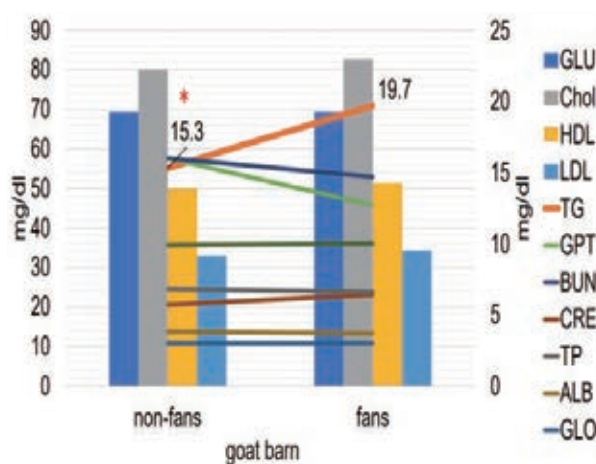
Item	HSP70 expression	Motility	Acrosome integrity	Mitochondrial depolarized
HSP 70 expression	-			
Motility	0.90	-		
Acrosome integrity	0.45	0.31	-	
Mitochondrial depolarized (%)	-0.44	-0.41	-0.92	-

Effects of fan cooling on growth, physiology and hematological traits of goats during the hot season

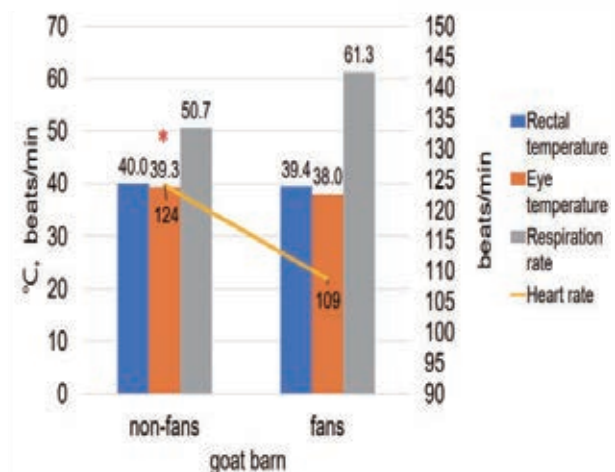
This study was to explore the effects of fans installed in livestock houses on the growth, physiological and hematological traits of goats during the hot season. Six 13-month-old Alpine wether and eight 13-month-old Nubian virgin goats were randomly assigned into control (non-fans) and treatment (fans) group according to breed. There were 2 replicates in each group, with 1 to 2 goats. The adaptation period was 7 days, and the experimental period was 60 days. The results showed that there were no significant differences in feed intake, body weight gain, conformation and average daily gains between control and treatment group. There was no significant difference in rectal temperature, respiration and heart rate between the goats in the control and the treatment group. However, the eye temperature of Alpine in the control (39.3±0.3°C) was significantly higher than that

in the treatment group (38.0±0.3°C) by 1.3°C. In addition, the triglyceride (TG) in the blood of Alpine in the control group (15.3±0.7 mg/dl) was significantly lower than that in the treatment group (19.7±0.7 mg/dl). That was, Alpine goats without fans during the hot season, the TG expression level dropped sharply, might be the high gluconeogenesis of the liver to satisfy the increased energy demand of heat stress. There was no significant difference in blood traits between groups of Nubian goats, while it was found that the red blood cells, hemoglobin and hematocrit with small ruminants' heat stress blood indicators showed higher expression levels in the controlled does, indicating that during the hot season. Without fans may cause thermal stress to the Nubian goats.

(C. C. Pan, M. C. Cheng and J. H. Wu)



The effects of fan-installation in the barn on hematological traits of Alpine wethers during the hot season.



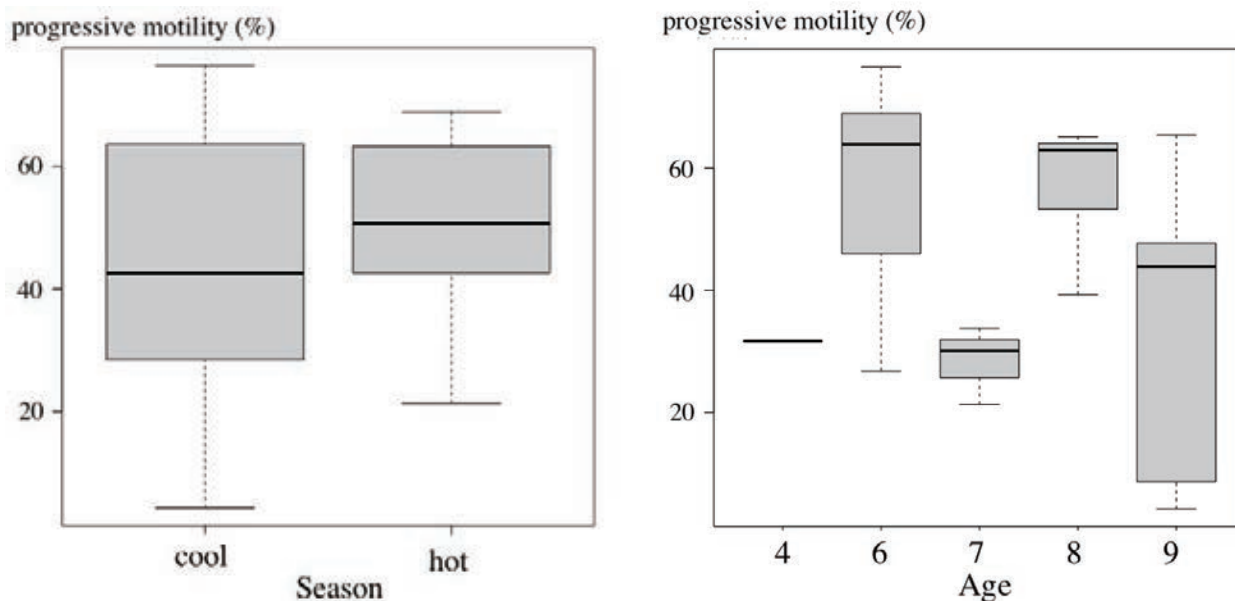
The effects of fan-installation in the barn on physiological traits of Alpine wethers during the hot season.

Annual semen quality analysis of Taiwan Yellow Cattle

Bull semen quality is an integral part of reproductive performance and an important component of beef cattle reproductive management. In order to understand the semen characteristics of Taiwan Yellow Cattle among different ages and seasons, semen from 11 bulls were collected annually in 2023. Seminal parameters including volume (ml), total motility (%), progressive motility (%), concentration (10^6 sperm/ml), post-thawed total motility (%), post-thawed progressive motility (%) were examined. The measured data in the cool season were 3.86 ± 3.1 , 76 ± 18 , 41 ± 23 , 5.89 ± 3.5 , 58 ± 14 and 15 ± 12 , respectively. In the hot season, those were 2.68 ± 1.28 , 87 ± 7 , 50 ± 15 , 6.7 ± 6.04 ,

57 ± 15 and 21 ± 11 . Although there was a slight decrease in sperm motility and concentration during the cool seasons compared to the hot seasons, the differences were not significant. No consistent trend of increase or decrease in semen characteristics was observed of bulls' ages across from 2 to 9 years old. In summary, the analyzed data indicated that the seasonal and age differences of semen characteristics in Taiwan Yellow bulls were not significant. More bulls of different ages and semen collected data over many years were needed to confirm whether there were any seasonal and age differences.

(Y. F. Lin, J. S. Shiu and G. F. Li)



Variations across different ages and season in bull semen progressive motility

Effects of extenders on semen characteristics after frozen and thawed of Formosan sambar deer

The purpose of this study was to evaluate the effects of extenders on the semen characteristics of Formosan sambar stag after frozen and thawed. Total of six sexually matured males were used for semen collection by electro-ejaculation from July to November in the breeding season. The semen was diluted with Tris-citric acid-yolk (TCY), Tris hydroxymethyl - 2 - aminomethane-sulphonic acid-yolk (TES-yolk; TY) and citric acid-yolk (CY) extenders and frozen. The results showed that the sperm motility (TCY: 56.6%; TY: 52.9%; CY: 52.0%) and pro motility (TCY: 43.4%; TY: 43.3%; CY: 43.4%) were no significant difference among the TCY, TY and CY groups. After frozen-thawed for 1 h and 2 h, the motility and pro motility of the TCY group were significantly higher than those of the TY group (34.2%

vs 23.4% and 24.5% vs 15.6%; $P < 0.05$). In conclusion, the Formosan sambar stag semen with TCY extender was able to obtain better motility after thawing.

(H. H. Lin, T. Y. Kuo, Y. C. Liu, S. C. Chang and J. R. Yang)



Stag semen collection by electro-ejaculation

Analysis of the growth characteristics of the offspring from crosses between TLRI and commercial chickens

The study utilized TLRI 7, 9, 11, and 12 as maternal lines, crossed with commercial roosters to assess the growth characteristics of the offspring (named H7, H9, H11 and H12), providing foundational data for establishing local chicken strains. The results showed that the offspring compared to the maternal lines, respectively, the H7, H9, H11, and H12 groups exhibited 20.44%, 13.41%, 19.64% and 34.43% increases in hatching weight, respectively. In comparison of 8-week-old body weight to the offspring and the paternal lines, the H7, H9, H11, and H12 groups had 27.78%, 23.54%, 3.33% and 11.82% increases, respectively. In comparison of 8-week-old body weight to the offspring and the maternal lines, the H7, H9, H11, and H12 groups

showed 27.76%, 23.80%, 3.22% and 11.34% increases, respectively.

(H. M. Liang, D. Y. Lin, K. H. Hung and C. Y. Lin)



The offspring from crosses between TLRI and commercial chickens

Production and field distribution of frozen semen of elite dairy bull

Fresh bull semen collection and subsequent semen cryopreservation were carried out 8 times, diluted and frozen with Biladyl-10% LDL semen diluent. The sperm quality was analyzed by iSperm. The average motility of fresh and post-frozen semen was $85.6 \pm 5.7\%$ and $56.1 \pm 6.5\%$, respectively; the progressive motility (%) was $26.8 \pm 4.6\%$ and $19.3 \pm 5.8\%$, respectively; the velocity of average path was 86.3 ± 8.2 and 48.5 ± 6.4 , respectively; the velocity of average curvilinear was 155 ± 20.2 and 101.6 ± 14.1 , respectively; the velocity of average straight line 74.6 ± 8.3 and 45.4 ± 6.8 , respectively. The hair follicles and genetic testing of 3 bulls were conducted to estimate the net merit of the animal, and the average value was 431. The average TPA milk was 445. The average type index was 1.17. The average production life was 3.57. The mean value of the somatic cell score was

2.70. According to the calculation of Dr. Wiggans of the Council on Dairy Cattle Breeding, the NM value of the young bulls tested by the genetic testing can be equivalent to the NM value of the bulls that will later become proven, which showed that the relevant important economic traits were excellent, and it was worth promoting frozen semen distribution from these elite bulls.

(J. S. Chao, J. Y. Chen, K. H. Lee, S. H. Wang and J. W. Shiau)



Elite Holstein bull

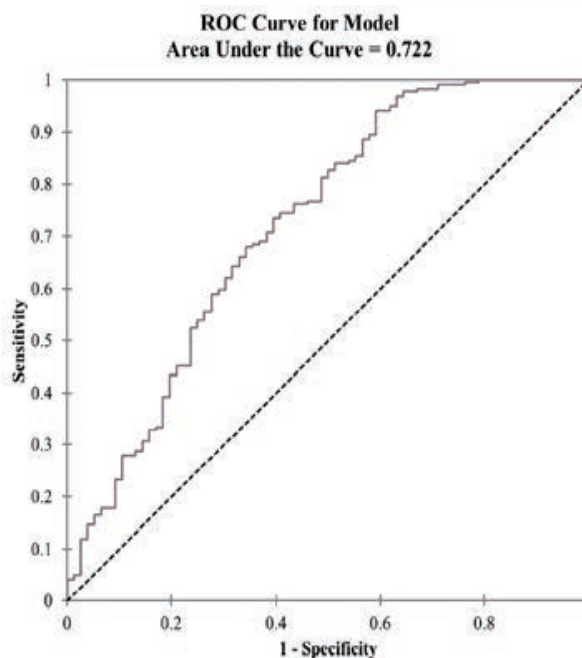
Pregnancy risk assessment of embryonic mortality and abortion in dairy cattle

Accurate diagnosis of pregnancy is an essential component in the reproductive management plan for dairy cows. Indirect methods of pregnancy detection can be performed soon after breeding, without requiring an experienced veterinarian,

and it thus offers an advantage over traditional direct methods for having automation potential. The objective of this study was to determine the pregnancy-associated glycoprotein (PAG) concentration in raw milk using ELISA for

pregnancy detection. We tend to establish milk PAG concentration data of the entire pregnancy period (from 14 days post-breeding to dry-off) and compare that in cattle that were embryonic maintenance and embryonic mortality. The developed pregnancy risk assessment of embryonic mortality and abortion system in dairy cattle will be fully assessed with sensitivity, specificity, and accuracy in the second year. The non-invasive pregnancy detection using PAG as a biomarker can assess the risk and predict the possible embryonic mortality and abortion. We estimate the developed system can reduce the pregnancy detection date to 21 days post-breeding, and reduce the days open to 60 days postpartum. The system can be used for precise management in dairy breeding and reproduction.

(P. A. Tu, Y. H. Yeh and M. K. Yang)



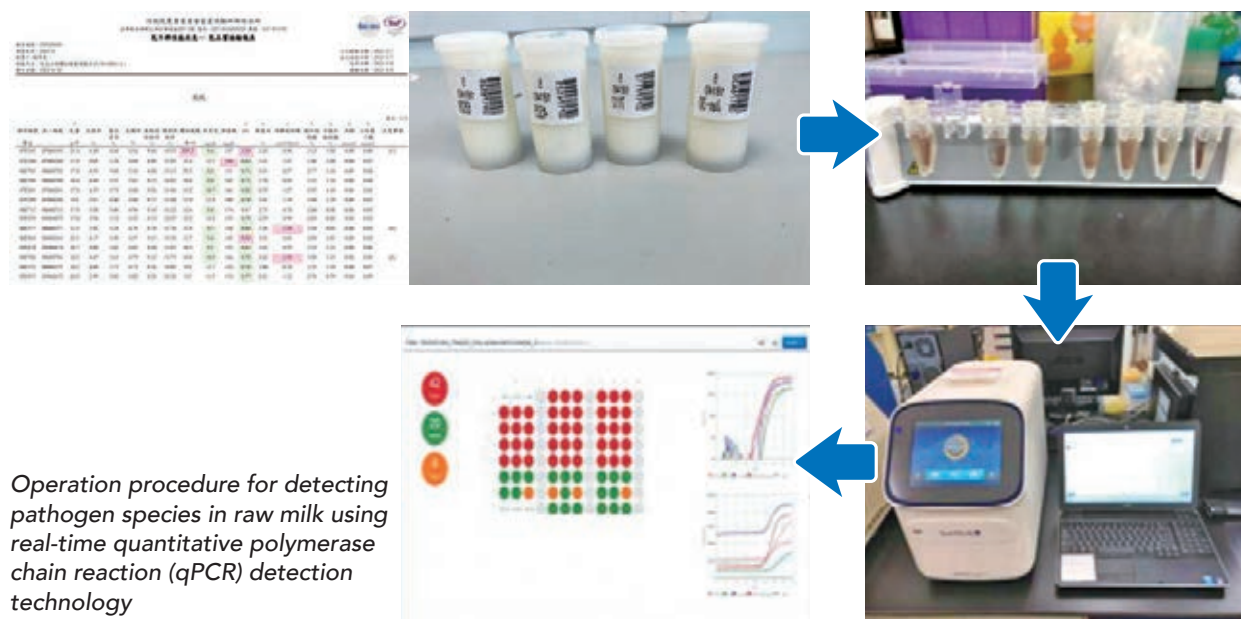
ROC curve generated using data corresponding to the pregnancy risk assessment of embryonic mortality and abortion model.

Application of total bacterial count and rapid pathogen test in raw milk

The objective of this experiment was to apply real-time polymerase chain reaction to identify the total bacterial count and types of pathogens in raw milk. The result shows that the detection of *Staphylococcus aureus* in the bulk tank milk of 90 dairy herds was carried out simultaneously by real-time polymerase chain reaction (qPCR) and traditional bacterial species culture. The results showed that 7 samples of bulk tank milk detected by real-time polymerase chain reaction were positive, and the culture of traditional bacterial species were also positive; 82 samples of bulk tank milk detected by real-time polymerase chain reaction were negative; the culture of traditional

bacteria species was also negative; another one was negative by real-time polymerase chain reaction test, but the traditional bacteria culture was positive. In addition, the sensitivity and specificity of qPCR detection were analyzed, and the values were 87.5% and 100%, respectively, and the correlation with traditional bacterial species culture was 98.9%. In conclusion, the detection of bulk tank milk bacterial species by QPCR has the advantages of rapidity and high accuracy, and could be used as a tool for rapid detection of bulk tank milk bacterial species.

(M.K. Yang, R. H. Yeh, C. J. Lee, Y. H. Yeh, Y. H. Chen, T. Banhazi and P. A. Tu)



Variation of heat shock protein in saliva of dairy cow during hot and cold season

This study explored the influence of different sampling time points and cold and hot seasons of heat shock proteins (HSP) in the saliva of dairy cows. The experimental animals were 6 lactating cows and 6 dry cows. Test 1: Saliva and blood samples were collected at 9:00 am and 14:00 pm. The test was repeated 3 times; Test 2: During the hot season (August and September) and the cool season (February and March), and saliva and blood samples were collected three times a month. The samples were collected and analyzed using Bovine HSP 70 ELISA Kit (EB0032, Fine Test) and Bovine HSP 90 ELISA Kit (EB0033, Fine Test). The results showed that different sampling time points would affect the HSP concentration in the saliva of cattle. Although there was no significant difference in the sampling time points of HSP70 in the morning and afternoon, the average value of HSP70 in the afternoon was slightly lower than the concentration of HSP70 in the morning. The concentration of HSP90 in the morning was significantly higher than that

in the afternoon. Therefore, it was suggested that the time point of future sampling should be fixed at a fixed time for sampling. The serum and saliva of HSP70 and HSP90 in hot season and cold season had significant differences ($P < 0.05$). The concentration of HSP in serum and saliva was several times different. But the two HSP concentrations have the same trend.

(C. X. Lee, H. H. Liao, S. H. Wang, and J. W. Shiau)



The saliva collection tube

Analysis of genetic structure of White Roman geese

The study carried out the selection program and the analysis of the genetic structure in the high egg production population of White Roman geese (WRH). The generations of parent (nP0), the first filial (nF1) and the new parent (nnP0) of WRH were used to test their growth and reproduction performances. The results showed highly significant differences were found between three generations, the generation of nP0 (4.59 ± 0.43 kg) was heaviest and nF1 (4.11 ± 0.49 kg) was lightest for the body weight at 14 weeks of age ($P < 0.01$). Moreover, the nnP0 and nF1 did not differ but better than nP0 for total egg number (41.1 ± 14.5), laying rate ($22.1 \pm 7.8\%$), average clutch length (6.6 ± 3.4 days), maximum clutch length (20.8 ± 12.0 days) and average pause number (9.9 ± 4.1 times) ($P < 0.01$), which was beneficial to the selection in high egg production line of White

Roman geese. In addition, the results of genetic variation analysis showed that the heterozygosity deficiency existed in the WRH population. The four microsatellite markers deviated from the Hardy-Weinberg equilibrium (HWE) ($P < 0.01$) may also indicate the inbreeding phenomenon due to the less number of founders in the WRH population. Because of the epidemic situation, nnP0 has no direct relationship with nP0 and nF1. The results of phenotype testing and genetic variance analysis cannot be clearly discussed, whereas it could be an important reference for the selection of the high egg production of White Roman geese.

(C. Y. Lien, C. H. Chiang, S. C. Liao, S. D. Wang and Y. C. Chen)

Analysis of reproduction performance in the population of White Roman geese.

Generation*	AFE	EggW	EN	LayR	CN	CL	Cmax	Cmin	PN	PL	Pmax	Pmin
nP0	-	155.8 ± 16.0^a	33.6 ± 13.0^b	24.0 ± 9.3^a	12.3 ± 4.2^a	4.2 ± 1.7^b	12.5 ± 6.5^b	1.0 ± 0.0	11.3 ± 4.2^a	4.4 ± 1.6	11.7 ± 6.9	2.0 ± 0.2
nF1	$284.9 \pm 33.2^{#b}$	138.6 ± 11.3^b	37.5 ± 12.5^{ab}	20.7 ± 6.9^b	9.7 ± 3.3^b	6.4 ± 3.3^a	19.1 ± 10.4^a	1.1 ± 0.7	8.7 ± 3.3^b	4.2 ± 2.7	11.6 ± 11.1	2.1 ± 0.5
nnP0	315.9 ± 35.5^a	141.4 ± 12.3^b	41.1 ± 14.5^a	22.1 ± 7.8^{ab}	10.9 ± 4.1^b	6.6 ± 3.4^a	20.8 ± 12.0^a	1.3 ± 2.0	9.9 ± 4.1^b	4.1 ± 1.7	11.6 ± 8.8	2.0 ± 0.3

AFE: age of first egg (day); EggW: average egg weight (g); EN: total egg number ; LayR: laying rate (%); CN: clutch number (time); CL: average clutch length (day); Cmax: maximal clutch length (day); Cmin: minimal clutch length (day); PN: pause number (time); PL: average pause length (day); Pmax: maximal pause length (day); Pmin: minimal pause length (day).

[#] Mean \pm standard deviation.

* nP0: parental generation (the sixth and seventh generation); nF1: the first filial (the eighth generation); nnP0: new parental generation

^{a,b,c} Means in the same column with different superscripts differ significantly ($P < 0.01$).

Genetic variability of the microsatellite markers in the White Roman geese population

Locus	n	Fragment size (bp)	Na	Ne	HO	HE	PIC	F	HWE ¹
5A5279	71	280-332	6	4.6	0.676	0.790	0.752	0.139*	NS
5A26648	77	252-372	14	5.9	0.792	0.837	0.812	0.047*	***
5A26681	63	235-363	12	6.4	0.825	0.850	0.825	0.021	NS
Ans02	65	206-233	8	2.1	0.492	0.536	0.505	0.075**	***
Ans21	67	184-188	3	1.5	0.299	0.332	0.303	0.095***	***
Ans25	42	332-346	3	2.0	0.405	0.509	0.388	0.195	NS
Bca µ1	50	113-122	4	2.8	0.500	0.647	0.567	0.219*	*
Bca µ8	49	155-158	2	1.7	0.469	0.421	0.330	-0.126	NS
Bca µ9	49	100-106	2	1.1	0.122	0.116	0.108	-0.065	NS
CAUD-G012	49	200-208	4	2.2	0.592	0.552	0.458	-0.083	NS
CKW21	51	350-383	5	2.2	0.569	0.544	0.502	-0.056	NS
TTUCG5	50	176-216	6	3.5	0.840	0.724	0.668	-0.173#	NS
Average²	56.9		5.8	3.0	0.548	0.572	0.518	0.024***	***
SE	3.2		1.1	0.5	0.063	0.063	0.063	0.037	

Na: number of observed alleles; Ne: number of effective alleles; HO: observed heterozygosity;

HE: expected heterozygosity; PIC: polymorphic information content;

F: fixation index on a per locus basis, indicating inbreeding or undetected null alleles ($F = \frac{H_E - H_O}{H_E}$), and * (P < 0.05), ** (P < 0.01) and *** (P < 0.001), indicating the significance of heterozygosity deficiency test.

¹ HWE: test of Hardy-Weinberg equilibrium; NS, non-significant; ***, P < 0.001.

² The value within this row indicates the genetic diversity of the selected White Roman population due to only one population included in this study.

Maintenance and production improvement in minimal diseases geese

This study was to regular detection of common pathogens of geese such as goose parvovirus, circovirus, goose hemorrhagic polyomavirus, *riemerella anatipestifer* (RA), fowl cholera, and avian reoviruses. In addition, we evaluated the effects of dietary supplementation of sodium bicarbonate (NaHCO_3) and potassium chloride (KCl) on the physiology of minimal diseases (MD) geese in hot season (during July to August). The experiment was divided into two parts, thirty-two 5-week-old MD goslings and twenty-four 40-week-old MD geese were evenly distributed into four treatment groups, a control group (basal diet) and experimental group (basal diet supplemented with NaHCO_3 250 ppm, basal diet supplemented with KCl 750 ppm and basal diet supplemented with NaHCO_3 250 ppm and KCl 750 ppm). The results showed that dietary supplementation of NaHCO_3 250 ppm and KCl 750 ppm could reduce mean corpuscular volume and increase mean corpuscular hemoglobin concentration in the blood of 12-week-old MD geese. It also increased potassium ion concentration in the blood of 48-week-old MD geese. Therefore, the dietary supplementation of NaHCO_3 and KCl could alleviate heat stress in MD geese. According to the guideline of ISO 9001: 2015 for operation and document management, we applied and

passed the ISO 9001: 2015 quality management system recertification, the certificate registration number is 17QMA31071. By the way, the total of 1,108 MD goslings, 12 MD geese and 268 MD goose eggs were provided for other experimental research and industrial application.

(S. H. Chuang, C. Y. Lien and S. D. Wang)



ISO 9001: 2015 international quality management system certification

Improving semen quality of dairy bulls by adding selenium

This plan was an adjustment measure to strengthen the heat-tolerant capabilities and production efficiency of dairy cattle, pigs, laying hens and forage industries. In the high temperature and high humidity climate of the summer season, the semen quality of dairy bulls in summer was improved by adding selenium. The work of adding nano-selenium (0, 1.0, 2.0 and 4.0 ug/ml) to the semen diluent of dairy bulls was completed. The ratio of freshly collected motile sperm was $85.4 \pm 4.5\%$; the ratio of motile sperm after thawing of semen treated with nano-selenium at different concentrations of 0, 1.0, 2.0 and 4.0ug/ml was $54.3 \pm 4.9\%$, $53.6 \pm 4.7\%$, $51.5 \pm 3.9\%$ and $51.1 \pm 3.9\%$, respectively. It shown that the ratio of motile sperm in frozen semen after thawing was about 30% lower than that

in fresh semen. Comparing the relevant sperm movement parameters, the average velocity of curvilinear after thawing of semen treated with different concentrations of nano-Se such as 0, 1.0, 2.0 and 4.0ug/ml was 100.7 ± 17.4 , 129.1 ± 22.1 , 94.2 ± 17.2 and 98.3 ± 14.9 , respectively. The average velocity of straight line after thawing of frozen sperm were 47.0 ± 6.8 , 53.8 ± 10.8 , 42.7 ± 4.9 and 43.8 ± 4.4 , respectively. The velocity of average path of frozen sperm after thawing was 49.9 ± 8.3 , 70.0 ± 8.7 , 46.6 ± 6 and 47.3 ± 6.7 , respectively. The results show that adding 1 ug/ml nano-selenium can maintain better sperm swimming ability after thawing bull semen.

(J. S. Chao, J. Y. Chen, K. H. Lee, S. H. Wang and J. W. Shiau)

Analysis of post-thawed motility of Holstein bull spermatozoa by nano-selenium treatment in diluent

Item		Motility, %	Progressive motility, %	Velocity of curvilinear, VCL, $\mu\text{m/s}$	Velocity of average path, VAP, $\mu\text{m/s}$	Velocity of straight line, VSL, $\mu\text{m/s}$
Fresh semen		$85.4 \pm 4.5\%$ ^a	$27.3 \pm 5.4\%$ ^a	156.6 ± 18.8 ^a	88.4 ± 6.0 ^a	78.7 ± 5.6 ^a
Post-thawed semen	Se-NP, 0 ug/ml	$54.3 \pm 4.9\%$ ^b	$20.0 \pm 3.4\%$ ^{bc}	100.7 ± 17.4 ^c	49.9 ± 8.3 ^c	47.0 ± 6.8 ^{bc}
	Se-NP, 1 ug/ml	$53.6 \pm 4.7\%$ ^b	$22.0 \pm 4.5\%$ ^b	129.1 ± 22.1 ^b	70.0 ± 8.7 ^b	53.8 ± 10.8 ^b
	Se-NP, 2 ug/ml	$51.5 \pm 3.9\%$ ^b	$17.9 \pm 3.5\%$ ^{bc}	94.2 ± 17.2 ^c	46.6 ± 6.0 ^c	42.7 ± 4.9 ^c
	Se-NP, 4 ug/ml	$51.1 \pm 3.9\%$ ^b	$16.0 \pm 3.5\%$ ^c	98.3 ± 14.9 ^c	47.3 ± 6.7 ^c	43.8 ± 4.4 ^c

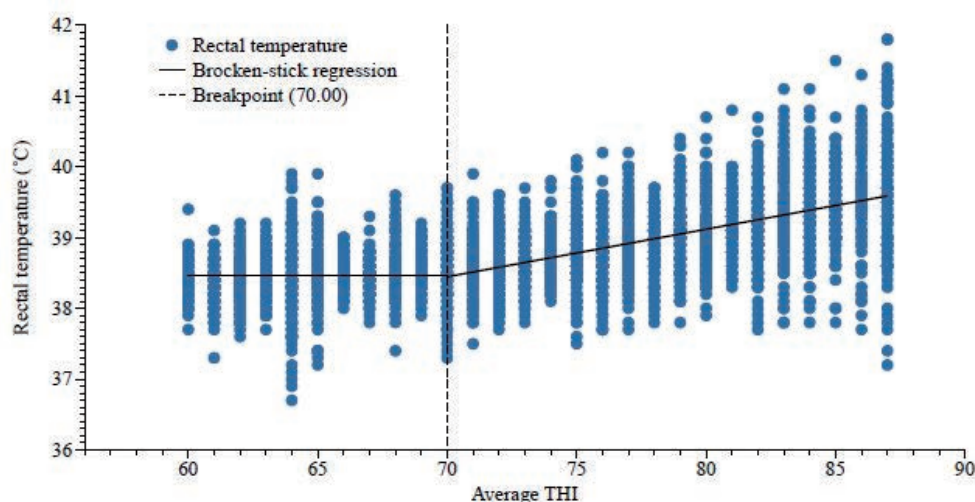
a,b,c: Means with different superscripts within same row were significantly different ($P < 0.05$).

The relationship of heat regulation physiological markers and production traits

Due to climate change, heat stress in dairy cows has become a serious concern for their health and welfare. Traditional methods using average Temperature-Humidity Index (THI) may underestimate the level of heat stress experienced by dairy cows. When evaluating heat stress, we consider the duration and intensity of the heat load to avoid underestimating the actual stress faced by the cows. We investigated the impact of different durations and intensities of heat loads on the behavioral responses and milking performance of Holstein dairy cows. Data on milk yield and behavior were collected for a cohort of 107 Holstein lactating cows. Using broken-stick regression analysis to determine the critical THI values for body temperature, respiration rate, and sweating rate, results indicated that body temperature began to rise significantly when THI exceeded 70, respiration rate increased significantly after THI surpassed 66, and sweating rate was more pronounced when THI was below 67, gradually increasing thereafter. We further defined the THI thresholds at 68 or 72 to calculate the daily duration of heat stress. Heat stress for milk yield was defined by the total duration of

THI threshold exceedance within three days; for behavior data analysis, the long-term relationship with heat stress was assessed by analyzing the degree of heat stress 1 to 3 days before milking. Overall, the findings suggest that models using only average THI or duration to estimate heat stress may underestimate its adverse effects on lactating cows. The results show that the behavior and milking performance of cows were negatively impacted by at least three days of cumulative heat stress effects. When experiencing heat stress before milking, increased duration and intensity of heat exposure resulted in increased daily standing time and reduced lying time. To sum up, when dairy cows suffer from heat stress, they will first dissipate heat through sweating and breathing, so their THI critical value was low. When the ambient THI value continues to rise to more than 70, the body temperature of dairy cows will increase significantly. Turning on cooling facilities when the ambient THI value reaches 66 to 67 will help dairy cows reduce heat stress. The results of this test can be used as a reference when applying cooling facilities in dairy farms.

(P. A. Tu, Y. H. Yeh and M. K. Yang)



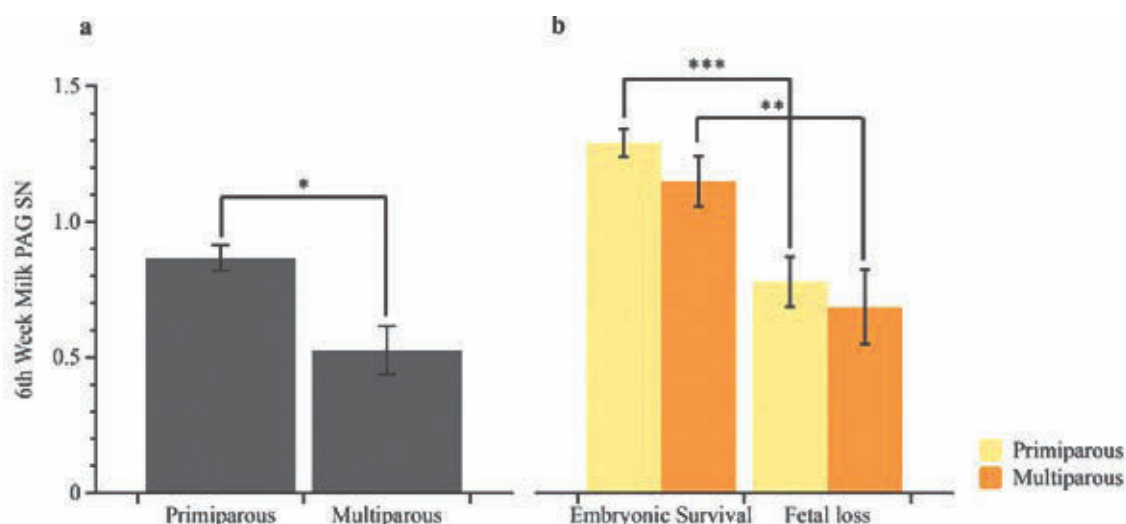
Broken-stick regression models of rectal temperature relative to average temperature-humidity index (THI) in observed lactating cows. Breakpoint at which the dependent variable changes significantly was indicated by a vertical dashed line.

Pregnancy maintenance and fetal loss assessment in Holstein cows through analyzing pregnancy-associated glycoproteins in milk

Fetal loss (FL) from the 45th day of gestation until calving can impose a significant economic burden on dairy farmers, resulting in lost profits and increased production costs. Pregnancy-associated glycoprotein (PAG) is commonly used for detecting pregnancy in cows. PAG is secreted by binucleated trophoblast cells of the placenta and regulated by more than 24 genes. The purpose of this study was to determine the PAG threshold for FL and a probability of pregnancy maintenance until calving based on milk PAG levels. Our results reveal that primiparous and multiparous cows that maintained pregnancy until the 40th week exhibited higher PAG sample-negative (SN) values in their milk in the 6th week of gestation than did those that experienced FL later in gestation. Pregnant cows with higher PAG SN values in the 6th week of gestation were more likely to maintain

their pregnancies. The area under the receiver operating characteristic curve for predicting the probability of pregnancy maintenance was 0.722 for our prediction model. On the other hand, a milk PAG SN value of <0.192 indicated 95 % confidence that FL would occur between the 7th and 40th weeks of gestation. Milk PAG testing was a noninvasive sampling technique that does not induce additional stress in lactating cows. The study reveals that PAG SN values increase significantly in Holstein cows during the 6th week of gestation. The predictive model developed was effective in forecasting pregnancy outcomes up to the 40th week of gestation or calving. The model's performance was moderately good for field application and could be a useful tool for dairy producers.

(M. K. Yang, R. H. Yeh, C. J. Lee, Y. H. Yeh, Y. H. Chen, T. Banhazi and P. A. Tu)



PAG SN values (means \pm standard errors of the mean) in pregnant Holstein cows that underwent artificial insemination on day 0 and had a viable embryo in the 6th week of gestation. (a). Holstein cows that experienced fetal loss ($n = 1,790$) between the 7th and 40th weeks exhibited lower ($P < 0.05$) milk PAG SN values in the 6th week than did cows that maintained pregnancy ($n = 8,077$) until the 40th week (b). *** $P < 0.001$, ** $P < 0.01$, and * $P < 0.05$. PAG, pregnancy-associated glycoprotein; SN, sample-negative.

Analysis of the growth characteristics of the offspring from crosses between TLRI and commercial chickens

The study utilized TLRI 7, 9, 11, and 12 as maternal lines, crossed with commercial roosters to assess the growth characteristics of the offspring (named H7, H9, H11 and H12), providing foundational data for establishing local chicken strains. The results showed that the offspring compared to the maternal lines, respectively, the H7, H9, H11, and H12 groups exhibited 20.44%, 13.41%, 19.64% and 34.43% increases in hatching weight, respectively. In

comparison of 8-week-old body weight to the offspring and the paternal lines, the H7, H9, H11, and H12 groups had 27.78%, 23.54%, 3.33% and 11.82% increases, respectively. In comparison of 8-week-old body weight to the offspring and the maternal lines, the H7, H9, H11, and H12 groups showed 27.76%, 23.80%, 3.22% and 11.34% increases, respectively.

(H. M. Liang, D. Y. Lin, K. H. Hung and C. Y. Lin)

The growth characteristics of the offspring from crosses between TLRI and commercial chickens

	H7	Line 7	H7-7 Divergence (%)	H9	Line 9	H9-9 Divergence (%)
Hatch weight (g)	34±3 ^b	28±3 ^a	120.44	31±2 ^b	28±2 ^a	113.41
8-week-old body (g)						
Male	1,038±83 ^{d,y}	812±116 ^{ab,y}	127.78	957±92 ^{cd,y}	775±68 ^{a,y}	123.54
Female	830±72 ^{b,x}	649±79 ^{a,x}	127.76	814±87 ^{b,x}	657±55 ^{a,x}	123.80
16-week-old body (g)						
Male	2,110±216 ^{d,y}	1,945±149 ^{cd,y}	108.47	2,637±145 ^{e,y}	1,594±116 ^{a,y}	165.37
Female	1,977±268 ^{e,x}	1,583±76 ^{d,x}	124.84	2,007±80 ^{e,x}	1,329±93 ^{b,x}	151.02
	H11	Line 11	H11-11 Divergence (%)	H12	Line 12	H12-12 Divergence (%)
Hatch weight (g)	35±3 ^b	29±2 ^a	119.64	36±3 ^b	27±2 ^a	134.43
8-week-old body (g)						
Male	874±95 ^{bc,y}	846±79 ^{ab,y}	103.33	1,008±101 ^{d,y}	901±101 ^{bc,y}	111.82
Female	653±74 ^{a,x}	633±97 ^{a,x}	103.22	806±78 ^{b,x}	724±107 ^{a,x}	111.34
16-week-old body (g)						
Male	1,840±432 ^{bc,y}	1,751±192 ^{b,y}	105.08	1,780±167 ^{bc,y}	2,017±282 ^{d,y}	88.25
Female	1,380±115 ^{bc,x}	1,245±125 ^{ab,x}	110.83	1,160±115 ^{a,x}	1,441±103 ^{c,x}	80.50

Effects of different kinds of dietary *Pleurotus eryngii* post-cultivation medium on growth performance of Peking ducks

The aim experiment was to estimate the effects of different kinds of *Pleurotus eryngii* waste media in the diet on growth performance of Peking ducks. A total of 225 ducks were divided into 5 groups, namely the control group (C); the groups (G1, G2), which replaced 50% and 100% of the bran with Pennisetum cultivation medium, respectively; and the groups (G3, G4); which replaced 50% and 100% of the bran with sawdust cultivation medium, respectively. There were 3 replicates in each group, and 15 Peking ducks were kept in each replica. The experimental period was 3-10 weeks of age, and the body weight and feed consumption were collected, and the length of the 8th primary feather of the ducks was measured during the 8-10 weeks of age. The results showed that the body weight of ducks in each group ranked from 641-665 g at 3 weeks of age, and were 2,577, 2,632, 2,600, 2,599 and 2,559 g at 10 weeks of age for C, G1, G2, G3 and G4 groups, respectively. The average feed consumption of 3-10 weeks of age ranged from

153-161 g/day. The lengths of the 8th primary feathers at 10 weeks of age of each group were 17.0, 18.3, 18.3, 18.3 and 18.3 cm, respectively. There was no significant difference of any parameters among groups. In conclusion, the use of *Pleurotus eryngii* cultivation media made from Pennisetum or sawdust as an alternative feed material during the growth period had no negative effect on the growth performance and feather growth of Peking ducks.

(C. H. Cheng, C. H. Su, J. H. Lin and Y. L. Lin)



Dry cultivation medium (from Pennisetum)

The effect of dietary *Bacillus licheniformis* fermentation products on laying performance, egg qualities, immune traits and intestinal villus traits of Brown Tsaiya ducks during the hot season

This experiment aimed to supplement *Bacillus licheniformis* fermentation products to the feed of Brown Tsaiya ducks to reduce the retarded performance caused by heat stress during the hot season, hoping to develop an application model for *Bacillus licheniformis* to assist ducks in resisting heat stress. 120 newly hatched Brown Tsaiya ducks were given a starter diet until 4 weeks old, and then switched to the grower diet. When the egg production reached 5%, the

feed was switched to the laying diet. The ducks were divided into 5 groups according to their body weight when put into the cage, with 24 ducks in each group. The five groups were the control group, the commercial antibiotics group (the control group supplemented with 5 ppm of commercial antibiotics Flavomycin), and the control group supplemented with 0.1%, 0.2% and 0.3% of *Bacillus licheniformis* products. Feed and water were given ad libitum throughout

the experiment. The experiment started in June, and the ducks were subjected to heat stress at natural ambient temperatures. The ducks were given the experimental feed two weeks before the start of the experiment to adapt to the feed. The experiment continued until the end of September. The results showed that adding *Bacillus licheniformis* to the diet of laying ducks failed to improve the egg production performance and egg quality during the hot season. However, the damage of the liver by heat stress of ducks in the 0.2% supplemented group was lower, and the

expression levels of IFN-r, IL-4 and IL-5 in the spleen and the expression amount of intestinal HSP70 protein were significantly increased, indicating that individuals in this group had better ability to cope with extremely heat stress. Therefore, it was expected that adding 0.2% *Bacillus licheniformis* to the diet of laying ducks during the hot season will help alleviate heat stress in ducks.

(C. H. Su, S. W. Liu, C. H. Cheng, J. H. Lin, and H. C. Liu)



Preparation of the bacillus licheniformis fermentation for the experiment



Effect of different protein and energy concentrations during growing period on laying performance of Brown Tsaiya ducks

The aim of this experiment was to investigate the effect of feeding brown Tsaiya ducks with different protein and energy concentrations of growing diets on laying performance. Ducks were fed the same diets that nutrient concentration recommended in the manual of nutrient requirements of ducks from 0 to 3 and 15 to 44 weeks of age. In the period from 4 to 8 weeks of age, ducks were given a diet containing 15.0% crude protein and 2,800 kcal/kg metabolizable energy. The experimental diets contained 10.0, 11.5, 13.0% crude protein and 2,800, 3,000 kcal/kg metabolizable energy given as a factorial

design during 9 to 14 weeks of age. There were three replicates in total of six treatments (3 CP x 2 ME) with 18 ducks in each replicate. Growth performance was measured from 9 to 14 weeks of age, and laying performance was measured from 21 to 44 weeks of age. The results indicated that the average daily feed intake and body weight of each treatment during 9 to 14 weeks of age were not significantly different among the treatments. The average laying performance from 21 to 44 weeks of age was between 82.4 to 87.4%, and treatment of the CP 11.5% and metabolizable energy 3,000 kcal/kg was 87.4%, which was the

highest one. The average egg weight of each treatment during 21 to 44 weeks of age were between 58.1 to 60.0 g, and the egg weight of the CP 11.5% and CP 13.0% groups were 59.5 g and 59.9g, which were significantly heavier than 58.3 g of the CP 10% group ($P < 0.05$). The average feed conversion ratio during 21 to 44 weeks of age in treatments was between 2.59 to 2.81, and 2.59 of CP11.5%, ME 3,000 kcal/kg group had a trend that was better than other groups. In summary, it was recommended to provide the diet containing CP11.5% and metabolizable energy 3,000 kcal/kg in the growing period, which was sufficient to meet the requirement of Brown

Tsaiya for egg production.

(J. H. Lin, Y. A. Lin, T. F. Tseng, C. H. Su, C. H. Cheng and Y. L.)



Brown Tsaiya ducks at 25 weeks of age

Effect of reducing dietary crude protein content in the early stage of breeding on growth performance of native chickens

The purpose of this study was to investigate the effects of reducing dietary crude protein (CP) content in the early stage of breeding on growth performance of native chickens. A total of 120 native chickens aged 5-12 weeks were used. The chickens were divided into male and female groups and randomly assigned to control and experimental groups (each with 10 chickens and 3 replicates). The control group was fed a basal diet with 17% CP, and the experimental group

received a diet with 15% CP. The feed formulation complied with the requirements outlined in the ROSS 308 feeding manual, and both groups had a metabolizable energy (ME) content of 3,100 kcal/kg. During the experimental period, water and feed were provided ad libitum. Feed intake, body weight, and feed conversion ratio were measured at 5, 8, and 12 weeks of age. The results revealed significant differences ($P < 0.05$) between the CP 17% and CP 15% groups in terms of daily weight gain (male 50.6 vs. 47.8 g and female 50.1 vs. 48 g) at different time points. However, there were no significant differences in body weight at 12 weeks (male 1,159 vs. 1,228 g and female 915 vs. 931 g) or in feed conversion ratio between the two groups. This suggests that reducing dietary CP content by 2% in the early growth phase of native chickens may result in slightly lower body weight gain without significant effects on early growth performance.

(Y. L. Lee, C. C. Hung, P. J. Huang, S. S. Yang and L. Y. Wei)



8-week-old experimental native chicken

Application of pumpkin waste mixed silage as feedstuff to native chicken

The pumpkin waste was mixed in silage as chicken feed in the Hualien area to promote the reuse of local agricultural by-products. A total of 120 native chickens, 60 males and 60 females, were raised separately by gender at 8 weeks of age. All birds were randomly divided into the control group and the experimental group. Both groups were raised on the floor. The control group was fed with commercial feed (CP 19.5%, ME 3,114 kcal/kg from 8-12 weeks of age and CP 15%, ME 3,071 kcal/kg from 13-20 weeks of age), and the experimental group was fed with silage mixed with commercial feed (silage: commercial feed = 2: 8 from 8-12 weeks of age, silage: commercial feed = 3: 7 from 13-20 weeks of age). The body weight was recorded at 8 and 20 wk of age to measure growth performance. Six chickens (3 males and 3 females) were selected randomly and slaughtered at 20 weeks of age to analyze the carcass quality. All data were analyzed with ANOVA to evaluate the differences. Compared to the roosters' body weight at 20 wk, the feed conversion rate from 8-20 wk (dry basis) and carcass weight of control and experimental

groups were $2,853.9 \pm 228$ g vs. $2,860.9 \pm 261$ g, 4.39 vs. 4.50 and $2,628 \pm 211$ g vs. $2,598 \pm 169$ g, respectively. And were $2,243.9 \pm 267$ g vs. $2,142.6 \pm 146$ g, 4.76 vs. 4.65 and $2,021 \pm 134$ g vs. $1,883 \pm 69$ g in these two groups in hens. There were no significant differences in all data. The results showed the pumpkin waste can be used to mix in silage to feed chickens and did not affect the performances. The way to produce silage has the potential to replace part of commercial feedstuff when corn prices rise.

(P. J. Huang, S. S. Yang, Y. L. Lee and L. Y. Wei)



Making silage with pumpkin waste

Establishment of a low carbon emission feeding system for the nursery pigs

The aim of this experiment was to investigate the effects of supplementing amino acids in feed with different crude protein ratios on growth performance and nitrogen excretion of nursery LYD pigs. Thirty LYD pigs with an average age of 29 days were randomly divided into three groups based on weight and gender. The groups were fed with feed containing the upper limit (H group), middle value (M group), and lower limit (L

group) of crude protein according to the national standard for feed. Amino acids were supplemented in each group to adjust the feed composition, including the early stage of the nursery period (crude protein content: 19%, 17.5%, and 16%) and the later stage (crude protein content: 18%, 16%, and 14%). The pigs were raised in an ad libitum manner for 4 to 12 weeks, and the growth performance, blood characteristics, and metabolic

trials were measured. The results showed no significant differences in average daily weight gain, average daily feed intake, and feed efficiency among the groups. The total protein content in blood showed no significant differences among the groups, indicating no nutritional deficiencies in the pigs under ad libitum conditions. Creatinine levels showed no significant differences in the early stage of the nursery period but exhibited a linear decrease in all groups in the later stage, with the L group significantly lower than the H group ($P < 0.05$). Urea nitrogen levels decreased linearly with the reduction of dietary crude protein across the nursery period, and the L group was significantly lower than the H group ($P < 0.05$). In the metabolic trials, the total nitrogen content in feces and urine decreased gradually along with the reduction of dietary crude protein. At 8 and 12 weeks of age, the total nitrogen content in feces and urine in the H group was

significantly higher than that in the L group ($P < 0.05$). In summary, reducing the dietary crude protein and supplementing with amino acids had no significant effect on the growth performance of nursery LYD pigs, but effectively reduced nitrogen excretion in feces and urine.

(S. H. Lee, S. Y. Wu, H. S. Wang, Y. L. Chen, Y. L. Huang and C. C. Chang)



Metabolic trials for nursery LYD pigs were conducted by metabolic cages

Establishing a characteristic feeding system of Lanyu Pig

The aim of this study was to investigate the effects of substituting corn in the diet with different levels of sweet potato meal (TNG No. 57) on growth performance and carcass characteristics of Lanyu pigs. Twenty-one Lanyu pigs, evenly



The measurement of loin eye area of Lanyu pig

divided between males and females and averaging about 25 kg at 180 days of age, were selected for the trial. The pigs were randomly assigned to three treatments, including the Control group (corn-soya basal diet), 15% group (corn-soya basal diet with 15% corn substituted by sweet potato meal), and 30% group (basal diet with 30% corn substituted by sweet potato meal). Pigs were allowed free access to water but were subjected to restrict feeding. The trial concluded when the pigs reached 271 days old, at which point the pigs were slaughtered to evaluate carcass characteristics, meat quality, and flavor, aiming to establish the characteristic feeding system of Lanyu pigs. The results indicated that there were no significant differences in average daily gain, average daily feed intake, and feed efficiency among the groups. The glutamic acid content

in the hydrolyzed amino acids (mg/100g) of the longissimus dorsi muscle in the 15% group was significantly higher than in the other groups ($P < 0.05$). Furthermore, the tenderness score of the 15% group was significantly higher than that of the 30% group ($P < 0.05$). In summary, dietary

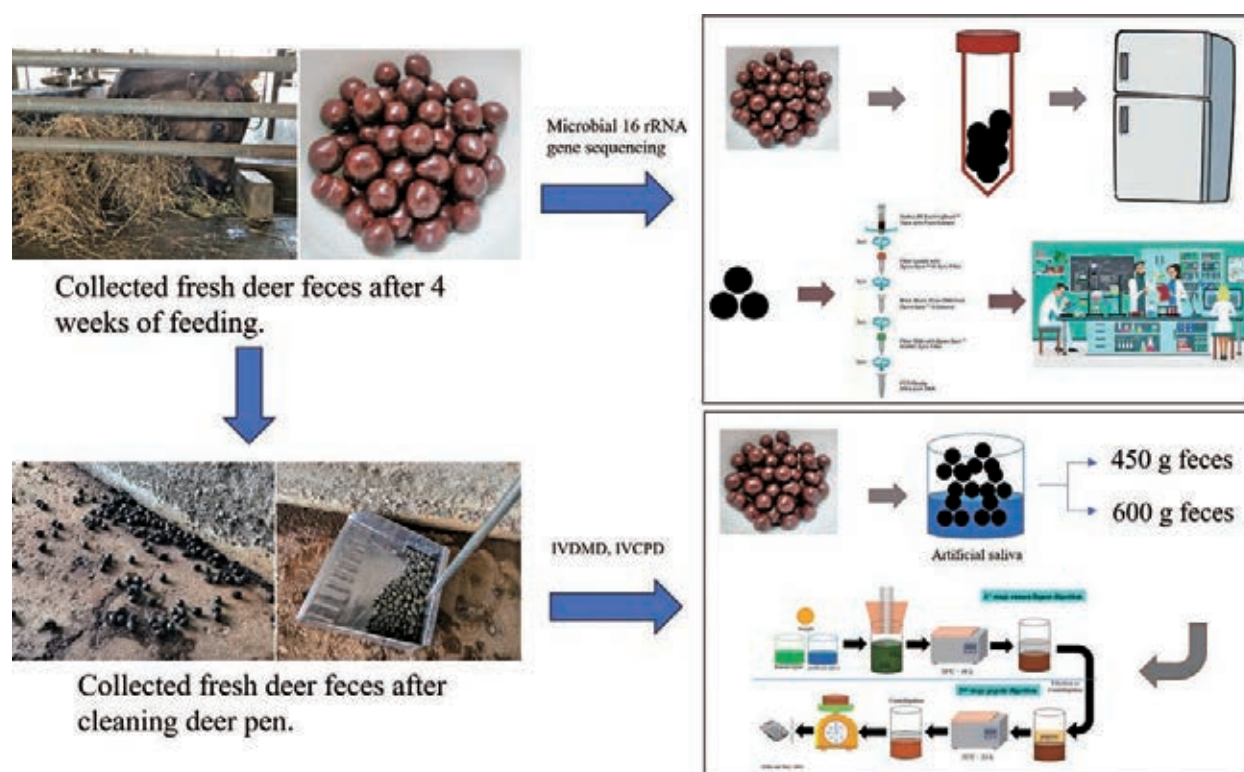
substitution with 15% TNG No. 57 sweet potatoes improved carcass characteristics without affecting the growth performance of Lanyu pigs.

(S. H. Lee, S. Y. Wu, H. S. Wang, Y. L. Chen, Y. L. Huang and C. C. Chang)

Feasibility evaluation of using deer feces as a source of microorganisms for the *in vitro* digestibility

The purpose of this study was to investigate the feasible evaluation of using deer feces as a source of microorganisms for *in vitro* digestibility. A total of 3 male Formosan Sambar deer were fed with the same feed. Fresh feces were collected after 4 weeks of feeding, and rumen fluid was collected after 12 weeks of feeding. The fecal and rumen fluid microbiota were analyzed by the 16S rRNA gene sequencing. In addition, the fecal liquid was prepared by 450 g and 600 g fresh feces, and were

mixed with artificial saliva, respectively. The rumen fluid and fresh feces liquid were collected as microbial inoculum, and then used pangola grass hay, alfalfa cubes and concentrate of sample for the analysis of *in vitro* dry matter digestibility (IVDMD) and *in vitro* crude protein digestibility (IVCPD). Results showed that the percentage of phylum Bacillota of feces was significantly higher than rumen fluid (57.8% vs. 48.3%; $P < 0.05$), while the percentage of phylum Bacteroidetes



Standard process for collecting fecal samples and subsequent analysis

of feces was significantly lower than rumen fluid (32.4% vs. 38.6%; $P < 0.05$). The family of Ruminococcaceae and Christensenellaceae were dominant bacterial in DF (28.1% vs. 10.2%), while the family of Prevotellaceae and Ruminococcaceae were dominant bacteria in rumen fluid (19.3% vs. 16.5%). The results showed no significant difference in dry matter digestibility between two different proportions of feces inoculum liquids. However, the *in vitro* digestibility of pangola grass hay for rumen fluid, 450 g and 600 g fresh feces inoculum were 59.8%, 44.8%, and 45.9%. The rumen fluid group was significantly higher than the feces inoculum groups ($P < 0.01$); the *in vitro* digestibility of concentrate were 86.3%, 91.9% and 91.6%. The rumen fluid group was significantly lower

than the feces liquid groups ($P < 0.01$). In crude protein digestion rate, the *in vitro* digestibility of alfalfa cubes were 77.2%, 80.0%, and 86.7%. The rumen fluid group and 450 g fecal liquid group was significantly lower than the 600 g fecal liquid group ($P < 0.01$); the *in vitro* digestibility of concentrate were 86.5%, 90.2% and 92.5% and the rumen fluid group was significantly lower than the feces liquid groups ($P < 0.05$). In summary, although there were significant differences in the results of microbiota and *in vitro* digestibility between rumen fluid and feces liquid. However, the trends were similar. Therefore, the feasibility of replacing rumen fluid with feces fluid will be further evaluated.

(Y. C. Liu, M. H. Tsai, R. J. Chen, H. H. Wu, H. H. Lin and S. C. Chang)

Effects of different dietary metabolic energy on growth performance and carcass traits during finishing period of black pigs

This study aimed to explore the use of low-energy feeds to feed black pigs in the later finishing stages. To examine the effects of low-energy feeding on growth performance and carcass traits in black pigs, 40 KHAPS crossbred black pigs (including 50% blood relatives of Meishan pig and Duroc) weighing about 90 kg, with equal numbers of both sexes, were randomly assigned into ME 3,250, 3,088, 2,925 and 2,762 kcal/kg, respectively (CP of each group was 13%). At 0-3 weeks, the ADG of the 3,250 group was significantly better than the other groups ($P < 0.05$). At 4-6 weeks, the ADG of the 3,250 group was significantly better than the 2,925 and 2762 groups ($P < 0.05$). At 0-9 weeks, the ADG of the 3,250 was significantly better than the other groups ($P < 0.05$). The muscle color a^* (redness) value in the 3,250 group was significantly better than the 2,925 and 2762 groups

($P < 0.05$). Muscle chemistry (moisture, crude protein, crude fat, and ash), sensory score (tenderness, juiciness, and flavor), firmness score, LM area, WHC, drip loss, and cook loss were not different between groups. In conclusion, the feed with CP 13% and ME 3,250 kcal/kg was able to improve the palatability and animals performance, and showed better ADG and muscle color a^* value.

(H. J. Huang, S. C. Chang, L. L. Peng, H. L. Lee and J. R. Yang)



ME = 2,762 kcal/kg group (left picture); ME = 3,250 kcal/kg group (right picture)

Effect of dietary energy on growth performance, physiological response and nutrient digestibility of growing-finishing pigs under high temperature environment

Heat stress causes a negative effect on production and physiology of pigs. The purpose of this study was to evaluate the effect of dietary energy on growth performance, physiological response and nutrient digestibility of growing-finishing pigs under a high temperature environment. A total of 18 LYD pigs at average of 44.5 kg with half barrow and gilt were randomly assigned into three diets that the CP of growing and finishing diet was 14.0% and 12%, respectively and the metabolic energy of treatments LE, ME and HE was 3,100, 3,200 and 3,300 kcal/kg, respectively. Pigs were raised in a metabolic cage in chambers where the highest temperature was set up at 35°C at 13:00, then gradually lowered to the lowest point at 26.5°C at 01:00. Humidity was set up at 85% throughout the experiment. Feed and water were supplied ad libitum. Seven days of total collection was carried out after five days of adjustment period. The respiratory rate and rectal temperature of pigs were measured on the 3th, 4th and 5th day of the collection period. Body weight data and blood of pigs were collected before and after the experiment. Results showed that during the growing period, compared to group LE, groups of ME and HE tended to have better growth performance under hot environments. Group HE also had higher blood glucose, albumin, CPK and MCV

and lower CRE. The respiratory rate and rectal temperature were not different among treatments. Group ME had the highest dry matter and energy digestibility ($P < 0.01$), and higher crude protein digestibility ($P < 0.05$) than Group LE. During the finishing period, compared to groups LE and ME, Group HE tended to have lower growth performance under hot environments. Group HE also had lower WBC while other biochemical values, differential cell counts, the respiratory rate and rectal temperature were not different among treatments. Neither digestibility nor metabolism of nutrients was different among treatments. In summary, high dietary energy might be applied to growing pigs to cope with heat stress, but high dietary energy might worsen the negative effect on growth of finishing pigs. The effect of dietary energy on physiological response was varied.

(H. F. Lee, T. C. Yang, Y. H. Hseih, Y. F. Lin and C. B Hsu)



Pigs in the metabolic cage during metabolic experiment

Effects of total mixed ration prepared by domestic forage on velvet antler production performance of Formosan Sambar Deer

The purpose of this study was to investigate the effect of velvet antler production performances of Formosan Sambar Deer fed with total mixed ration (TMR) prepared by domestic forage. Twelve male deers were divided into two groups randomly based on their previous velvet antler production, age, body weight (BW), and body condition score (BCS). The control group fed with commercial TMR (CT), and the treatment fed with self-prepared TMR (ST). Calculated crude protein was 16% for both groups. The feeding trial was executed during the velvet antler production period, approximately 75 days. Feed and water were provided *ad libitum*. Results showed that no significant differences were found on the average dry matter intake (2.9 vs. 2.7 kg/d), antlers production (2.2 vs. 2.1 kg), antlers production days (80 vs. 77 days), final BW (159.8

vs. 157.4 kg), and BCS (3.7 vs. 3.6) between CT and ST groups. This domestic forage could be an alternative solution when the import forage was out of stock or the price increased.

(Y. C. Liu, H. H. Wu, C. W. Yao, H. H. Lin, S. R. Kang and J. R. Yang)



Feeding Formosan Sambar Deer with total mixed ration (TMR) prepared by domestic forage

The effect of different forage on rumen microbiota and milk composition of Holstein cows during the late lactation period in Taiwan

The objective of the present study was to compare the milking cow's microbiota profiles and milk composition by feeding different forage total mix rations. A total of 10 Holstein cows at late lactation period with similar milk production and lactation days were selected, and five lactating cows were assigned to the Pangola hay (P) or Bermuda hay (B) group each. In the experimental period, cows were pre-fed for 18 days. Milk samples were collected in the last three days, and rumen fluid samples were only collected at the end of the experimental period. The results showed 2,071 and 1,974 DNA barcoding

of unique microbial species in the rumen of dairy cows in groups P and B, respectively, and between different treatment groups. At the phylum level, the rumen microorganisms of the P and B groups were dominated by four dominant bacteria, including Bacteroidetes, Firmicutes, Proteobacteria, and Tenericutes. Nevertheless, the relative abundance of the dominant phylum in the samples of the two treatment groups was different. The relative abundance of Bacteroidetes as the first dominant phylum in the samples of group P was 69.81%, which was higher than that of 67.22% in group B. No significant differences

existed between groups P and B of milk yield, fat, protein, lactose, solids not-fat, urea nitrogen, and citric acid content. However, the content of de novo fatty acids of milk in the milk of group P was significantly higher than that of group B (0.98 vs. 0.75 g/100 g; $P < 0.05$). To summarize the results, the composition of rumen microbiota in milking cows fed with different compositions was similar, but the proportions differed. It might be due to the difference in the composition of rumen microbiota caused by the diet, which also made the proportion of newly synthesized fatty acids in milk fat related to rumen fermentation significantly different between the two groups. Understanding the changes in rumen core microbial composition and milk composition of milking cows with different forage complete mixed diets will help to develop the most suitable ratio of domestic forage that was stable in the rumen and capable of exerting production capacity

(S. H. Wang, H. H. Liao, C. X. Lee, H. M. Chen and J. W. Shiau)



Rumen fluid collection

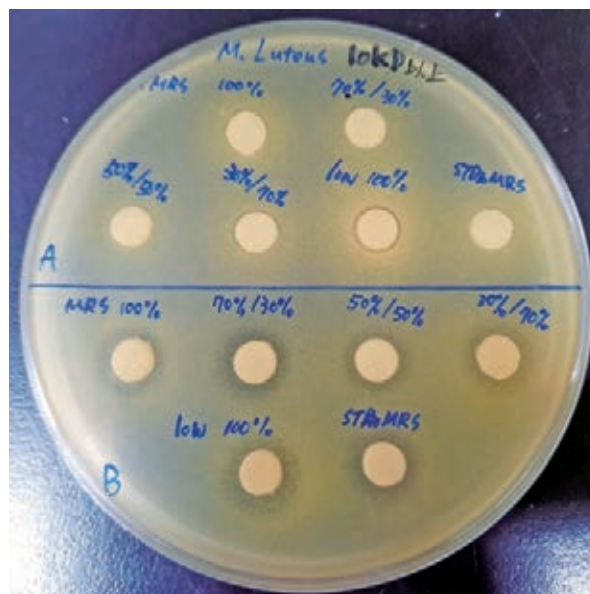
Effects of *Bacillus coagulans* fermentor on growth performance, diarrhea incidence and fecal bacterial phases of weaning pigs

A lower unit price culture solution modified from MRS (only 1/10 of the unit price of MRS culture solution) and MRS culture solution (Cat. No. 288210 BD company, USA) were used to evaluate the effects of the two different cultures on the growth performance, incidence of diarrhea, and fecal phases of weanling pigs. For the analysis of the inhibitory activity of the fermentation solution, the use of paper loaf agar diffusion containing 1×10^6 cfu/mL *Micrococcus luteus* (BCRC No. 80243) showed that the inhibitory activity of these two fermentation solutions was similar. In the weaning pigs rearing test, a total of 36 LYD crossbred weanling piglets (half male and half female) from 26 to 28 days of age were

used. There were 4 piglets (half male and half female) were selected according to sex and body weight and reared in a nursery pen, and the diets were supplemented with the LFP (Lower unit price) vs. MRS (MRS) fermenter in the blank group and the two groups of the test. As a result of this study, the growth performance of weanling piglets in LFP group was higher than that of the control group only in the second week of average daily weight gain, but there was no significant difference in the growth of weanling piglets fed the LFP diet compared to the MFP diet. The incidence of diarrhea in piglets was 9.5% in the second week of feeding LFP, 25.0% in the control group without the added fermentation solution,

and 14.2% in the MFP diet. In the fecal phase, the addition of LFP had the effect of reducing the number of pathogenic *E. coli*. There were no significant differences between the diets in terms of blood status, blood cell counts and white blood cell percentages. Taken together, these results showed that the addition of LFP ferment could increase the daily weight gain of weaned piglets in the second week after weaning, reduce the incidence of diarrhea, and reduce the number of pathogenic *E. coli* in the feces.

(F. C. Liu, Y. J. Lin and B. S. Lin)



Disk diffusion method

Reducing methane emissions from the gastrointestinal tract of pigs using dietary nutritional modification and feeding management

Higher fiber content of feed ingredients such as wheat bran and alfalfa will increase the crude fiber, acid detergent fiber, neutral detergent fiber and hemicellulose content of the feed when the amount in feed formula was increased. This in turn affects the production of methane production in the gastrointestinal tract of pigs. The crude fiber content of the feed was less than 3% for both growing and finishing pigs, but the crude fiber, acid detergent fiber, neutral detergent, and hemicellulose contents in finishing diet were higher than growing diet, mainly due to the use of 10% wheat bran in the feed formulation of finishing diet, whereas growing diet did not have

10% wheat bran. *In vitro* fermentation analysis of methane and carbon dioxide production from feed ingredients and feeds using rumen fluid showed that corn, alfalfa, and ground rice produced higher amounts of methane and carbon dioxide, while



In vitro gas production technique

corn and ground rice produced higher amounts of carbon dioxide; the methane production from finishing-phase hogs was higher than that of growing-phase hogs, while the carbon dioxide production of growing-phase hogs was higher than that of finishing-phase hogs. This might also be due to the use of 10% wheat bran in finishing feeds. Gastrointestinal methane and carbon

dioxide emissions per pig per day for growing and finishing pigs increased with different feeding rates (amount of food consumed), and were about 2.5 and 2.3 times higher for fattening pigs than for growing pigs, respectively, and the correlation between the two was quadratic.

(F. C. Liu, Y. J. Lin and B. S. Lin)

Effects of different content of soybean oil in the diet on goat milk compositions in summer

In the summer of Taiwan, goats suffer heat stress that makes goats eat less and have less energy to produce milk. At the same time, goats drink more water due to the hot weather, and the milk composition was also affected, which affects the income of goat farmers. Therefore, the purpose of this study was to use the oil with lower heat increment to be added to the feeding of goats and discuss the effect of different proportions of soybean oil on the goat milk quality during the hot weather. 18 goats were assigned to three treatments according to their body weight and milk yield. Each treatment had 6 heads of goats. At the beginning and end of the experiment, the body weight and milk yield of goats were measured, and milk composition was analyzed. The results showed that the goats fed with 1% soybean oil only had higher body weight, and milk yield was similar to the control group. The milk fat percentage,

milk protein percentage, lactose percentage, nonfat solids percentage and total milk solid percentage of 1% soybean oil group were higher than the other two groups.

(Y. H. Hsieh, B. Y. Wang, H. Y. J. Chen, J. L. Lin, S. P. Huang, S. J. Huang and C. P. Hsu)



Goats feed a different content of soybean oil diet

Effects of dietary biotin and organic zinc on growth performance, blood, and milk compositions of dairy goats in summer

Goats suffer heat stress that suppresses feed intake, then resulting in insufficient nutrient intake which consequently reduces the milk production during summer in Taiwan. At the same time, the milk composition may be affected due to more water being drunk by goats under the hot weather, which affects the income of farmers. Therefore, the purpose of this study was to evaluate the effect of biotin and organic zinc, known for alleviating heat stress on growth performance, blood and milk compositions of dairy goats during summer. 12 dairy goats were divided into two treatments according to their body weight and milk yield. Goats received diets adding 0 (control group) or 0.5 g biotin, and 0.4 g organic zinc (head/day) (treatment group). The body weight and milk yield of each goat were measured at the beginning and end of the experiment. Blood and milk samples were collected at the same time for composition analysis. The results of the study showed that the

additional supplementation of biotin and organic zinc had no significant impact on goat growth, blood and milk composition during the summer.

(Y. H. Hsieh, B. Y. Wang, Y. J. Chen Huang, J. R. Lin, S. P. Huang and J. B. Hsu)



Goats feeding in barn

Fruit peel by-products ensilaged as a feed resource

There are more than 4.7 million tons of agricultural by-products produced in Taiwan over the past decade. These by-products not only caused environmental problems but also increased cleaning costs, resulting in economic losses. Therefore, exploring a sustainable way to re-use these by-products was essential, as it can enhance the value and reduce the burden on the environment. In this study, fruit peel by-products from food processing plants were ensilaged by adding various materials. The quality of the silage was assessed by the composition and Flieg scores. The results showed that after one and three months of ensiling, the Flieg scores



Silages production of fruit peel by-products

of various peel residues, such as orange peels, grapefruit peels, lemon peels, and kumquat peels was between 50 and 99, that is equivalent to the grade of acceptable to good. This suggests that these fruit peel by-products silage can be served as potential feed ingredients for ruminants,

offering opportunities for ruminant producers to utilize these silages effectively based on various conditions.

(Y. H. Hsieh, B. Y. Wang, G. J. Fan, Z. R. Li and J. B. Hsu)

Effect of substitution proportions of Japonica rice for dietary corn on carcass traits and sensory evaluation of broilers

The purpose of this study was to investigate the effect of dietary corn replaced with ground brown Japonica rice on carcass traits and sensory evaluation of broilers. 256 day-old hatched birds with half male and female were equally allocated to 4 treatments. Each treatment had 4 replicates with a total 64 birds. Feed and water were provided ad libitum during the 5 weeks experiment. Control diet was formulated by corn-soybean basis, and the corn in other treatments was replaced with ground brown Japonica rice by 50%, 75% and 100%, respectively. At the end of the experiment, 2 male and 2 female broilers per

replicate were randomly selected and sacrificed for the measurement of heart, liver, and gizzard weight as percentage of carcass weight. The left-side breast was vacuum-sealed and placed in a water bath at 80°C for 30 minutes. The smell, flavor, color, taste, and overall acceptability were rated by 31 assessors afterward. The results indicated that Japonica brown rice had no significant effect on carcass traits while the assessor favored the 75% corn replacement group. (H. W. Hung, B. L. Shih, T. Y. Lee, C. C. Hung and C. B. Hsu)

The sensory evaluation of broilers

Items	Substituting ratio of ground brown rice on corn, %				SEM
	0	50	75	100	
Smell ⁺	3.90b	4.23ab	4.42a	4.35ab	0.09
Flavor ⁺	4.42	4.39	4.77	4.42	0.11
Color ⁺	4.52	4.74	4.74	4.61	0.11
Texture ⁺	4.03b	4.23ab	4.58ab	4.84a	0.12
Overall acceptability ⁺	4.45	4.48	4.90	4.55	0.11

^{a,b} Means in the same row with different superscripts differ significantly ($P < 0.05$).

⁺ A 7 point Likert scale was used to sum the values of each selected option and create a score for each respondent. Score 1 means strongly dislike, 2 means dislike, 3 means less dislike, 4 means neither like nor dislike, 5 means less like, 6 means like, 7 means strongly like.

Evaluation the requirement of metabolizable energy and protein for Leghorn laying hens on the second laying period

The price of eggs has been high in recent years. Operators used to make the laying hens to enter the second period by forced molting. However, there was very little information of nutritional requirements in diet for the second laying period. The experiment was to investigate dietary crude protein (CP) and metabolizable energy (ME) levels on laying performance and egg quality of layer hens during the second cycle of egg production. A total of 240 Hy-line W36 hens at 65 week-old were used as experimental animals. The hens were caged individually and randomly divided into 6 groups according to the egg production rate. The 2×3 factorial designs were used with CP 16 and 18%, ME 2,650, 2,850 and 3,050 kcal/kg. The experiment was conducted for 12 weeks. Laying performance and egg quality were determined. The results indicated that daily feed intake of hens had no significant difference on the main effect of CP in diet. However, ME 2,650 kcal/kg had a significantly higher daily feed intake than ME 2,850 kcal/kg and ME 3,050 kcal/kg in diet ($P < 0.05$). Group of 18% CP was significantly increased hen day egg production rate and egg mass ($P < 0.05$). Group of ME 2,850 kcal/kg had the highest egg mass of main effect. Hens fed with ME 2,650 kcal/kg in diet had significantly poorer egg conversion ratio than that of ME 2,850 kcal/kg and ME 3,050 kcal/kg groups ($P < 0.05$). In the main effect of dietary protein contents, the group of CP 18% had significantly higher egg weight and egg shell thickness than those of CP 16% group ($P < 0.05$). Group of CP 16% had significantly higher albumin height, Haugh unit and yolk color ($P < 0.05$). Main effects of dietary ME indicated

that groups of ME 2,850 and 3,050 kcal/kg had significantly higher egg weight ($P < 0.05$). Group of ME 3,050 kcal/kg had significantly lower Haugh unit and yolk color. In conclusion, hens fed with CP 18% and ME 2,850 kcal/kg had better laying performance, economic benefit and egg quality for layer hens during the second cycle of egg production period.

(B. L. Shih, W. T. Chen and H. W. Hung)



Egg shell breaking strength-meter

Effects of astaxanthin supplement on laying performance, egg quality and yolk color characteristics of laying hens

Astaxanthin is a pigment with strong antioxidant capacity. It can be used as a new type of animal health feed additive. The trial was conducted to study the effects of dietary astaxanthin (AST) supplementation on laying performance, egg quality, and yolk characteristics of laying hens. A total of 90 Leghorn layers at 36 weeks of age were randomly assigned into 5 groups according to the egg production rate. Each group of hens had three replicates, and each replicate with 6 layers. A corn-soybean meal basal diet was offered in the control group; otherwise, 4 experimental diets were added with 50, 100 and 500 ppm AST and 10 ppm Carophyll red® in the basal diet, respectively. All experimental diets contained 2,900 kcal/kg ME and 17% crude protein. Feed and water were ad libitum. Hens fed with the experimental diets lasted for 6 weeks. The laying performance, egg quality and egg color were measured during the experimental period. The results indicated that hens fed with AST supplementation did not

affect feed intake, hen-day egg production and body weight changes. Moreover, hens fed with 500 ppm AST had significantly ($P < 0.05$) higher egg yolk percentage and egg white height ($P < 0.05$). A linear regression added of egg yolk red color ($P < 0.05$) increased with the concentration of AST supplementation. Especially, increasing AST supplementation gradually increased the concentration of astaxanthin and carotenoids in the yolk ($P < 0.05$) for the high supplementation of AST and Carophyll red® treatments. Furthermore, hens fed with pigment supplementation had significantly higher antioxidant value ($P < 0.05$). In conclusion, dietary AST supplementation significantly increased the red color of egg yolk, and that AST supplementation showed benefits to increase the egg quality and additional value of egg product.

(B. L. Shih, L. J. Su and S. H. Wn)



Egg yolk color by the treatments

Effects of supplementation of *Bacillus subtilis* TLRI 211-1, electrolytes and phytase on laying production and egg quality

A total 240 of Hy-line laying hens at 24 wks-old were used as experimental animals. The experiment was conducted for 12 weeks during the egg production period in the hot season (July - Oct). The basal diet as control group, the 2nd and 3rd group had 500 IU/kg phytase and was added with 300 and 400 dEB/kg electrolytes, respectively. The 4th and 5th group had 1% LRI-211-1 *Bacillus subtilis* and added with 300 and 400 dEB/kg electrolytes, respectively. The 6th group was added with 0.1% commercial *Bacillus subtilis* and 300 dEB/kg. The results indicated that diets added with phytase + electrolytes or *Bacillus subtilis* + electrolytes under hot season significantly increased egg production ($P < 0.05$).

Bacillus subtilis + 400 dEB/kg electrolytes group or commercial *Bacillus subtilis* + 300 dEB/kg electrolytes group had the best feed conversion ratio ($P < 0.05$). *Bacillus subtilis* + 300 dEB/kg electrolytes had a lower percentage of soft egg ($P < 0.05$). The control group had significantly lower egg weight, albumin height and yolk yellowness ($P < 0.05$). In conclusion, layer hens fed with LRI-211-1 *Bacillus subtilis* + electrolytes can significantly improve egg production performance, egg weight, and albumin height and yolk color. (B. L. Shih, R. B. Liaw, W. T. Chen, T. Y. Lee and H. W. Hung)

Effects of supplementation *Bacillus subtilis*, electrolytes and phytase in diet on changes of body weight cloaca temperature and odor in excreta of hens under hot season

Items	Control	Phytase 500 U/kg		TLRI 211-1 1%		CBA 0.1% + Electrolytes 300 dEB/kg	SEM
		Electrolytes 300 dEB/kg	400 dEB/kg	Electrolytes 300 dEB/kg	400 dEB/kg		
Weight gain, g/hen	5.85 ^b	74.83 ^a	106.25 ^a	83.03 ^a	78.38 ^a	88.86 ^a	15.10
Cloaca temperature, °C	41.45	41.30	41.18	41.11	41.22	41.15	0.08
Ammonia (NH ₃)	20.11 ^a	13.58 ^b	5.62 ^b	7.86 ^b	18.38 ^{ab}	9.19 ^b	4.34

^{a,b} Means with different letters within the same row were significantly different at 5% level.

CBA: Commercial *Bacillus subtilis* additive.

Effects of reduction level of dietary crude protein and supplementation with *Bacillus subtilis* solid-state fermentation product on growth performance and blood chemical traits of broilers and litter properties

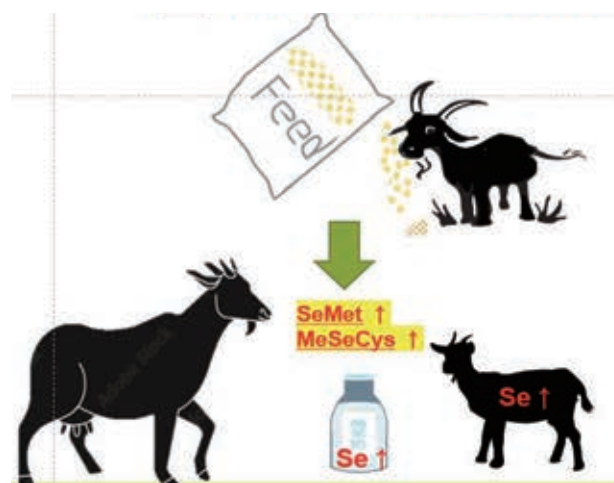
This study investigated the effects of reducing the dietary crude protein (CP) and supplementation with *Bacillus subtilis* solid-state fermentation products on performance of broilers, and litter properties. A total of 432 one-day-old Ross broiler chicks were randomly assigned to a 3 x 3 factorial arrangement, considering 3 reducing levels of dietary CP (0%, 1%, and 2%) and 3 adding levels of *Bacillus subtilis* solid-state fermentation product were used. Nine treatments with six replicates and eight chicks per replicate were used and 48 chicks each treatment totally. Body weight of chicken and feed intake of replicate were weighed at 1, 21, and 35 days of age to calculate weight gain and feed efficiency. Experiment was ended at 35 days of age. The results showed that diet supplementation with solid-state fermentation products of *Bacillus subtilis* improved weight

gain, feed efficiency of broilers and decrease the litter ammonia concentration in the 21-35d period ($P < 0.05$), while reducing dietary CP level significantly reduced blood creatinine, calcium and litter ammonia concentration ($P < 0.05$), and increased feed intake and feed efficiency in the early growth period. However, when reducing dietary CP with increasing the solid-state fermentation products of *Bacillus subtilis* increased blood calcium concentration and alkaline phosphatase activity ($P < 0.05$). It was recommended to add 1% of *Bacillus subtilis* solid-state fermentation products to the diet and reduce 1% of dietary CP to maintain the growth performance of broilers.

(T. Y. Lee, J. H. Wang, H. W. Hung, B. L. Shih, and R. B. Liaw)

The impact of supplementation of different forms of selenium in the feed on the production performance of ewes and lambs

Selenium deficiency in animals leads to nutritional muscular dystrophy, and sheep is considered more susceptible to this condition compared to cattle. The purpose of this experiment was to study the effect of adding different forms of selenium to the feed on the production performance of ewes and lambs. A total of 24 healthy pregnant ewes were randomly divided into four groups (6 ewes/group). Different forms of selenium were added to the feed from 35 days before the expected parturition day until 14 days postpartum. These forms included 0.15 mg/kg sodium selenate (Selenate), 0.5 mg/kg sodium selenite, 0.5 mg/



Development of selenium content and patterns transferred from ewes to lambs

kg selenium methionine, and 0.5 mg/kg selenium yeast. The growth characteristics and lamb survival rates were evaluated on the day of parturition and 14 days postpartum. The results indicated that adding different forms of selenium to the ewes' feed during the late pregnancy period did not result in significant differences in the body weight of the ewes or weaned lambs. However, the groups receiving 0.5 mg/kg sodium selenite,

selenium methionine, and selenium yeast showed an increased survival rate of 21-23% of lambs, although this increase did not reach statistical significance. In conclusion, adding different forms of selenium to the feed did not significantly impact the growth performance of ewes and lambs, but it may have a positive effect on lamb survival rates.

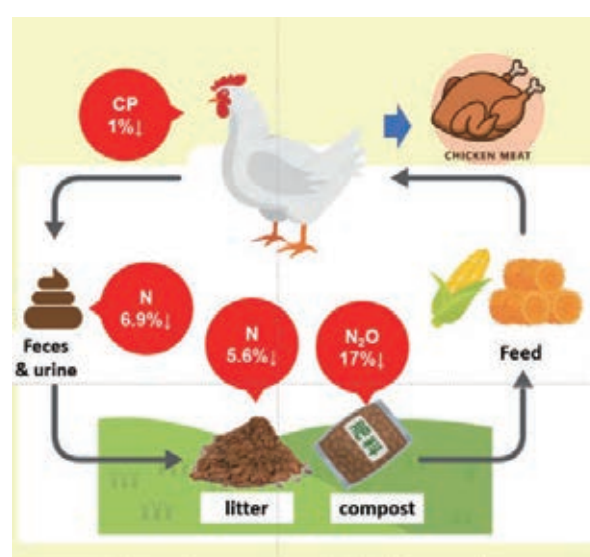
(C. C. Hung, T. T. Chen, Y. P. Dai and C. B. Hsu)

The carbon emissions assessment of low-protein feed for broiler chickens

The objective of this experiment was to assess the impact of reducing dietary protein on feed carbon emissions. The protein content in the feed for the broiler chickens during the growing period was as follows: 21.5% (Growing control diet), 20.5%, 19.5%, 18.5%, and 17.5%. During the finishing period, the protein content in the feed was adjusted to 19.5% (Finishing control diet), 18.5%, 17.5%, 16.5%, and 15.5%, with additional amino acid supplementation to meet the ideal amino acid requirements for broiler chickens. Using the carbon footprint emission coefficients announced by the Environmental Protection Administration and parameters from the Simapro software, the carbon emissions from each feed group were calculated. In the growing period (11-24 days), the carbon emissions for the control diet were 1,250 kgCO₂e (including water and electricity emissions). Reducing dietary protein by 1%, 2%, 3%, and 4% resulted in reductions of 4.15%, 7.89%, 11.37%, and 15.00% in carbon emissions, respectively. In the finishing period (25-32 days), the carbon emissions for the control diet were 1,166 kgCO₂e. Reducing dietary protein by 1%, 2%, 3%, and 4% led to reductions of 4.81%, 6.85%, 10.74%, and 14.42% in carbon emissions, respectively. In summary, reducing the

protein content in the feed can reduce feed carbon emissions. For every 10 g/kg decrease in protein content in the growing period feed, there was an average reduction of 3.75% to 4.15% in kgCO₂e emissions, while in the finishing period feed, there was a reduction of 3.42% to 4.81% in kgCO₂e emissions.

(C. C. Hung, B. L. Shih, C. F. Kang, L. G. Su, S. J. Yan, C. B. Hsu)



Reducing dietary protein in broiler diets to reduce nitrogen emissions (The N₂O emissions from composting were estimated using the IPCC tier2 approach)

III

Breeding of Napier grass: Improving fiber quality of purple line

Napier grass (*Pennisetum purpureum*) is one of the commonly used forage crops in Taiwan. It can be fed to livestock by green or silage. Napier grass line No. 1120 was named Napier grass Taishiu grass No. 9 on October 15, 2023. It has the highest ability of flooding tolerance among all varieties. Even though 9 cultivars have been bred, however, in response to climate change and animal needs, the Napier grass cultivars improvement project is still ongoing. There were three research objectives in the project: First, developing a new line with functional ingredients, such as anthocyanins, and good palatability. Second, breeding a new line of Napier grass with both high quality and yield in a stress environment. Third, improving the quality of the high stem type Napier grass. Through parental selection, hybrid combination, single plant selection, three-level line comparison tests, animal test, the object of this study was to select high forage yield and quality of Napier grass by interspecific hybridization. The major works were as follows: the agronomic traits, forage yield, the contents of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL), water-soluble carbohydrate (WSC), and functional components

of the selected lines would be determined. The new ideal functional line requires a fresh grass yield higher than Taishiu grass No. 3, a CP content higher than that of Taishiu grass No. 5 and above 6.0%, a NDF and ADL lower than that of Taishiu grass No. 5, and an anthocyanin content of the dry leaf extract greater than 2.0 mg/100 ml. Finally, three lines, No. 2, 4 and 7, were selected to enter the regional test. In the salinity stress test, the Napier grass Taishiu grass No. 3, 7, and 9 were able to be continuously irrigated by 250 mM NaCl solution without affecting the plant height at harvest, showing the potential to endure slight salt tolerance. In the selection of high-stem lines, at 12 weeks of regeneration, the CP of line 1114, 2111, and 2213 was higher than 7.1%, while line 2213 had low NDF and ADF, 61.7 and 34.6 %, respectively. The nutritional quality of the test lines were acceptable, and lodging resistance of 2201 was the best among all lines. Overall, with the breeding goals of lodging resistance, high quality and yield, we selected both line 2201 and 2111.

(T. R. Li, L. C. Tsai, P. Chung, S. R. Chang, C. H. Lu and J. B. Lin)



Napier grass Taishiu grass No. 9

Effect of water irrigation amount on the yield and quality of pangolagrass and Nilegrass

The experiment with different water irrigation levels of Nilegrass and pangolagrass was divided into four treatments: daily watering of 1,200 ml (control group), 1,000 ml, 800 ml, and 600 ml, respectively. The effects of irrigation water on grass yield and quality would be explored. For Nilegrass, the plant height was the highest at 73.6 cm with irrigation of 1,200 ml, and the significantly ($P<0.05$) lowest at 61.5 cm with 600 ml treatment. Similarly, both fresh weight and dry weight were the significantly highest with 1,200 ml treatment at 353.5 and 97.1 g/pot, respectively, and the significantly lowest with 600 ml treatment, at 201.3 and 63.5 g/pot, respectively. Regarding forage quality, the crude protein content (CP, dry basis) was the highest at 11.33% with 600 ml treatment, and the lowest with 1,200 ml treatment at only 9.16%. Acid detergent fiber (ADF) content was the highest at 38.7% with 1,200 ml treatment, and the lowest at 35.8 and 34.8% with 600 ml and 800 ml treatments, respectively. These results indicate that irrigation levels significantly affect the growth and forage quality of Nilegrass. For pangolagrass, the tallest plant heights were observed in 1,000 ml and 1,200 ml treatments, at 64.5 and 64.2 cm, respectively, while the lowest was at 55.6 cm with 600 ml treatment ($P<0.05$). Similarly, in terms of fresh weight, 1,000 ml and 1,200 ml treatments (338.5 and 339.0 g/pot, respectively) were significantly

higher than the 600 ml treatment (188.8 g/pot). In terms of dry weight, 1,000 ml treatment was significantly higher than other treatments at 78.4 g/pot. Regarding forage quality, the CP content was the lowest at 6.8% with 1,200 ml treatment, and ADF content was the lowest at 40.8% with 600 ml treatment. As irrigation levels increased, both Nilegrass and pangolagrass showed a trend of increasing plant height, while plants under water-deficit treatments exhibited curled and reduced leaves, indicating that water deficiency affects plant growth. Drought avoidance mechanisms in grass include the ability to reduce water loss under drought conditions or regulate their own growth to avoid drought period. For example, many tropical grasses exhibit leaf wrinkling or curling, mutual shading of leaves, deeper root systems, thicker cuticles, denser leaf hairs, or developed water storage tissues, and all of which can reduce water loss. Both Nilegrass and pangolagrass showed low dry weight and high dry matter ratio with the 600 ml treatment, indicating that water deficiency not only affects plant growth but also promotes early maturity. CP content for both grasses was the lowest with 1,200 ml treatment and the highest with 600 ml treatment, while ADF exhibited the opposite trend, was the lowest with the 600 ml treatment, with non-different from other treatment in neutral detergent fiber (NDF) content.

(P. Y. Chen)



Effect of water irrigation amount on Nilegrass



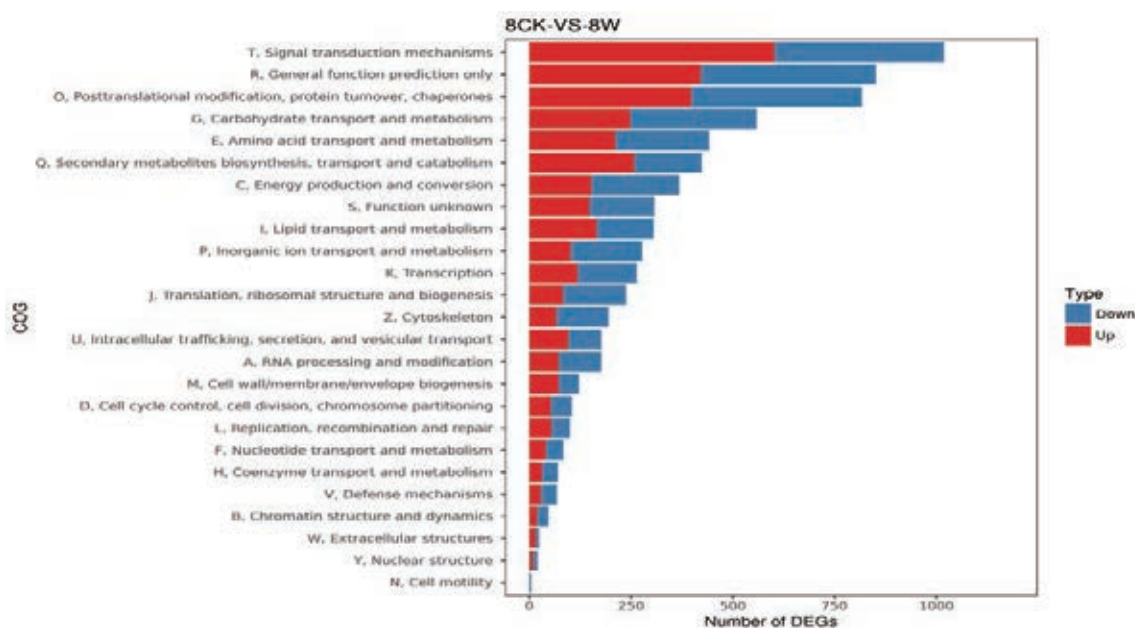
Effect of water irrigation amount on pangolagrass

Expression and transcriptome analysis of Napier grass under waterlogging stress

Napier grass is one of the major forage crops in Taiwan. In response to climate change, it is expected to breed varieties with environmental tolerance to maintain a stable supply of forage production. Napier grass Taishiu grass No. 4 (TS4), 6 (TS6), and 8 (TS8) were grown as cuttings for 3 weeks, and then flooded for 7 days. The drop ratio of the shoot height of TS4 was the highest (30.4%), followed by TS6 (24.8%), and TS8 was the lowest (13.5%). Under the waterlogging treatment, the contents of crude protein (CP), phosphorus (P), potassium (K), and calcium (Ca) in TS4, TS6, and TS8 all decreased significantly. Among them, the reduction ratio of CP content in TS4 was as high as 55.3%, and that of TS6 was 41%. TS8 has a minimum of 35.8%. The content of water soluble carbohydrate (WSC) among the three varieties all increased significantly. Compared with the control, TS4 and TS8 increased by about 3 times, while TS6 increased by about 2 times. There was no

significant difference in the contents of neutral detergent fiber (NDF) and acid detergent fiber (ADF) between the waterlogging treatment and the control of TS8. Based on the above, it shows that TS8 has a better tolerance to waterlogging stress than TS4 and TS6. The results of RNA-Seq gene expression analysis showed that between the control and waterlogging treatment, the significant differential expression genes (DEGs) of TS4, TS6, and TS8 were mostly negatively regulated. By comparing the Cluster of Orthologous Groups of Proteins (COG) database, it showed that the proteins represented by the significant DEGs, most of their functional classifications were related to signal transduction mechanisms, posttranslational modification, transport and metabolism of carbohydrate and amino acid, and biosynthesis, transport, and catabolism of secondary metabolites.

(P. Chung and T. R. Li)



The results of comparing the COG database by the significant DEGs of Napier grass Taishiu grass No. 8

Develop alternative feeds for agriculture by-products to promote sustainable utilization of agriculture

In order to promote the value-added reuse of domestic agriculture by-product, we researched silage technology and applied on high-fiber agriculture by-products to develop alternative feeds for ruminants. The feeding efficiency was no less than that of general feeding methods, reducing the dependence on imported feeds of the domestic livestock industry, and the cost of raising grass-fed livestock, promoting agricultural recycling, and benefiting the environment. In addition, we cooperated with agriculture by-product raw material suppliers, transporters, silage manufacturers, and livestock farmers to establish industrial chain supply models for silage of agriculture by-products. Two agriculture by-product silage supply chains had been successfully established in southern Taiwan. The first chain was between a local agriculture by-product raw material supplier in Pingtung, PINGTUNG LEMON Transportation and Marketing Cooperative, and Liangmu Livestock Farm. The second chain was between a local agriculture by-product raw material supplier in Tainan, Guan Nan Biotechnology Co., Ltd, and the silage supply and utilization partner, TXI BA WENG INC. In terms of efficiency, establishing an industrial chain can effectively save the cost of handling agriculture by-products, for livestock farmers, it can reduce their feed costs and dependence on imported feed. In terms of social benefits, it can improve the recycling and reuse of agriculture by-product resources. It also guided

the private industry TXI BA WENG INC, and 21 dairy farmers to combine the value-added reuse of livestock waste and agriculture by-products, and through industry-government cooperation, build a circular agriculture demonstration site in the BA WENG dairy farming area. The operation model of this field was mainly divided into two parts. One was to provide guidance on the production of space-packed silage of agriculture by-products such as lemon peel and pineapple peel to feed dairy cows. The other was to use agriculture by-products for the production and application of vermicomposting to promote environmental friendliness and sustainably agricultural recycling, taking into account the three-win situation of industry, environment, and society.

(P. Chung, G. J. Fan, J. B. Lin and T. R. Li)



Development of agricultural processing by-products - lemon peel and Napier grass silage making and value-added reuse

Establishment of grass-legume mixture film-packed silage model

The aim of this research was to establish the optimal mixed-intercropping ratio and cutting period of sesbania (*Sesbania roxburghii*) and pangolagrass (*Digitaria decumbens* L.). The experiment was carried out in June (summer cultivation) and September (autumn cultivation), sesbania seeds were sown by 4 density, 40, 30, 20, and 10 kg/ha in pangolagrass land, and the pure pangolagrass land on the side was used as the control group. The mixed-intercropping sesbania and pangolagrass were harvested in 30 days, 60 days, and 90 days after planting (DAP), and we evaluated the yield, grass quality, and silage quality of the grass. Results showed that summer cultivation had higher plant height and yield than autumn cultivation, however, with the low water-soluble carbohydrate (WSC) content and the high fiber content, the grass and silage quality of summer cultivation were lower than autumn cultivation. In the autumn cultivation, WSC and

starch contents were the highest in DAP90, which was significantly higher than DAP60 and DAP30. Among the treatment groups, WSC and starch contents were the highest in 10 kg/ha. Therefore, we suggested that sowing sesbania in autumn, in the amount of 10 kg/ha, and harvesting in DAP90, was the most optimal cultivation to mixed-intercrop sesbania and pangolagrass. The plant height and fresh yield of the mixed-intercropping pangolagrass were not significantly lower than the control group. However, in terms of quality, crude protein (CP) content increased significantly. The pH and lactate content of the silage were not significantly different from the control group, and the Flieg's score could reach 79 points. This research established a new model for sesbania utilization and provided a new choice for the domestic livestock industry.

(L. C. Tsai, S. R. Chang, T. R. Li and J. B. Lin)



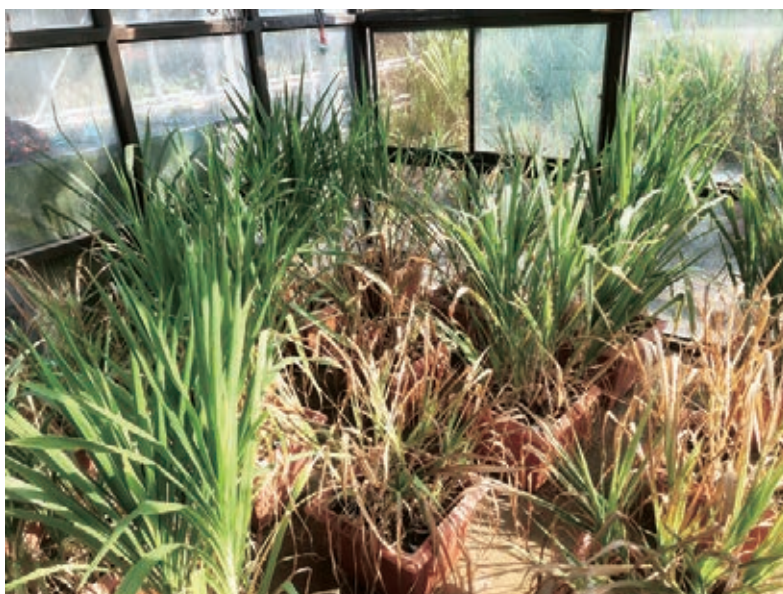
The mixed-intercropping sesbania with pangolagrass in DAP30

Establishment of physiological index for drought and salt tolerance of forage crops

The frequency of extreme climates around the world is gradually increasing, which has a negative impact on the production of forage crops. A suitable stress-tolerant selection indicator can help the stress-tolerant breeding jobs. This study investigated the agronomic traits and physiological values of Napier grass Taishiu grass No. 3, Napier grass Taishiu grass No. 8, Pangolagrass line A254, Nilegrass Taishigrass No. 2, and Nilegrass Taishigrass No. 3 in drought environment. In the experiment, control groups were normally irrigated twice a week, treatment groups A were irrigated once every 2 weeks, and treatment groups B were irrigated once every 4 weeks (the soil water content was 23.7%, 6.1%, and 4.2%, respectively). The irrigation water was underground water and the volume was equal. Results showed that plant height of leaf tip, fresh yield, dry matter yield, stem diameter, and tiller number of all the forage crops declined under drought environment. In terms of physiological values, the Soil-Plant Analysis Development (SPAD) values and the water soluble carbohydrate (WSC) content decreased in the drought environment. The electrolyte leakage (EL) rates and K content increased in the drought environment. Because the change of EL rate was the most significant, it was suggested to be the physiological indicator for evaluating the drought tolerance of the forage crops. This study also evaluated the feasibility and applicability of various physiological values applying on the forage crops salt-tolerant selecting. In another experiment, we used Napier grass

Taishiu grass No. 3, 8, and 9 as the experiment materials. We irrigated the Napier grass with three NaCl concentrations of irrigation water, B. 0.3%, C. 0.6%, and D. 1%, and we also irrigated the Napier grass with normal underground water as the control groups A. The volume molar concentrations of the three treatment groups B. 0.3%, C. 0.6%, and D. 1% were approximately equal to 50, 100, and 170 mM, respectively. The results showed that the yields of all varieties in C and D groups were significantly lower than those in control groups. Correlation analysis between SPAD value and dry matter yield, and between EL rate and dry matter yield showed that the correlation coefficients were both bigger than 0.7, indicating a high degree of correlation. Therefore, as both SPAD value and EL rate can well express changes in yield, we suggest that they can be used as good physiological indexes to evaluate salt tolerance of Napier grass.

(L. C. Tsai, P. Chung and T. R. Li)



Napier grass irrigated with different concentrations of saline irrigation water

Carbon sink of perennial forage pasture irrigated with livestock manure digestate

In this study, livestock manure digestate was used to irrigate the pasture of pangolagrass (*Digitaria decumbens* L.) to improve the physical-chemical properties of the soil, so as to increase the absorption efficiency of soil fertilizers by plants, and to reduce the fertilizers application while taking into account the production of forages. In addition, this study compared the greenhouse gas emissions and soil carbon accumulation between the traditional cultivation and the cultivation modes that reduced chemical fertilizers and increases soil organic matter content, then estimated the carbon reduction efficiency and carbon sink benefit of the production modes that reduced CO₂ emissions and carbon sink increase, to achieve the goals of net-zero emissions production and sustainable pasture management. This study conducted field greenhouse gas emission monitoring and soil carbon accumulation measurement in order to present the carbon emission status of forage production objectively and accurately, and evaluated the carbon accumulation efficiency of pasture by livestock manure digestate treatment. The transparent closed chamber system with gas-concentration

analyzer was used to simultaneously measure the concentrations of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) in the pangolagrass pasture. The results showed that the greenhouse gas emission monitoring values of the pangolagrass pasture before treatment were CO₂, -8.99644 t CO₂ e/ha, CH₄, 0.00058 t CO₂ e/ha, and N₂O, -0.07189 t CO₂ e/ha. It means that the background value of greenhouse gas emissions from pangolagrass pasture was 9.06775 t CO₂ e/ha. The soil carbon accumulations of pangolagrass pasture after one-year treatment were: Conventional fertilization (full nitrogen fertilizer), 0.460 Mg/ha, Livestock manure digestate irrigation + half nitrogen fertilizer, 0.487 Mg/ha, and Livestock manure digestate irrigation, 0.459 Mg/ha. The performances of soil carbon accumulation for the treatments were similar. Slight increase was observed while compared with the carbon amount of pangolagrass pasture before treatment (0.453 Mg/ha). The study will continue monitoring to evaluate whether the fertilization treatment could improve the carbon accumulation of the pangolagrass pasture or not. (S. R. Chang)

Investigation and test on moisture removal effect in modified container hay barn

Intake of small herbivores is low, and hay is prone to long-term storage deterioration. In this study, a modification with a container for small scale hay storage was carried out, and its micro-meteorological changes and dehumidification effect were also investigated. After the ventilation tower was installed in the container, the surveyed

ventilation rate was 378 m³/h, calculated as 5.6 times the air changes per hour in the modified container. The relative humidity (RH) of the modified container dropped from 90 to 75% on the 5th day after injection of 100 L water, while the control set (without water injection) remained stable at about 85%, indicating that the modified

container could effectively remove the internal moisture. According to the continuous micro-meteorological records, the RH changes of the upper layer of the modified and original containers were similar, which could be reduced to 30 to 35% during the day, and the RH of the modified set were lower than that of the original set. The RH of the lower layer in the original container was higher than that in the modified container and also higher than that of outdoors in the evening. The hay bales of pangolagrass and Bermuda grass were placed in the modified container, original container and the concrete barn to conduct a 35-day survey on their weight reduction. Although the test in the modified container was disturbed by the entry of rainwater entrained by strong winds, the moisture loss of hay bales in the modified container was higher than those in others. The results were similar in both Bermuda grass and

pangolagrass hay bales.

(C. S. Chen, H. H. Liu and T. H. Yu)



The corrugated steel sheet under the roof (up) and the floor below were provided with holes (down) to facilitate ventilation

Effects of different treatments on the quality of pangolagrass haylage in medium-size bales covered with plastic membranes

The purpose of this study was to investigate the effects of dry matter content, inoculation, and storage period on the quality of pangolagrass haylage in medium-size baled covered with plastic membranes. Each factor had two levels as follows: low dry matter content (below 40%, haylage processing in the morning) vs. high dry matter content (above 40%, haylage processing in the afternoon); control (no inoculation) vs. inoculation (commercial inoculum, *Lactobacillus plantarum*, *Lactobacillus casei*, 2×10^8 cfu/kg), and short-term storage (within 2 months) vs. long-term storage (6 months and above), for the comparison of fermentation performance. Each treatment processes 4 plastic membranes. The results showed that there was a major significant effect regardless of the inoculation, the level of dry matter content, and storage time. There was

no significantly individual interaction effect other than the acetic acid content. The inoculation treatment could increase the ratios of lactic acid/acetic acid and reduce the butyric acid contents of pangolagrass haylage. The lactic acid/acetic acid ratios of inoculation treatment increased from 2.8 to 7.3 and from 5.2 to 9.2, and the percentages of equivalent butyric acid in the total volatile fatty acid (VFA) decreased from 6.4% to 0.7% and from 1.4% to 0.5% under low dry matter and high dry matter rates, respectively. The inoculation treatment could achieve a better preservation effect. From the comparison of storage period, the results showed that the lactic acid/acetic acid ratios of the control treatment (without inoculation) decreased from 4.3 to 1.3, and the percentages of equivalent butyric acid in the total VFA increased from 3.4% to 9.3%

at low dry matter content after 6 months of storage, respectively. The results indicated that the fermentation quality was reduced, while the inoculation treatment could reduce the degree of poor fermentation. According to the results, the fermentation quality of pangolagrass haylage in medium-size bales covered with plastic membrane was better than when the dry matter content was adjusted to 35-65% after a short period of wilting. However, considering the changes of weather and the flexibility of hay processing, the grass could be wrapped directly after cutting. The lactic acid bacteria inoculation was recommended and used as soon as possible. The diameter of the medium-size haylage bale was 90 cm, and the weight of the whole bale was 160 to 200 kg, which was 30 to 40% of the original hay bales with diameter 120 cm. Haylage bales with such size were

easier to be operated on small herbivore farms such as goats or deer for less loss on less feeding. (S. M. Wang, T. H. Yu and C. S. Chen)



The medium-size baler worked in the field for haylage

Development of the drying room by solar thermal energy for hay production

The purpose of this study was to develop an energy-saving drying system for hay production by taking into account the forage quality and the energy efficiency. Solar thermal energy was a rich and green energy and was the major energy used in this drying system to reduce fossil energy and electricity consumption. From the result of drying simulation by laboratory oven, it showed that the moisture content of fresh alfalfa stacked with 10 cm thickness could be reduced to a safe storage standard level with moisture content 15%

after 8 hours drying at 50°C in the solar dryer. The prototype drying system was designed with forage loading, drying and unloading systems, and could be operated in a semiautomatic way. According to the records in the drying room, the temperature in the drying room could reach 50°C and the high temperature could last until 4:00 pm, when the outdoor temperature was 28°C at 9:00 am. The relative humidity was below 20% during this period. The design of air circulation and dehumidification devices could improve

the uniformity of the indoor environment and increase hay drying efficiency. The average drying rate of alfalfa during the day could reach 6.1%/h. Compared with electric drying, the drying room could save 99% of energy consumption and reduce carbon emission. It was suggested that the solar dryer might have used solar thermal energy with high potential applied in producing high quality hay for pets and experimental animals.

(S. M. Wang, H. H. Liu, T. H. Yu and C. S. Chen)



The appearance of drying room (left-up) and drying processing of alfalfa (left-down, right)

Feasibility assessment on the production of short stem forage mixed planting in the field set with photovoltaic panel

In order to understand the feasibility of growing forage crops in the field set with solar photovoltaic panels, two mixed planting experiments of pangolagrass-alfalfa and oat-alfalfa were studied under simulated solar photovoltaic panels. The results showed that the dry matter yield of mixed planting of pangolagrass and alfalfa were 8.7 t/ha in the unshaded area (control) and 8.5 t/ha in the semi-shaded area (next to the photovoltaic panel), respectively. There was no significant difference between these two treatments. There was also no significant change in the ratio between the two harvests. However, under photovoltaic panels (shade area), the forage yield of pangolagrass decreased with the harvest times, and alfalfa could hardly grow. In the oat-alfalfa mixed planting, the oat grew well under the unshaded area. Its dry matter yield was up to 7.2 t/ha, while that of the semi-shaded area was 4.8 t/ha, and it decreased with shading level. According to the estimated forage yield, it showed that the total yield of pangolagrass-alfalfa mixed planting grown in

the field with 40% shading could reach 78% of that growing in the field without shading. The forage yield of oat-alfalfa mixed planting grown in the field with 40% shading reached 60% of that growing in the field without shading. In addition, there was no significant difference between the forage quality under the shade of photoelectric panels and the control. The preliminary results of



Installation of simulated photovoltaic panels in grass-land

this experiment showed that the field setting 40% of the photoelectric panel could be considered for short stem forage planting at the same time which could produce forage with low input. In addition to being used by herbivores, forage planting could

reduce exposed ground and had the maintenance effect of water and soil, even if it was not for production purposes.

(J. F. Liu and C. S. Chen)

Development of paper mulberry as forage shrub for small ruminants

Paper mulberry (*Broussonetia papyrifera*) is a perennial plant which belongs to the family of Moraceae. Except for its highly lignified trunk, leaves and tender branches of mulberry are characterized by high nutritive value and good palatability, fast growth rate and resistance to long-term mowing, so it is suitable as forage. To determine the fluctuation of forage yield and quality of paper mulberry in different harvest seasons, this study was conducted to harvest mulberry at three different cutting intervals (40, 60, and 80 days) and plant spacing (40, 60, and 80 cm) annually. In terms of cutting interval, plant height (PH), stem ratio (SR) and dry matter yield (DMY) were all the highest at 80 days of cutting interval, but its leaf ratio (LR) was the lowest, which content of crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) of whole plant were 13.7, 39.1, and 52.4%, respectively. However, PH, SR, and DMY were all the lowest at 40 days of cutting interval, but its LR was the highest, which content of CP, ADF, and NDF of whole plant were 19.7, 28.5, and 39.8%, respectively. In terms of harvest season, PH, SR, and DMY were all the highest in summer, but its leaf ratio (LR) was the lowest, which content of CP, ADF and NDF of whole plant were 14.5, 36.8, and 49.7%, respectively. However, PH, SR, and DMY were all the lowest in winter, but its LR was the highest, which content of CP, ADF and NDF of whole plant were 20.9, 27.3, and 38.4%, respectively. In terms of

plant spacing, DMY was the highest by 40 cm and was the lowest by 80 cm, but other agronomic traits and forage chemical components were all not different significantly. In addition, the annual total dry matter yield and CP yield of paper mulberry were both the highest under 60 days of cutting interval by 40 cm plant spacing, which was 35.2 and 5.6 t/ha, respectively. It contained both high yield and quality, and could be used as a reference for shrub forage production.

(M. H. Chu)



The growth performance of paper mulberry under different cutting intervals

Development of mulberry and paper mulberry pellets for forage use

Mulberry and paper mulberry both have the characteristics of fast growth and high nutritional value, making them suitable for cultivation in shrubs as forage. To improve the quality and convenience of domestic forage, this study was conducted to develop mulberry and paper mulberry pellets for forage by: (1) Comparison of different die diameters (6 mm and 8 mm), (2) Establishment of the pelletization for mulberry and paper mulberry by withering, mechanical drying, and the addition of dry matter materials (corn meal, pangolagrass, and soybean hull), which determined the influence of particle size and dry matter on the preparation of forage shrub pellets, and established the production process of mulberry and paper mulberry pellets. The results showed that the pelletization efficiency of the 6 mm pore diameter was significantly better than that of 8 mm, and its bulk density was also higher than 8 mm. After 24 hours of withering, the moisture content of mulberry and paper mulberry remained above 68%, making it difficult to form pelleting. The more the dry matter materials were

added, the palletization easier, but it reduced bulk density and durability. Considering the production rate and pellet quality, withered mulberry and paper mulberry could be pelleted in a ratio of shrub/cornmeal or soybean hull at 1/4. Approximately 2.5 to 3.0 cycles were needed to produce pellets. The addition of corn meal resulted in low crude protein (CP) content, but significantly reduced fiber content. On the other hand, the addition of soybean hull increased CP content but significantly increased fiber content. The dry matter content of shrub after oven drying at 60°C for 15 hours was about 71%, it needed approximately 2.3 cycles to produce pellets. With a shrub/cornmeal ratio of 3/1, it required about 1.5 cycles to produce pellets. The CP content of mulberry and paper mulberry pellets were 15.8 and 15.1%, and the acid detergent fiber (ADF) and neutral detergent fiber (NDF) content of mulberry were 25.3 and 36.9%, and for paper mulberry were 26.4 and 36.1%, respectively.

(M. H. Chu)

Change of anti-nutrient and evaluation of utilization benefits of forage sorghum

The objectives of this study were to investigate the changes of anti-nutrient content and evaluation of utilization benefits of the new forage sorghum line SEN under different sowing dates in both early April and May. The results showed that the forage sorghum growth of 45 days with the highest cyanic acid content, 132.4 and 105.6 ppm, respectively. Content of cyanic acid decreased gradually with maturity. After 75 days of sowing, the content of cyanic acid

decreased to the lowest, 13.5 and 11.2 ppm, respectively. The plantlets of forage sorghum were harvested at 75 days after sowing, and their nutritional components were analyzed. Results showed that there were no significant differences in nutrient compositions. The cyanic acid content in perennial roots of forage sorghum was the highest at 40 days sowing in April, between 72.1 to 85.8 ppm, and the lowest at 10.2 to 12.9 ppm at the 75th day of growth. The cyanic acid content



The growth of forage sorghum new line SEN in sowing April and May (left - right)

in the 40-day-old plant which showed in May was the highest, between 63.6 to 71.8 ppm, and the cyanic acid content in the 75-day-old plant was the lowest, between 10.2 to 11.2 ppm. The cyanic acid content of the plantlets in the same growth period was lower in summer ratoon than that in spring cropping, which indicated that the summer perennial root cultivation could be harvested with low cyanic acid content. The nutrient composition and silage quality of forage sorghum both were good in summer ratoon harvest.

(M. L. Chang and L. J. Liao)

A comparison of production models using different types of automatic feeding systems in medium to large dairy farms in Taiwan

Increasing feeding frequency and reducing feed wastage can enhance the efficiency of dairy cow production. Freshly fed feed can also increase palatability and preference for cows. However, Taiwan's agriculture faces a severe labor shortage, and increasing the feeding frequency of dairy cows can lead to higher labor costs. If labor costs can be reduced and overall production efficiency improved by introducing automatic feeding systems, it has the potential to increase dairy farm income and improve working conditions. Three farms located in Changhua, Taitung, and Tainan introduced three different international brand automatic feeding robot equipment types. The automatic feeding systems were categorized as "kitchen-separated self-propelled," "kitchen-combined self-propelled," and "kitchen-separated cart-type." These systems were then subjected to a situational investigation. The "kitchen-separated self-propelled" system had the highest construction cost, reaching 13 million NT\$, while the "kitchen-combined self-propelled" and "kitchen-separated cart-type" systems had similar

construction costs of 11.5 million NT\$. Annual equipment electricity costs ranged from 50,000 to 330,000 NT\$. The annual equipment maintenance costs for cart-type systems were 54% lower than self-propelled systems. Regardless of the equipment used, daily labor costs were reduced by 5 to 8 person-hours, saving fuel costs of 360,000 to 530,000 NT\$ annually, reducing feed wastage by 24 to 35 t annually, and increasing milk production by 182 to 223 t annually.

(Y. M. Shy, J. W. Shiau and P. A. Tu)



The prototype machine of automatic feeding developed by domestic institutions for dairy cows

The impact of Napier grass irrigated with swine wastewater on the palatability of goat

Livestock wastewater after anaerobic treatment still contains some nutrients needed for plants and can be used as a source of fertilizers. However, some farmers have reported that crops irrigated with swine wastewater seem to affect animal consumption due to the presence of odors. Therefore, the purpose of this study aimed to assess the impact of Napier grass irrigated with swine wastewater on the palatability of goats. The results of the first experiment showed the NO_3^- -N content in the swine wastewater-treated groups (averaging 165 mg/kg) was slightly higher than the control group (102%), but this difference was not significant ($P>0.05$). There were no significant differences among the different treatment groups in terms of dry matter percent, crude protein (CP),

neutral detergent fiber (NDF), and acid detergent fiber (ADF) ($P>0.05$), averaging 20.2%, 8.3%, 31.1%, and 60.5%, respectively. Regarding the effects of stop irrigation for different weeks to Napier grass on sheep intake and weight gain, no significant differences were observed among the different treatment groups ($P>0.05$). The sheep intake was 55.9 g and weight gain was 0.85 kg on average. In conclusion, using swine anaerobic wastewater for irrigating Napier grass does not affect goat intake or weight gain, suggesting its feasibility for field production without impacting the palatability of goats.

(Y. L. Huang, Y. H. Hsieh, J. Y. Lai, H. J. Lee, T. M. Su and T. H. Hsiao)



Napier grass irrigated with swine wastewater



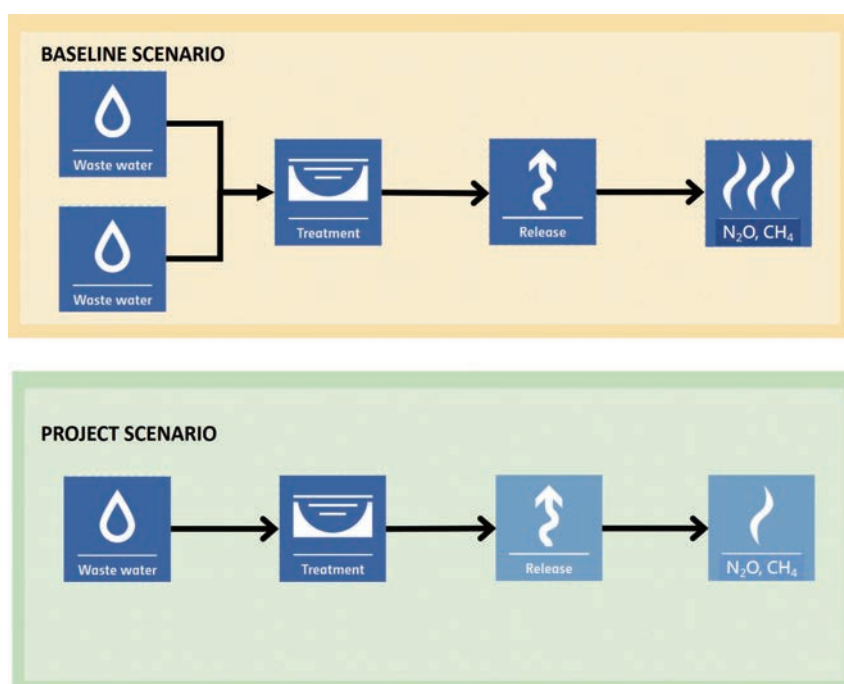
Feeding goat with Napier grass irrigated with swine wastewater

IV

Estimation of greenhouse gas reduction from the reuse of livestock wastewater

In the policy of applying livestock wastewater to farmland, there is a lack of data on carbon emissions in the process of operating a farm under the concept of agriculture-livestock circular systems, making it difficult to understand the carbon reduction benefits. In recent years, with the promotion of policies on processing chicken manure into fertilizers, private chicken farmers and composting facilities have actively invested in the installation of chicken manure drying and pelletizing equipment. Since the process does not require composting, theoretically, it should reduce the loss and emission of nitrogen during the composting fermentation period, thereby reducing greenhouse gas emissions. However, actual estimation was still needed to assess the effectiveness of greenhouse gas reduction. This project established the baseline and project methods, and collected data for the reuse of livestock wastewater. The baseline scenario involves the use of a three-stage wastewater

treatment process on the farm, followed by the discharge of treated wastewater into surface water bodies. In the project scenario, livestock farms can reuse the separated solid and liquid components of livestock wastewater during any stage of the wastewater treatment process, reducing the volume of wastewater requiring treatment. Using real-field data simulation, for a case study of a dairy farm with 200 cows and a livestock farm wastewater reuse volume of 8,000 t. The annual reduction in carbon emissions was calculated to be 42.85 t of CO₂ equivalent. By integrating monitoring data from both livestock and agricultural sectors, the project aims to present a comprehensive picture of the carbon reduction benefits formed under new resource recycling policies. Additionally, the development of a new methodology will facilitate industry applications for greenhouse gas offset projects. (H. J. Lee, C. H. Chung, W. Z. Liu and Y. L. Huang)



Scenario setting of livestock wastewater reuse and reduction methodology

Effects of exercise ground at night on locomotion score and milking performance of Holstein lactating cows under high temperature-humidity index

The purpose of this study was to evaluate the effects of exercise ground at night on locomotion score and milking performance of Holstein lactating cows under high temperature-humidity environment. A total of 16 Holstein lactating cows were assigned into two groups according to their body weight, milk yield, parity and days in milk. This experiment was divided into a control group (indoor housing all day) and treatment group (indoor housing during the day and exercise ground at night) for 90 days. The results showed that the average temperature and humidity index in a traditional barn was 76.4 ± 1.8 units, and 75.5 ± 1.4 in exercise area. Exercise ground at night could help retard locomotion score (2.31 vs 2.00). Milk production and composition were not affected by treatments. From the above results, it

was trendy to exercise ground at night under high temperature-humidity environment could help improve cow's hoof health, but not milk trait.

(C. T. Chang, G. J. Fan, C. J. Li and L. T. Wu.)



Feeding status of dairy cow

Quality and the risk of mastitis of auto-milking systems in dairy production

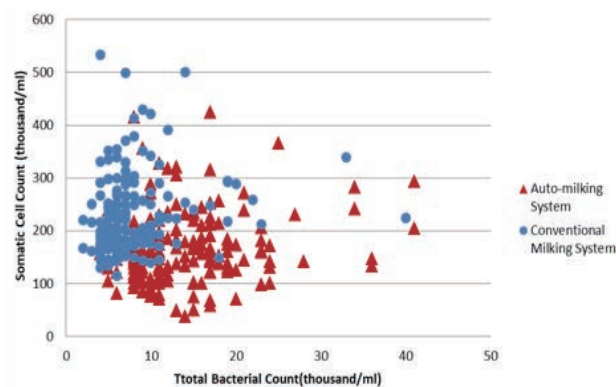
Mastitis is one of the most important issues in dairy cow farming in our country, causing significant economic losses in the domestic dairy industry every year. Even after mastitis is cured, the milk production from the affected udder can be reduced by 5% to 25%. Auto-milking systems (AMS) can replace labor and improve the welfare of dairy cows. However, the efficiency of AMS under warm and humid climates in Taiwan presents unique challenges. The effectiveness of reducing mastitis rates and ensuring milk quality in AMS in humid and hot regions was a major concern. The present study was conducted from April to June and September to November in 2022 to 2023. Cattle were divided

into AMS group (treatment) in Lely Astronaut A5 and conventional milking system (CMS group, control) with an Afimilk 4.0 milking system. The results showed that the freezing point of milk in the AMS group was significantly higher than that in the CMS group (-0.518 ± 0.004 vs. $-0.524 \pm 0.004^{\circ}\text{C}$, $P < 0.05$). The total bacterial count in raw milk was higher in the AMS group (14.4 ± 6.9 vs. 8.1 ± 5.8 thousand/ml). Under daily management, the somatic cell count was better maintained in the AMS group which may be related to the AMS's ability to detect early mastitis through conductivity. Regarding the risk of mastitis pathogen transmission through milking cups, the dirt scores before milking of

AMS group showed significantly higher than after milking (2.1 ± 0.7 vs. 1.4 ± 0.6 , $P < 0.05$), while the CMS system had no significant difference in dirt scores before and after milking (2.5 ± 0.7 vs. 2.6 ± 0.7). The data indicated that immediate cleaning of milking cups after milking in the AMS system significantly reduced bacterial counts, but contamination before cup attachment also

affected the bacterial count in raw milk. There was no significant difference in the incidence rate of mastitis between the two groups. It was worth noting that the AMS self-check system can detect the self-healing cases of cattle with mastitis, not only reducing the use of antibiotic ointments but also minimizing economic losses.

(C. J. Lee, G. J. Fan and C. T. Chang)



A comparison of the total bacterial count and somatic cell count between the auto-milking system and conventional milking system



The design of separated-operation cups in the auto-milking system contributes to the reduction of teat injuries

Development of feed to alleviate heat stress in pigs

In Taiwan's subtropical climate, the heat from May to October often stresses pigs. We developed a feed to alleviate this by adjusting crude protein levels. In growth trials, pigs fed diets with 16%, 14%, and 12% crude protein showed differences in weight. The control group averaged 87.8 ± 8.0 kg, while group A (14% protein) averaged 86.2 ± 8.5 kg, and group B (12% protein) 80.2 ± 8.8 kg, indicating significant differences. Feed conversion ratios were 2.43, 2.55, and 2.61 respectively, suggesting that a 4% reduction in protein in group B might adversely affect growth. Fattening trials showed similar trends. Control group pigs averaged 135.1 ± 14.3 kg, while group A (12% protein) averaged 133.8 ± 11.6 kg, and group B (10% protein) 133.6 ± 13.2 kg, with respective feed conversion ratios of 2.74, 2.60, and 2.68.

Interestingly, group B exhibited better daily weight gain during fattening. Serum urea nitrogen levels differed significantly ($P < 0.05$) between control and experimental groups, indicating protein intake



The feeding behavior of the experimental pigs

influences biochemical values. Despite this, a 2% reduction in crude protein during growth and 4% during fattening did not reduce growth efficiency. Considering costs and efficiency, we recommend 14% crude protein in growth phase

feed and 10% in fattening, optimizing growth without compromising performance, yielding approximately NT\$230 increased profit per pig. (Y. Z. Lu, Y. H. Chen, P. Y. Hsieh, H. L. Lee, F. C. Liu and C. Y. Lin)

Effects of dietary lysine concentration on growth performance of nursery pigs

Lysine is the first limiting amino acid in feeds based on corn-soybean meal, affecting the growth and weight gain of pigs. The purpose of this study was to adjust the lysine concentration of feed in the nursery stage of piglets and to improve the nutritional conditions after weaning. Sixty 4-week-old Landrace × Duroc nursery pigs were divided into 5 groups (half male and female) as control group (Corn-soybean meal as the basal diet with CP 18%, ME 3,500 kcal /kg and lysine 1.50%). The other groups were adjusted based on the basal diet, group A (lysine 1.20%), group B (lysine 1.35%), group C (lysine 1.65%) and group D (lysine 1.80%), and were fed ad libitum during the pigs aged 4-12 weeks. Test results showed the average feed intake of groups C and D was significantly lower than the others, indicating poor palatability of feeds with higher lysine concentrations. Although there were no significant differences between the groups in other growth traits and blood biochemical values,

there was a better trend in the average weight, daily weight gain, feed conversion rate and profit of the control group. The profit of the control group was 9.47% higher than the lowest group, indicating that weaning piglets fed with 1.50% lysine concentration of feed (CP 18%, ME 3,500 kcal/kg) can achieve better growth efficiency and economic benefits.

(Y. H. Wu, H. L. Lee, Y. H. Chen and C. Y. Lin)



The piglets in the experiment

Nutritional and environmental strategies to reduce diarrhea and promote growth in weaned piglets

The aim of this experiment was to investigate the effects of different insulation temperatures on the growth performance of piglets. One hundred and eighty 4-week-old LD (Duroc ×

Landrace) weaned piglets were randomly selected as experimental animals. They were randomly divided into 3 groups based on body weight and sex, with 3 replicates per group. Ten piglets were

housed together in each pen, and the experiment was conducted separately during cool and hot seasons. The experimental treatments consisted of a control group (Group A) and treatment groups (insulation at 25°C and 28°C). The experiment lasted for 4 weeks, during which feed intake and weight were recorded weekly. Blood biochemical parameters were measured at the beginning of the experiment (4th week post-weaning), at the 6th week, and at the end (8th week). Diarrhea incidence in the piglets was monitored and recorded twice weekly. The results of the experiment showed no significant differences in growth performance and blood biochemical parameters among the different treatment groups using different insulation temperatures. Therefore, providing insulation for piglets after weaning can alleviate the phenomenon of poor initial weight

gain and diarrhea. In the future, insulation at 25°C during the early post-weaning period can enhance piglet health and immunity.

(H. L. Lee, Y. Z. Lu, Y. H. Wu, Y. H. Chen and C. Y. Lin)



The piglets in the warming zone

Effects of water-pad cooling farrowing sow house on suckling and weaning piglet production performance

The research aimed to investigate the influence of different types of housing on the reproductive performance of pregnant sows. A total of 36 pregnant Landrace sows were randomly selected during the warm season, and data on reproductive performance were collected in various housing setups. On day 107 of pregnancy, the sows were allocated to either traditional open farrowing houses or water-pad cooling farrowing houses. After a post-farrowing period of 28 days, measurements were taken on sow body weight, backfat thickness during lactation, feed intake, birth weight of piglets, weight gain during lactation, and piglet survival rate. The findings revealed no significant differences in the growth performance of lactating piglets and changes in sow backfat thickness between sows housed in traditional open farrowing houses and those in water-pad cooling farrowing houses during both

the hot season (June to August) and cool season (November to January). However, sows housed in water-pad cooling farrowing houses exhibited a significantly shorter weaning-to-estrus interval compared to those in traditional open farrowing houses ($P < 0.05$). During the hot season, lactating



Traditional open farrowing houses

sows housed in water-pad cooling farrowing houses demonstrated significantly better daily feed intake and post-weaning sow body weight compared to those in traditional open farrowing houses ($P < 0.05$). Overall, housing sows in water-pad cooling farrowing houses during Taiwan's hot summer season (June to August) could mitigate the adverse effects of heat stress. These findings were significant for improving sow management practices and enhancing reproductive performance in swine production systems.

(H. L. Lee, Y. H. Wu, Y. Z. Lu, Y. H. Chen and C. Y. Lin)



Water-pad cooling farrowing houses

Evaluation of the optimal nutritional strategies for growing-finishing pig

The aim of this project was to evaluate the effects of different energy concentration on the growth performance and plasma traits of growing finishing pigs. A total of 64 crossbred pigs, average body weight at 30 kg, were used as experimental animals. Pigs were allocated into 4 treatments by body weight (BW) and eating with four diets. Feed and water were provided on an *ad libitum* basis. Experiment finished when the BW of pigs above 125 kg. Pigs at growing period (31 kg body weight) fed with diets of 17% CP and 3,200, 3,300, 3,400 and 3,500 kcal/kg ME, respectively. Pigs at growing to finishing period (61-90 kg and 91-125 kg body weight) will be fed with 16 and 13.5% CP and 3,200, 3,300, 3,400 and 3,500 kcal/kg ME, respectively. Body weight weighed and blood sample collected for biochemical profiles analysis at the initiation and the end of the experiment. The results showed that during the fattening period, the average daily weight gain of the ME 3500 group was significantly ($P < 0.05$) slower than that of the

other groups. There was no significant difference between the groups in the blood biochemical values of different energy levels during the growth and fattening period. Based on the above results, the energy content in the diet at 3200-3400 kcal/Kg has a better performance on the daily weight gain of pigs.

(H. L. Lee, Y. Z. Lu and C. Y. Lin)



The feeding behavior of the experimental pigs

Development of a multistage low protein formula for pigs to reduce nitrous oxide emissions

Thirty LYD pigs were used as experimental animals. Half males and half females were allocated to 3 treatment groups at the opportunity, namely the control group (19% crude protein in the early nursery period; 18% crude protein in the late nursery period; 16% crude protein in the growth period, and 14% crude protein in the fattening period); experimental group A (the middle value between the control group and experimental group B) and experimental group B (the crude protein of the diet in the early nursery period was 16%; the crude protein in the late nursery period was 14%; the crude protein in the growth period was 13%, and the crude protein in the fattening period was 10%), with synthetic amino acids adjusted to the same content for lysine, sulfur-containing amino acids, hydroxybutyrate, tryptophan, valine, and isoleucine. Serum urea nitrogen, creatinine acid and total nitrogen were measured every 4 weeks, and body weight was measured every 2 weeks to understand growth. Feces and urine were collected. The test results showed that during the nursery period, there was no difference in the growth of the control group and the experimental group A, but the control group B had a tendency to gain less weight. However, during the growth and fattening periods, there was no significant

difference between the groups. Moreover, a low-protein diet reduces the emission of nitrogen-containing substances in pig excrement. This result can be used as a reference for farmers to prepare feed in the future. This experiment aimed to investigate the effects of different dietary crude protein and amino acid supplementation ratios on the growth performance, blood characteristics, and nitrogen emissions in nursery pigs. Thirty LYD pigs, with an average age of 29 days, were randomly divided into three groups based on their weight and gender. These groups received diets with different levels of crude protein: the upper limit according to the national standard composition table for feeds (Group H), the middle (Group M), and the lower limit (Group L). Synthetic amino acids were added to each group's diets during both the early (CP: 19%, 17.5%, 16%) and late (CP: 18%, 16%, 14%) nursery phases. The pigs were raised under ad libitum, and their growth and metabolic experiments were conducted from 4 to 12 weeks of age. Results showed that there were no significant differences in average daily gain, average daily feed intake, feed efficiency, and total protein content in the blood among the groups throughout the experimental period. However, there was a linear decrease in urea nitrogen and creatinine content with decreasing dietary crude protein. The total nitrogen content in feces and urine also decreased linearly across the groups. At 8 and 12 weeks of age, the H group exhibited significantly higher total nitrogen content in feces and urine compared to the L group ($P < 0.05$). In summary, reducing dietary crude protein content while supplementing synthetic amino acids had no significant impact on the growth performance of LYD pigs during the nursery period and effectively reduced nitrogen emissions in feces and urine.

(Y. Z. Lu, S. H. Lee, C. Y. Lin, P. Y. Hsieh, Y. H. Chen and H. L. Lee)



The piglets in the experiment

The investigation of physiological parameters of quail during the warm and cool seasons

This study investigated the changes in physiological and blood biochemical parameters of laying Japanese quail during the cool season and warm season to understand the effects of extreme weather on the performance of poultry species. The temperature, humidity and THI values in and outside the poultry house during the cool season (January-February) and the warm season (June- August) were measured. The blood biochemical parameters and hematology were determined in cool and warm seasons. The results indicated that the THI values outside the poultry house in cool and warm seasons were 57.2 and 84.4, respectively ($P < 0.05$). The hematology and blood biochemical parameters had significant difference in cool and warm seasons including hematocrit, blood glucose, mean cell volume (MCV), mean corpuscular hemoglobin concentration (MCHC), white blood

cell, lymphocyte, glucose, creatinine, blood urea nitrogen (BUN), albumin/globulin, globulin, calcium and potassium ($P < 0.05$).

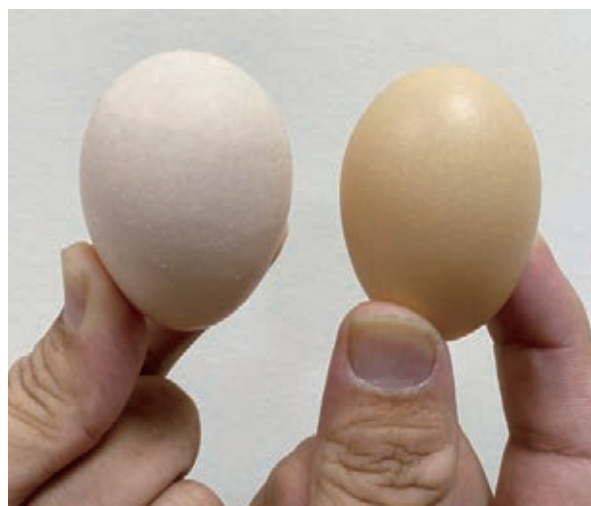
(M. Y. Tsai, H. C. Tsai, C. M. Hung and C. Y. Lin)



Japanese quail

Determination of egg laying performance and eggshell color of Black velvet silkie chicken from 2021 to 2022

This experiment measures the egg-laying performance and eggshell color of the population of black velvet silkie chickens for the reference of breeding and production performance improvement. The chicks were wing banding and the feeds were provided ad libitum. Hens were caged at 18 weeks of age for the measurement of egg laying performance. A total of 281 hens in 2021 and 392 hens in 2022 of Black Silky chickens were evaluated. The results showed that the number of eggs laid at 40 weeks of age were 104.4 ± 14.9 in 2022, which was significantly higher compared to 96.8 ± 28.6 in 2021 ($P < 0.05$). The eggshell color for a^* values at 30 weeks of



The eggshell color distribution range
(left L-82.0, a-2.25, b-9.15; right L-71.6 a-10.3, b-23.6)

age in 2022 and 2021 were 6.86 ± 2.62 and 7.18 ± 1.97 , respectively. The a^* values exceeding 7 accounted for 45.3% of the hen population in 2022, while in 2021, the a^* values were 49.7% of the population. In 2022, both the eggshell color for a^* value and the percentage of hens with a^* values exceeding 7 were slightly lower than in

2021. Subsequently, according to the egg-laying performance and eggshell color record, the hens with the higher number of eggs laid and the eggshell color of a^* values (7.5-13) were selected and reproduced for the next generation.

(M. Y. Tsai, H. C. Tsai, C. M. Hung and C. Y. Lin)

Preliminary results on the effects of dietary metabolizable energy on the egg production and reproductive performance of silkie chickens

The experiment was to investigate the effects of dietary metabolizable energy on the egg production and reproductive performance of LRI white silkie chickens. The experiment utilized four treatment groups with varying metabolizable energy (ME) of 2,929, 3,071, 3,214, and 3,357 kcal/kg, while maintaining a consistent protein (CP) of 18.6%. Each treatment group consisted of 24 birds (8 birds/replicates). Water was provided ad libitum and feeds was provided 70g per day during 29-34 weeks of experimental period. Egg production was recorded daily and feed intake and egg weight were recorded weekly. AI was conducted in the 3rd and 5th weeks. Eggs were collected after the 2nd day of AI for 5 days and then incubated. Number of hatched chicks was recorded. The results showed that the ME 3,357 kcal/kg group had significantly lower egg production rate ($72.9 \pm 6.3\%$) and daily egg production ($27.6 \pm 2.6\%$) than that of the other groups ($P < 0.05$). There were no significant differences among the groups on feed-to-egg ratio, average egg weight, daily feed intake, fertilization rate, hatchability of incubated

eggs and hatchability of fertilized eggs. When considering the net profit of egg (10 NT dollars/egg) or the net profit of chicks (NT dollars/bird), the ME 2,929 kcal/kg group and ME 3,214 kcal/kg group were the most profitable, with a net profit per hen of 303.8 NT dollars and 721.0 NT dollars, respectively.

(C. M. Hung, H. C. Tsai, M. Y. Tsai, H. Y. Kuo and Y. C. Lin)



Feed nutrition test site for LRI white silkie chickens

Preliminary assessment of egg production performance and carbon emissions from electricity consumption in layer houses with constant frequency exhaust fans

The research was to investigate the egg production performance of layer hens in layer houses equipped with constant frequency exhaust fans and to assess the carbon emissions from electricity consumption. The study aimed to provide insights for the poultry industry when considering the adoption of variable frequency exhaust fans and environmental monitoring intelligent speed control systems in place of traditional constant frequency fans, which consume significant energy. The electricity consumption and carbon emissions of layer houses equipped with constant frequency exhaust fans were determined. Additionally, it recorded egg production performance of the Hy-Line hens. The results indicated that in 2022, the

egg production rate, average egg weight, daily egg production, daily feed intake and feed-to-egg ratio of Hy-Line laying hens were 68.3%、56.4 g、38.8 g、133.4 g and 3.71, respectively. The average hourly electricity consumption of 8 constant frequency exhaust fans in the layer houses was measured to be 9.725 kWh. Using daily meteorological data from the Livestock Research Institute's weather station, the estimated electricity consumption and carbon emissions for the period from January to December in 2022 were 72,989 kWh and 43,064 kg CO₂e, respectively.

(C. M. Hung, M. Y. Tsai, H. C. Tsai, and C. Y. Lin)



The original constant frequency exhaust fans before the improvement of the laying hen house



The variable frequency exhaust fans after improvement in laying hen houses

Preliminary assessment of the carbon footprint of the life cycle of domestic broiler chicken production

This study was to utilize management information from broiler chicken farms to quantify the greenhouse gas emission intensity of broiler chicken production systems using a life cycle assessment system. This aimed to identify various

sources of emissions and their relative proportions, in order to develop mitigation strategies and complete the assessment of greenhouse gas reduction management models for broiler chicken farms. The product life cycle assessment

information software (SimaPro) was used to evaluate domestic broiler chicken farms operating under traditional models. The assessment boundary was set from chick placement to the farm gate (cradle-to-farm gate), covering the production of feed ingredients and broiler chicken production. Management information such as chicken population, production, live weight, feed intake, water and electricity consumption, and fuel consumption was collected. This information, in conjunction with greenhouse gas emission coefficients for each production process, was

used to assess the carbon footprint of domestic broiler chicken production. The results indicated that in 2022, the production of each kilogram of domestically produced broiler chicken resulted in 2.124 kg of CO₂e. Among this, the acquisition of raw materials contributed to 1.986 kg of CO₂e, accounting for 93.47%, while the manufacturing phase contributed 0.139 kg of CO₂e, accounting for 6.53%.

(C. M. Hung, H. C. Tsai, M. Y. Tsai, C. Y. Lin and M. P. Cheng)

Carbon emissions of broiler chicken production in Taiwan

The phase of life cycle	Carbon emission (kg CO₂e)	Proportion
The acquisition of raw materials	1.986	93.47%
The manufacturing	0.139	6.53%
Carbon emission	2.124	100%

Production performance determination of Zhudong native chicken in 2022

The experiment was to measure the production performance of Zhudong native chickens for future breeding and egg production performance improvement. A total of 16 males and 166 females with better body shape in the breeding population of Zhudong native chickens were selected and caged. Body weight, pullorum disease, body shape and skin yellowness score were recorded at 16 weeks of age. For the hens, the age and egg weight at first egg, egg weight and the number of eggs laid at 40 weeks of age were determined. The results showed that average body weight of males and females at 16 weeks of age were 3,499 ± 362 g and 2,627 ± 367 g, respectively. Body shape scores were 2.34 ± 0.75 and 2.20 ± 0.60, respectively. The positive rate of pullorum disease

was 4.39% at 16 weeks of age. The results of the egg production performance showed that the



Blood sample collection for pullorum disease

average age and egg weight at first egg was 188 ± 29.0 days and 48.5 ± 10.0 g, respectively. Egg weight and the number of eggs laid at 40 weeks

of age was 56.7 ± 4.7 g and 37.7 ± 4.3 , respectively. (H. C. Tsai, D. Y. Lin, M. Y. Tsai, C. M. Hung, Z. H. Xu, D. F. Xu and C. Y. Lin)

Explore the performance of different breeds of pigs raised in high-bed pig houses with cooling pad

The study aimed to investigate the effects of raising LD and LYD crossbred fattening pigs in high-bed, pig houses with cooling pad on their growth performance, blood characteristics, and carcass traits. The results showed that during the growth period, the daily weight gain of the LYD group was higher than the LD group, regardless of whether the pigs were castrated males or females for meat. However, no significant differences were found in growth performance between the LD and LYD groups over the entire growth to fattening period. Under similar slaughter age and weight, the carcass length of the LYD group was significantly shorter than that of the LD group for both castrated males and females. The female pigs of the LD group had significantly higher lean meat percentage and lower fat percentage ($P < 0.05$), with a higher bone rate ($P < 0.05$). During both the growth and fattening periods, the total protein (TP) in the blood of the LD group was significantly higher than that of the LYD group, while the blood urea nitrogen (BUN) level of the LYD group was higher during the

fattening period. The concentrations of copper and zinc in the feces of the test pigs during the growth and fattening periods were 51.6, 54.3, and 375, 352 mg/kg, respectively. If converted into compost, the concentrations of copper and zinc in the compost could reach the upper limits of the regulatory standards in Taiwan.

(W. Z. Liu, T. M. Su and T. H. Hsiao)



Pig weighing

Study on the treatment of high concentration pig wastewater with model tanks

The purpose of this study was to use a model tank to investigate the performance of a three-step treatment process for treating high-concentration pig wastewater. Twelve LD pigs with an average

weight ranging from 47 to 107 kg were arranged in individual metabolism cages. Feed and water were provided ad libitum during the experimental period. The feces and urine of each pig were

collected daily, weighed separately, and then mixed. Two concentrations of wastewater were prepared by mixing manure and washing water at ratios of 1:1 (wastewater A) and 1:2.5 (wastewater B) by weight. After solid-liquid separation, the mixture was injected into 6 anaerobic tanks with an effective volume of about 200 L. The hydraulic retention time (HRT) of the anaerobic treatment was about 10, 15, and 20 days, respectively. The HRT of the aeration treatment for each group was about 1.5 days. Results showed that after the three-step treatment process, the chemical oxygen demand (COD), biochemical oxygen demand (BOD), suspended solids (SS), total nitrogen (TN), and total phosphorus (TP) concentrations of wastewater A were 904, 298, 638, 488, and 420 mg/L, respectively, all significantly ($P < 0.001$) higher than those of wastewater B. The COD, BOD, SS, TN, and TP concentrations of the 10-day HRT group after the three-stage treatment were 823, 257, 545, 453, and 369 mg/L, respectively, which were higher than those of the 15-day and 20-day HRT groups. Except for the COD concentration, the water quality of the 15-day HRT group was also significantly higher than that of the 20-day HRT group. The

results indicated that even though wastewater A underwent anaerobic treatment for 20 days and aerobic treatment for 1.5 days, the water quality still failed to meet the discharge standard. However, wastewater B, which underwent anaerobic treatment for 10 days and aerobic treatment for about 1.5 days, met the discharge standard. In summary, after the three-stage treatment of high-concentration pig wastewater, the concentrations of TN and TP remained high. Considering compliance with regulations and treatment costs, it can be reused for irrigation on farmland as a nutrient source for crops.

(T. M. Su, C. H. Chung and T. H. Hsiao)



Pig wastewater treatment module

Effects of growing-finishing pigs in water-pad cooling pig house on growth performance and water quality of wastewater treatment

The purpose of this study was to investigate the effects of raising growing-finishing pigs in a water-pad cooling pig house with manure ditch on the growth performance of pigs, biogas production and effluent quality after anaerobic treatment of wastewater. During the experiment, 64 LD pigs with an average body weight of 23 kg grew to 120 kg, and both diet and drinking water were given ad libitum. The manure ditch was washed twice a week with the anaerobic treated wastewater and the raw wastewater produced

was stored in a water storage tank. The raw wastewater was automatically controlled into a 10 m³ vertical anaerobic reactor at a rate of 500 L / day. While the anaerobic treatment system was stabilized, the flushing water for manure ditch, raw wastewater, anaerobic treated wastewater and the mixture in the anaerobic reactor were collected every 2 weeks to analyze the water quality. The biogas production and compositions were also determined. During the finishing stage of pigs, the gas samples of manure ditch before

and after flushing were collected to detect the ammonia concentration, and the sampling sites included wet-pad side (P1), the 2nd to 3rd pen (P2), fan side in the house (P3), and fan side outside the house (P4). The results showed that the weight gain, feed intake and feed efficiency of pigs were 0.90 kg/day/head, 2.24 kg/day/head and 0.40, respectively, during the experiment period. The ammonia concentrations of P2 before and after flushing were 0.53 and 0.25 ppm, and those of P3 were 2.36 and 0.77 ppm. The ammonia concentrations of gas samples after flushing were lower than those before flushing ($P < 0.05$). The average biogas production rate during the experimental period was 3,380 L/day. The concentrations of methane and carbon dioxide in the biogas were 62.0% and 25.6%, respectively. The results of analysis of the mixture of anaerobic reactor showed the copper and zinc

concentrations were significantly higher than those of the raw wastewater. In conclusion, it was recommended to flush the manure ditch regularly and remove the sludge in the anaerobic reactor for the maintenance of the air quality in the pig house and reduction of copper and zinc accumulation.

(T. M. Su, Y. H. Weng, C. H. Chung, W. Z. Liu and T. H. Hsiao)



Vertical anaerobic tank

Investigation on microclimate and air quality of water-pad cooling system pig house in hot season

The purpose of this study was to investigate the microclimate and air quality data in the pig house before and after the pigs were reared in a water-pad cooling pig house. In the hot season (between May and Aug.). A total of 500 LYD [(Landrace ♀ × Yorkshire ♂) ♀ × Duroc ♂] hybrid pigs (average weight about 36 kg) were raised in 20 pens with 25 pigs/pen. Pigs were fed diet and drinking water *ad libitum*, and the feeding period was terminated when the body weight of pigs reached 110 kg. Investigate the microclimate and air quality of the water-pad cooling system end outside the pig house (P1), the wet-pad cooling system inside the pig house (P2), the front end of the air pollution prevention and control facilities (P3) and the back end of the air pollution prevention and control facilities (P4) during the empty house and pigs raising period.

The results show that ambient temperature (AT) and temperature-humidity index (THI) of P1 was significantly higher than empty house under the condition of automatic control of the fan operating power (FOP). However, there was no difference of the AT, relative humidity (RH) and THI in the pig house when the FOP was adjusted between 40-100%, but the ventilation volume decreased with the increase of FOP ($P < 0.05$). Regardless of automatic or manual adjustment of FOP, both of the air quality indexes (AQI) in the pig house were between good and normal. The average AT outside the pig house during the grower stage and finisher stage of the pigs were about 31°C and 34°C, respectively. The RH inside the pig house was 30-45% higher than that outside the pig house ($P < 0.05$), and the temperature was significantly lower 4-6°C, THI between 30-35 was

also lower than outside the pig house ($P < 0.05$), while the AQI inside the pig house was between 42-77. The ammonia concentrations in P3 and



Wet-pad cooling system pig house

P4 during the pig grower stage were 3.66 and 0.39 ppm, and 4.86 and 0.70 ppm in the finisher stage, respectively. The measure point of P4 significantly reduces the ammonia concentration about 89% and 85% compared to P3 in grower stage and finisher stage ($P < 0.05$). It shows that the installation of air pollution prevention facilities between P3 and P4 does play a role in improving ammonia emissions. In conclusion, the application of a water-pad cooling system to a pig house can improve the microclimate and air quality of pig houses in hot season, and improve the comfort of pigs.

(T. M. Su, Y. H. Weng, C. H. Chung and T. H. Hsiao)

Research and development of fertilizer production equipment for chicken manure processing

The project established a poultry manure value-added production treatment kit for laying hen farms to produce high-quality pelletized poultry manure fertilizer. The raw material for the processing kit was dry poultry manure with a moisture content below 20%. The kit mainly consists of a feeder, grinder, pelletizer, heater, and electrical control equipment. The pelletized diameter length was 6 mm, with a production capacity of more than 200 kg/h. The production process complies with the No. 5-08 poultry manure processing fertilizer product specification. After granulation, it undergoes a key heating treatment program to maintain a temperature above 70°C for at least 30 minutes for sterilization. The finished product's coliform count was less than 1×10^3 MPN per gram and has been confirmed to be non-toxic through the "Crop Toxic Test". Based on an annual processing capacity of 550 tons, the production cost per kilogram of processed poultry manure

fertilizer was about 5.2 NTD. After deducting 2 NTD per kilogram for dry poultry manure and factoring in the cost of mechanical equipment, labor, and maintenance (calculated at 3.2 NTD per kilogram), the total cost was determined. In conclusion, this set provides a reference for the treatment of chicken manure in laying hen farms, aiming to address the issue of chicken excrement treatment and promote the diversified use of products.

(C. H. Chung, T. M. Su, Y. C. Chi and T. H. Hsiao)



Wet-pad cooling system pig house

Investigating the composition characteristics of granulated chicken manure fertilizer on the market

The aim of this study was to investigate the composition characteristics of granulated chicken manure fertilizer available on the market. It requires chicken manure as the main raw material (comprising more than 50% of the fertilizer), which must be maintained at a temperature above 70°C for at least 30 minutes for sterilization. The finished product must be granulated, with a moisture content of less than 20%. The coliform count should be less than 1×10^3 MPN/g, and the fertilizer must pass the crop toxicity test. According to the survey, there were currently 30 brands of fertilizer products on the market, with a total of 25 companies applying. The average content of total nitrogen (TN), phosphorus (P_2O_5), potassium oxide (K_2O), and organic matter was 3.72%, 3.53%, 3.06%, and 62.8%, respectively. Additionally, the types of conditioning materials added in fertilizer production mainly include mushroom cultivation waste bags, castor meal, and bulk rice bran, with some manufacturers also utilizing sesame meal, peanut shell powder, rice

husk, and zeolite. The survey results indicate that the nitrogen, phosphorus, potassium, and organic matter content of granulated chicken manure fertilizer were generally higher than that of livestock manure compost products. The manufacturing process adopts drying and granulation instead of composting, which helps reduce nitrogen loss.

(C. H. Chung, T. M. Su, Y. C. Chi and T. H. Hsiao)



Granulated chicken manure fertilizer

Investigation on wastewater composition of different types of egg washing and grading machines

This study aimed to collect data on the components of wastewater generated by different egg washing and grading machines in Taiwan and utilize this data for future wastewater treatment design to address water pollution issues. The wastewater was collected from egg washing and grading machines at five different laying hen farms. Sampling was conducted three times on different dates at each farm. The water usage in the machines was categorized into two methods: water flushing and simultaneous discharge



Egg washing and grading machine

(Disposable way, DW) (implemented in three farms), and water flushing followed by recycling and filtration for reuse (Recycling Filtration Reused way, RFRW) (implemented in two farms). During the operation of the machines, wastewater generated during the egg washing stage was collected, as this stage typically yields the highest wastewater concentration. The pH,

COD (Chemical Oxygen Demand), TS (Total Solids), VS (Volatile Solids), $\text{NH}_4^+\text{-N}$ (Ammonium Nitrogen), and TN (Total Nitrogen) of the wastewater were analyzed. The results indicated that, except for pH, the concentrations of the other analyzed wastewater components in RFRW were significantly higher than those in DW.

(H. W. Ou, C. H. Chung and T. H. Hsiao)

Evaluation of the efficiency of co-digestion of livestock wastewater and agricultural by-products

The purpose of this study was to investigate the effect of adding orchid plant waste (OPW) to cow manure wastewater (CMW) for co-digestion on biogas production and wastewater treatment, as well as to determine the optimal proportion for adding OPW. The OPW was sourced from the Taiwan Orchid Biotechnology Park, while the CMW was obtained from a wastewater treatment facility at a cattle farm housing 200 dairy cows. The components of both OPW and CMW were analyzed. The OPW was dried, finely chopped, and ground into small particles. Based on the total solids (TS) content of the CMW, OPW addition ratios ranging from 0% to 20% were calculated. This mixture was used for co-digestion in 5 upright continuous stirred-tank anaerobic digesters, each with a volume of 11.4 liters. The temperature was maintained at $37 \pm 1^\circ\text{C}$, and the hydraulic retention time was set to 30 days. The experimental results indicated that the average daily biogas production from co-digestion of wastewater with 0-20% OPW were

0.88, 0.89, 0.87, 0.99, and 0.94 L, respectively. The average specific biogas yield (SBY) and specific methane yield (SMY) were found to be 181, 189, 179, 218, and 201 L/mg COD, and 109, 116, 105, 128, and 121 L/mg COD, respectively. Notably, the addition of 15% OPW demonstrated a significantly optimal gas production.

(T. H. Hsiao, T. M. Su, and H. W. Ou)



Orchid plants waste

Chiayi livestock farm repurposes agricultural materials for circular reuse

In recent years, due to the rising prices of imported feed raw materials, the feeding model using agricultural by-products and domestically produced fodder is more advantageous for reducing feeding costs. The manure and wastewater from cattle farms were recycled and used to irrigate Napier grass fields, replacing the use of chemical fertilizers, not only increases crop yields, but also reduces waste and carbon emissions. This survey targeted a 600-head beef cattle feedlot farm in Chiayi County. Silages that use sweet sorghum or corn mixed with agricultural by-products were made. After taking samples to evaluate their quality, the results showed that scores of sweet sorghum and edamame mixed silage (75 points) and sun hemp and corn silage (76 points) were relatively high, followed by bagasse, sweet potato and corn mixed silage (67.5 points), and lastly the edamame and corn mixed silage (56 points). The above four types

of silage samples were all in line with or better than the acceptable range. Among them, the sweet sorghum-edamame silage and the corn-sun hemp silage had good palatability and acceptability to cattle. The costs of different combinations of silage was also considered and met the expectations of the farm owner. In addition, the biogas residue and biogas slurry after treatment of cattle manure and urine wastewater were irrigated into the Napier grass field. The results showed that the crude protein content of the irrigated grass was higher than that of the non-irrigated grass, and when compared to the field that only used the solid manure residue that has been composted for 30 days after solid-liquid separation, the field that irrigated with biogas residue and biogas slurry can harvested once more a year, which can effectively save the cost of purchasing forages.

(J. S. Shiu, Z. H. Wu, Y. F. Lin and G. F. Li)



Preparation of ensiled feed by mixing sweet potatoes with forage corn



Tanker irrigating Napier grass fields with sludge and liquid from the biogas digester

Evaluation of productivity and carbon reduction benefits of roof-mounted solar photovoltaic cattle barns

The aim of this study was to compare the differences in environmental parameters such as internal and external temperatures, humidity, and the growth performance of cattle between a roof-mounted solar photovoltaic (PV) barn and a non-PV barn. The experiment was conducted at a beef cattle farm in Chiayi County, using continuous automatic temperature and humidity recorders, logging data every hour. These recorders were placed above the roof, below the roof, and inside the barn to assess the temperature and humidity effects caused by the two types of roofing. The barn was of an open gable roof design without side walls, measuring 3.5 meters in height with eaves at 2.5 meters, constructed using plastic-coated steel corrugated sheets. The solar PV modules were installed 25 centimeters away from the roof, collecting data from June to October. The results indicated that the average maximum indoor temperatures in the roof-mounted solar PV barn and the non-PV barn were 34.4 and 34.3°C, respectively.

The average temperatures were 28.7 and 28.8°C, with average relative humidity at 79.5% and 79.4%, respectively. The daily weight gain was recorded at 0.79 ± 0.09 kilograms and 0.78 ± 0.15 kilograms, with no significant difference observed between the two groups. The study demonstrates that in an open-style beef cattle barn with solar PV modules, there was no particular impact on temperature. However, it can additionally generate an average of 20,085 kilowatt-hours of green electricity production per month. (Z. H. Wu, J. X. Xu and G. F. Li)



Louvered enclosures housing temperature and humidity sensors installed above (left image) and below (right image) the solar panel roof

Goat grazing management technology in solar sites

Ground-mounted solar facilities require regular weed removal to maintain the efficiency of the solar panels. Currently, weed removal methods include using engine-powered shoulder-carrying mowers, chemical herbicides, or weed mats, all of which not only incur costs but also cause environmental pollution through the use of petrochemical fuels or chemical agents. The shoulder-carrying mower also emits greenhouse

gasses. Goats were herbivores, and grazing was their instinct. Therefore, this technology allows legal solar photovoltaics companies to utilize the grass in ground-mounted solar fields to provide the necessary nutrition and management for goat grazing, as well as grazing field planning and evaluation, biosecurity, and disease treatment techniques. Suitable grazing areas for goats were developed, and rotational grazing was conducted

in several nearby solar fields. This can save at least NTD\$50,000 per hectare annually in labor and fuel costs for weed removal in solar fields. In addition, it reduces carbon emissions from the reduced use of petrochemical fuels, provides

a source of roughage for goats, and generates significant income from the sale of goats after fattening. This approach achieves the goals of recycling and reducing carbon emissions.

(M. C. Cheng, C. C. Pan and J. H. Wu)



Goat grazing in solar sites



Influence of goat barn with solar photovoltaic roof on temperature in summer

The aim of this study was to investigate the impact of rooftop solar photovoltaic on the temperature of goat shed. Five goat farms located in Pingtung, Tainan, Chiayi, Yunlin, and Changhua were selected to measure the shed temperature each hour. The results showed that the temperature difference between indoor and outdoor environments was about 5°C. Furthermore, when comparing the temperature between sheds with and without rooftop solar photovoltaic equipment, there was no significant difference observed in the two types of buildings. The average indoor temperature in both types of goat sheds was 30.17 and 30.09°C, with the same average maximum temperature of 31.74°C. Preliminary results showed that the positive effect of rooftop solar photovoltaic on temperature conditions was not observed. Indoor temperatures can be influenced by several factors, including

the location of the building, the orientation of the shed, the type of roofing material used, ventilation, and any cooling measures in place. Further analyses were still under investigation.

(Y. C. Fei and M. C. Cheng)



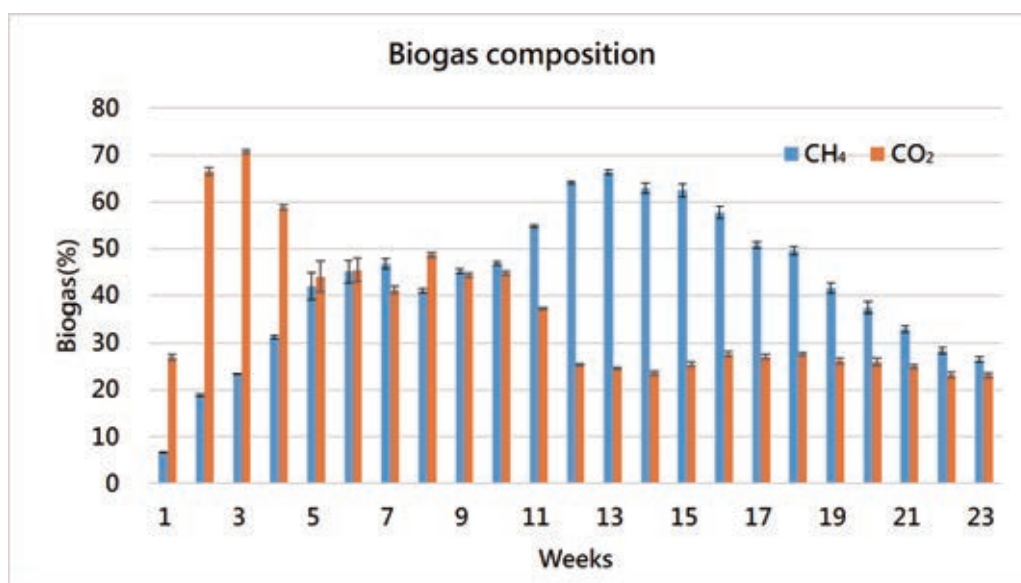
The temperature measurement with louvered enclosures on the roof of a goat shed

Terminal waste treatment setting of modularized pig house

In response to the impact of the broader environment and climate change, the pig industry has implemented the construction of facilities to separate manure and urine in high-bed pig houses to reduce water and wastewater usage. However, this measure leads to an increase in total solids content in the manure, making it unsuitable for conventional wastewater treatment processes. Therefore, this project employs three methods— aerobic composting, dry anaerobic digestion, and direct drying—to treat pig manure comprehensively. The study assesses the composition of pig manure fertilizers produced through different treatment methods and their impact on the agronomic characteristics and yield of Napier grass. The results showed that after anaerobic digestion, significant reductions in total solids (TS), volatile solids (VS), and chemical oxygen demand (COD) were observed, with removal rates of 69.1, 73.8, and 74.2%, respectively. This indicates that pig manure with lower TS in the early stages of fattening can be significantly degraded through dry anaerobic digestion. The daily stable biogas production ranges from 0.045 to 0.191 m³/kg VSadd, with an average of about 0.089 m³/kg

VSadd. On the 30th day after stop feeding pig manure, the maximum daily biogas production reaches 2.61 m³/day, equivalent to an average biogas production of about 0.45 L/kg digestate. The methane content in biogas averages about 41.2% during the continuous feeding period, likely due to initial acidification leading to CO₂ production in the anaerobic digestion. In the 13th week after stop feeding pig manure, methane production reaches a peak, accounting for over 64%, with an average methane production of about 58.6%. Pig manure, whether treated through aerobic composting or drying, exceeds the copper (Cu) and zinc (Zn) content standards. Therefore, additional adjustments were needed for subsequent utilization. Napier grass (*Pennisetum purpureum*) with pig manure fertilizers from different treatment methods shows no significant differences in agronomic characteristics among groups. The three fertilizer products from this experiment have no significant impact on soil quality, indicating their suitability as a fertilizer source.

(H. J. Lee, T. M. Su, W. Z. Liu, L. C. Tsai, Y. L. Huang and T. H. Hsiao)



Biogas composition of solid-state anaerobic digestion



Improvement of domestic mozzarella cheese process

This project was to establish the production process of fermented mozzarella cheese, so as to improve the quality of cheese and product competitiveness. Firstly, the production method of lactic acid bacteria starter was established. Then, fermented mozzarella cheese was made and modified the process conditions. Finally, the effects of different production processes (direct-acidified or fermented mozzarella cheese) on the cheese quality were studied. The results showed that *Lactococcus lactis* subsp. cremoris was a good fermentation strain, and its fermentation stability was good. The production method of lactic acid bacteria starter: inoculate 5% lactic acid bacteria (10^9 CFU/mL) in 10% skimmed milk powder solution (low temperature long time pasteurization), and cultured at 20°C for 15 - 24 hours. The cheese milk was inoculated

with 5% lactic acid bacteria (10^9 CFU/mL), and the curds were fermented until the pH value reached 5.30, and then heated and stretched. The different production process significantly affected the cheese yield, physical properties, color, proximate analysis and sensory evaluation, and the performance of fermented mozzarella cheese was better than direct-acidified, which proves that lactic acid bacteria fermentation can improve cheese quality. The sensory evaluation of the mozzarella cheese produced in this project was good, and the performance of flavor, texture, salty and overall acceptability was even better than some imported products. The results of this project can be used as a reference for domestic cheese research and development.

(R. H. Yeh and C. Y. Kuo)



The results of this study can be used as a reference for technology transfer or food and agriculture education activities (National Cishan Agricultural & Industrial Vocational Senior High School)



Make a salad with mozzarella cheese

Development of Tremella polysaccharides used in dairy curd products

This study intends to take advantage of the characteristics of *Tremella fungus* (TF) rich in polysaccharides, natural plant-derived gums and dietary fiber, and apply it to the research and development of dairy curd-related products. It was expected to establish new types of milk jelly and yogurt products that contain *Tremella* polysaccharides and contribute to the stability of the curd structure. Firstly, it was planned to establish the extraction conditions of TF filtrate. Using a autoclaves at 121°C and heating for 15 minutes, the viscosity of fresh TF filtrate can reach 277.50 m.Ps, which was better than the viscosity value of 229.63 m.Ps in a 95°C water bath for 4 hours. Subsequent options were to use autoclaves for high-pressure heating. Using domestic and imported dried TF, adding water to 100 times the weight, heating under high pressure for 60 minutes, and then filtering out the solids, can make the TF filtrate have the highest total

sugar content (domestic and imported were 8.20 and 8.10 µg/mL, respectively) and viscosity (domestic and imported Imports were 549.2 and 276.5 m. Ps, respectively). Based on the concept of whole material utilization, the dried TF was crushed, the TF powder was taken to prepare the TF liquid, and the viscosity was analyzed. The TF powder was added with 50 times of water, and the viscosity of the TF liquid heated at 121°C for 30 minutes could reach 571.8 m.Ps (domestic) and 421.2 m.Ps (imported). Using fresh or dried TF filtrate (filter out solids), or TF liquid prepared from whole TF, the milk jelly made has excellent water retention rate, and the water separation rate was lower than 1%. The TF solution prepared from the whole TF was used to replace the moisture of yogurt raw material. The results showed that the treatment group with TF solution replacing 5 and 20% water had a multiple increase in the growth of lactic acid bacteria. The domestic TF solution was better than the imported TF solution.

(C. Y. Kuo, R. H. Yeh and S. H. Yang)



Domestic dried *Tremella fungus*



Milk jelly with *Tremella fungus*

Effect of different drying methods on the qualities of Chinese style sausage

The experiment was conducted to analyze the effect of hot air (HD), vacuum (VD) and microwave drying (MD) on the quality of Chinese-style sausage. During drying periods of 120 min, all groups were analyzed for the surrounding and core temperature, weight loss and color every 10 min. When drying finished, the proximate analysis, shear force, TBARS value, baking loss, total plate counts and sensory evaluation were also analyzed. The results showed VD had higher weight loss ($P>0.05$), crude protein and crude ash contents ($P<0.05$) after drying for 120 min. When the drying time increased, L^*

and b^* values were decreased, but a^* value was increased ($P>0.05$). MD had the highest TBARS value at 0 month, but all groups were decreasing after storing for 2 months at -18°C . The total plate counts were no significant differences among all groups. The VD had higher acceptability ($P>0.05$) than other groups. In conclusion, the efficiency of vacuum drying was the highest, and the firmness of sausage was decreased for microwave drying. There were no negative effects for other quality traits. Therefore, it was feasible to apply vacuum and microwave drying to meat drying processing. (M. R. Lee, R. J. Tu, Y. C. Wu and W. S. Chen)



The sausages drying process in vacuum (a) and microwave (b) chambers

Development of prepared poultry gel product using aged chicken feet

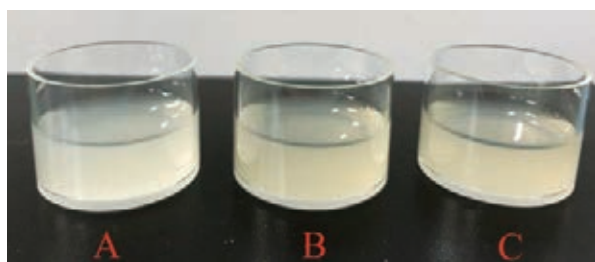
This experiment was conducted to explore the effect of the concentration of organic acid solution and heating conditions on the quality of chicken feet broth. The raw material was domestic white broiler chicken feet which was added with tap

water (named Control, C), 1, 2% of vinegar (named V_1 , V_2) or 1, 2% of lactic acid solution (named L_1 , L_2), and heated at 110°C for 1, 2 or 3 hours later. Then, the broth was filtered, and the upper oil was removed. The pH value, proximate

analysis, calcium, sodium and gelatin content were analyzed. The results showed that the crude protein (CP), calcium, sodium and gelatin content in the chicken feet broth added with vinegar or lactic acid were increased at the same heating time. The CP in L₂ heating for 1 hour was 6.66%, and the calcium content was 1,300 mg/100g. However, the CP in L₂ heating for 3 hours was 10.56%, and the calcium content was 3,600

mg/100g. The chicken feet heated for 2 or 3 hours were soft and rotten, and they could not be used for subsequent processing. However, after heating for 1 hour, the chicken feet in each treatment still contained 19.34 - 19.93% of CP and 2,609 - 2,820 mg/100g of calcium, which can be boiled into chicken feet braised products to increase the added value of the products.

(R. J. Tu, M. R. Lee, Y. C. Wu and W. S. Chen)



The chicken feet broth heating for 1 (A), 2 (B) or 3 (C) hrs



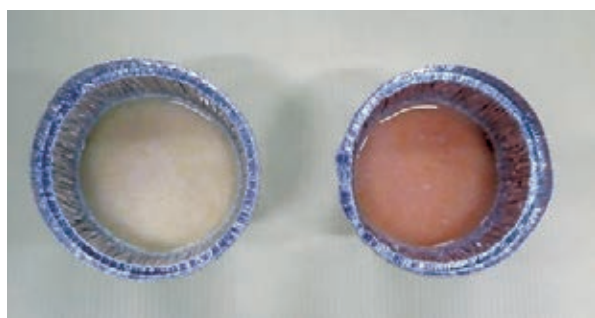
The braised chicken feet products were heated for 1, 2 or 3 hours (from left to right) at 110°C

Development of softened meat production technology

This experiment used frozen chicken breast meat and swine longissimus dorsi as raw materials, minced and homogenized for extraction of minced meat liquid. After filtering, the filtrate was heated and solidified into soft meat products. The approximate composition (moisture, crude protein, crude fat and ash), pH value, shear value, meat color (L value, a value and b value), thiobarbituric acid (TBA value), amino acid composition and sensory evaluation were evaluated. The results showed that chicken meat

products had higher crude protein content than that of pork products, but, there was no significant difference in moisture, crude fat, ash and pH value. The shear value of chicken products was higher than that of pork products, ranging from 0.72-0.76 kg, while the shear value of pork was from 0.54-0.57 kg. The L value of chicken soft products was higher than that of pork products, ranging from 70.86-73.23. The oxidative rancidity (TBA value) of chicken products ranged from 0.62-0.69 mg/kg, which was significantly higher than that of pork products. All soft meat products have gradually increased their TBA value with the extension of the storage period. Total amino acid content of chicken products was higher than that of pork products, ranging from 8.85-9.04 mg/g, while that of pork products was 7.04-7.37 mg/g. In the aspect of sensory evaluation, the chicken soft products were most favored by tasting staff, followed by pork soft products.

(W. S. Chen, R. J. Tu, M. R. Lee and Y. C. Wu)



Soft chicken meat (left) and soft pork meat (right)

Black pork phosphate-free meatball and specialized low-nitrite frankfurter sausage production technology

This experiment was used black pigs as the raw meat source. Black pigs with high market weight (about 150 - 160 kg) and black pork with low market weight (125 - 130 kg) were selected for made meatball and frankfurter sausage. The production process of meatball was based on 75% lean meat and 25% back fat, with 0% (control group) and 0.3% phosphate, respectively. Frankfurter sausage was made of 75% lean meat and 25% back fat, with 0% phosphate and nitrite (control group) and 0.3% phosphate and 0.015% nitrite, respectively. Proximate composition (moisture, crude protein, crude fat and ash), pH value, drip loss, cooking loss, shear force, TBA value and total plate count were evaluated to

measure the quality of two products. The results showed that various meat quality of meatball and frankfurter sausage, whether 130 kg or 160 kg black pork weight, high-quality meatball and frankfurter sausage can be produced, but, phosphate was added to meatball and frankfurter during the manufacturing process, which has the effect of improving the texture of the final product. Therefore, when actually producing meatball and frankfurter, the quality performance of the product and consumer acceptance should be taken into consideration, and the process should be adjusted.

(W. S. Chen, R. J. Tu, M. R. Lee and Y. C. Wu)



Phosphate-free meatball



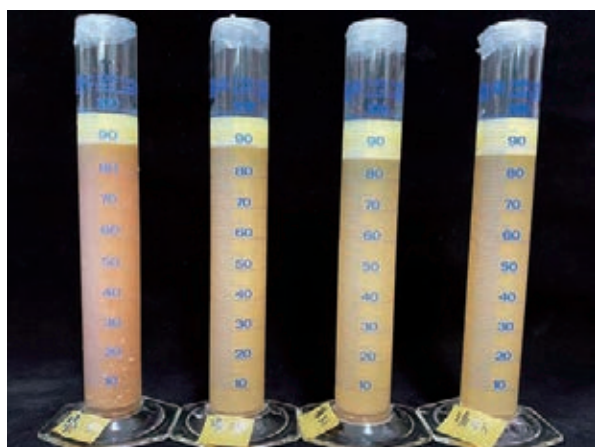
Low-nitrite frankfurter sausage

Studies on the manufacture of meat essences products using spent quails layers

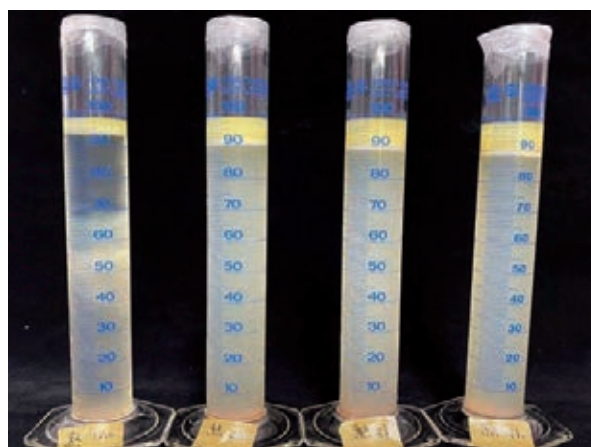
The purpose of this study was to investigate and compare the production of extract liquid products by DEM (dripped essence method) and BEM (boiled essence method) of spent quail layers. The results of the carcass survey showed that the live weight of spent quail layers was 147.55 g, the slaughter weight was 101.08 g, and the slaughter rate was 68.51%. And the live weight of meat quail was 267.13 g, the slaughter weight was 223.92 g, and the slaughter rate could reach 83.82%. The experiment was designed to heat in a steam room at 93-97°C for 1-4 hours, and the extracted liquid and the heated carcass were sampled every hour for analysis. The results showed that the crude yield and floated oil rate of the sample obtained by the DEM after heating for 1 hour were 14.57% and 6.1%, respectively, while the crude yield and floated oil slick rate of the sample heated to 2 hours was up to 32.4%

and 11.2%, respectively, and the crude yield of the BEM was between 126-128%, and the floated oil rate increased with the heating time increasing (3.1 to 6.1%). The moisture and fat content of carcasses by DEM and BEM were reduced, and the DEM was notable. The hardness, adhesive force and fracturability of the carcass by DEM and BEM decreased with the increase of heating time. The moisture content of the extract liquid products decreased with the heating time increasing, while the protein content increased. And the content of glutamic acid and glycine was the highest in the analysis of amino acid composition. The results of the evaluation test showed that the 2-hour extract liquid product was the best for both DEM and BEM, and the extract liquid product of BEM was better than that of DEM.

(Y. C. Chen and L. T. Wu)



Measurement of floated oil rate of the extraction liquid of spent quail layers at different heating extracted times by dripping essence method (1, 2, 3, and 4 hours from left to right)



Measurement of floated oil rate of the extraction liquid of spent quail layers at different heating extracted times by boiling method (1, 2, 3, and 4 hours from left to right)

Research and analysis of pork processing technology that can be preserved at room temperature ①

This experiment was conducted to develop Chinese-style sausages products, which were treated with different sterilization conditions, and could be preserved at room temperature. The experiment was divided into two stages. The first stage was that the sausage samples were vacuum packaged and sterilized at 105°C for 60 mins (A), at 110°C for 40 mins (B) and at 121°C for 25 mins (C), respectively. The second stage was that the sausage samples whose weight loss rate were 10, 20 or 25%, respectively, were vacuum packaged and sterilized at 121°C for 25 mins. The color, proximate analysis, shear value, microbiological test and thiobarbituric acid value (TBA) of Chinese-style sausage were detected every month during the storage at room temperature. The results showed that the total plate count, the number of coliform and *Escherichia coli*, molds and yeasts were not detected in each treatment during the storage at room temperature for 3 months. The color of cooked sausage could be significantly improved through the different weight loss. The texture score of the sausage with 25% weight loss was the best in the three

treatments, followed by the sausage with 20% weight loss, while the score of the sausage with 10% weight loss was lower than 4 ($P < 0.05$). The color scores of the sausage with 20 or 25% weight loss were significantly higher than the score of the sausage with 10% weight loss. Above all results, the shear value, appearance and sensory evaluation in the color and texture of the sausage with different weight loss was better than normal sausage. Although the TBA values of sausages were increasing following the increasing weight loss, there was no significant difference between each treatment at the same storage period. However, the drying time of the sausage samples, whose weight loss rate was 10, 20 and 25%, and was 2, 5.5, and 10 hrs respectively. If it was considered that all the preservation quality and the cost during the dry processing, the processing procedure of the sausage, which weight loss rate was 20% and was sterilized at 121°C for 25 mins, was the best in the study this year.

(R. J. Tu, Y. C. Wu, M. R. Lee and W. S. Chen)

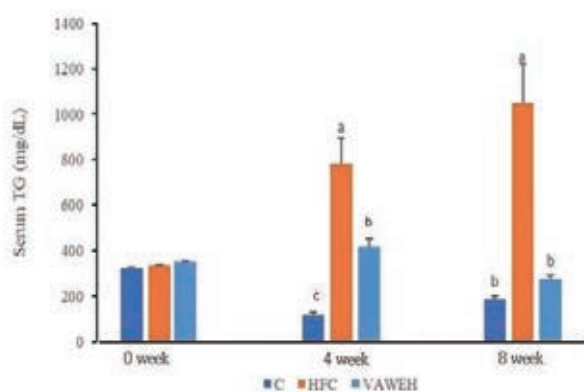


The sterilized sausage samples whose weight loss rate were 10, 20 or 25% (from left to right)

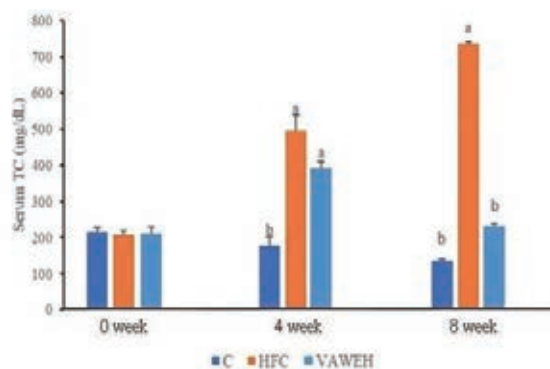
Effects of deer velvet extract from Formosan sambar deer on adipogenesis in mice

This study aimed to investigate the effect of deer velvet extract on lipid metabolism, providing reference for the development of health products in the future. Domestic red deer antlers were sliced and frozen for the experiment. After grinding the frozen antlers, the extraction was performed by dissolving 1g of the sample in 20 mL of deionized water, resulting in an extraction yield of approximately 26.5%. Human hepatocellular carcinoma cells (HepG2) were treated with deer velvet water extract at concentrations of 0, 25, 50, and 100 µg/mL, and the cells were cultured for 48 hours to assess the impact of deer velvet extract on lipid metabolism. The cell viability assay results showed that the deer velvet water extract showed no proliferative or inhibitory effect on the survival of HepG2 cells. In terms of cellular lipid droplet accumulation, the deer velvet water extract did not show a significant effect on lipid generation in HepG2 cells, and it had no impact on the cellular morphology. Analysis of cellular triglyceride content also revealed that the deer velvet water extract did not affect the accumulation of triglycerides in HepG2 cells. Using 15 five-week-old male hamsters, which were fed with commercial diet (positive control group), high-fat diet (negative control group), and

high-fat diet supplemented with deer velvet water extract (negative control with dosage group) for a duration of 8 weeks. The aim was to evaluate changes in body weight, food intake, serum triglyceride, and total cholesterol concentrations. The results indicated that the body weight was significantly higher in the high-fat diet group (negative control group), while the group fed with a high-fat diet supplemented with deer velvet extract (negative control with dosage group) showed no significant difference in body weight compared to the positive control group. There was no significant difference in food intake among the groups, suggesting that the lack of increase in body weight in the group supplemented with deer velvet extract was not due to reduced food intake. In terms of serum total cholesterol, after 8 weeks of feeding, the serum total cholesterol content in the group fed with a high-fat diet supplemented with deer velvet extract was similar to that in the positive control group and significantly lower than the high-fat diet group ($P < 0.05$). In the analysis of serum triglycerides, the group fed with a high-fat diet supplemented with deer velvet extract showed a serum triglyceride content similar to that in the positive control group and significantly lower than the high-fat diet group.



The effect of the deer velvet extract on serum triglyceride in male hamsters



The effect of the deer velvet extract on serum total cholesterol in male hamsters

Animal experiments demonstrated that feeding male hamsters with deer velvet water extract for 8 weeks significantly reduced serum triglyceride

and total cholesterol levels.

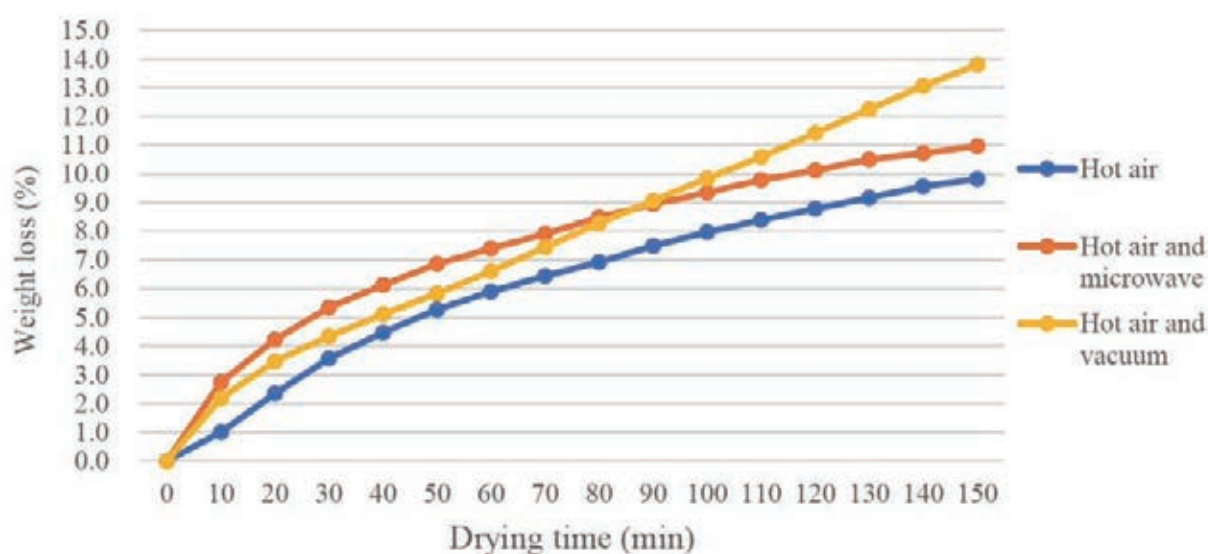
(*H. M. Liang, S. C. Chung, S. H. Lin and Y. K. Chen*)

Effect of different drying methods on the qualities of Chinese style sausage

The experiment was conducted to analyze the effects of three drying methods: hot air (HD), hot air and microwave drying (HMD), and hot air and vacuum drying (HVD), on the quality of Chinese-style sausage. All groups were analyzed for weight loss, proximate analysis, color, shear force, TBARS value, total plate counts and sensory evaluation. The results showed HMD and HVD groups had less drying time, with reductions of 26.67 % and 33.33%, respectively. For all groups, the L* and b* values decreased, while the a* value increased with the increasing drying time. The HVD had higher shear force than other groups ($P>0.05$) due to its higher weight loss, which was about 3% lower in moisture content than others. After storing for 3 months at 4°C, HMD

had the highest TBARS value, but all groups had not consistently changed with increased drying time. The HMD had lowest total plate counts among all groups ($P<0.05$). There were no significant differences in sensory evaluation among all groups. In conclusion, the application of microwave and vacuum mechanisms in the drying process could enhance the efficiency of sausage drying compared to conventional hot air drying. There were no negative effects on the quality of sausage. Therefore, it was feasible to apply vacuum and microwave drying in meat processing.

(*M. R. Lee, R. J. Tu, W. S. Chen and Y. C. Wu*)



The weight loss analysis of sausage treated by hot air, hot air-microwave and hot air-vacuum drying methods

Development of wet-aging technology for domestic pork and beef

This study aimed to develop wet-aging techniques for domestic pork and beef using a temperature of 2°C with varying relative humidity (RH85, 75, and 70%) as the cold conditions. A dry aging group served as the control, providing a reference for the industry in developing wet aging technology for domestic pork and beef. The raw materials used were pork loin and bone-in strip loin (commonly referred to as New Yorkers) from beef. Various parameters, including weight loss rate, production rate, pH, proximate analysis, shear value of meat samples, cooking weight loss rate, free amino acid composition, fatty acid composition, microbial detection, volatile base nitrogen, 2-thiobarbituric acid reactive substances, and sensory evaluation data, were collected during both dry and wet aging periods. Results indicated that the shear value

of pork wet-aged for the second week (RH85%) was significantly lower than that of other pork samples, with moisture content similar to fresh pork. In sensory evaluation, the score for pork (RH85%) in the second week of wet aging resembled that of commercially available dry-aged pork in the second week. Beef quality during the second week of wet aging remained relatively stable under the RH85% environment. Although no significant difference was found in sensory evaluation results among the beef groups, the acceptability of beef aged dry or wet for two weeks was higher than that of commercially available wet-aged beef. Considering microbial growth, it was recommended to complete wet aging within 14 days.

(R. J. Tu, M. R. Lee, Y. C. Wu and W. S. Chen)



The fresh pork (at the top), dry-aged pork (left at the bottom) and wet-aged pork aged (right at the bottom) for 2 weeks



The deboned fresh beef (at the top), dry-aged beef (left at the bottom) and wet-aged beef aged (right at the bottom) for 2 weeks

The changes in physicochemical properties of salted duck eggs during soaking

The purpose of this study was to evaluate the changes of physicochemical properties of fresh duck eggs at different soaking periods. One hundred and forty duck eggs of Tsaiya duck were soaked in the saturated salt solution (about 26.5%) at 25°C. On 0th, 5th, 10th, 15th, 20th, 25th and 30th days, 20 duck eggs were randomly selected to measure egg weight, shell strength and thickness, egg yolk color, egg yolk coefficient, egg white salt concentration, pH value, moisture, crude protein, foaming ability and emulsifying properties. The results showed that eggshell strength decreased significantly ($P < 0.05$) on 20-30th days, and egg yolk colors were significantly darker ($P < 0.05$) with the increase in soaking days (0-15th days), but there was

no significant change on the 15-30th days. The egg yolk coefficients were increased on 0-10th days and then decreased on 10-30th days. The physicochemical properties of egg whites, the salt concentration increased with the days of soaking (0-30th days). The egg white pH value, moisture, crude protein, foaming ability and emulsifying properties all decreased with the increase of the soaking days. In conclusion, the physicochemical properties of salted duck eggs and their egg white were changed with the days of soaking. Therefore, the results could be provided to processors for application in duck egg processing.

(L. T. Wu, R. H. Yeh, Y. C. Chen and C. Y. Kuo)

The physicochemical properties of salted duck egg white during soaking

	Shell strength, kg/cm ²	Yolk color	Yolk Coefficient	Salt, %	pH value	Moisture, %	Crude protein, %	Foaming ability, mL/g	Emulsifying capacity, mL oil/g protein
0 th day	4.94 ± 0.42 ^{ab}	11.90 ± 0.32 ^d	0.36 ± 0.03 ^d	0.42 ± 0.01 ^g	9.19 ± 0.03 ^a	87.06 ± 0.09 ^a	11.94 ± 0.14 ^a	7.13 ± 0.05 ^a	674.60 ± 13.17 ^a
5 th day	5.09 ± 0.66 ^a	13.30 ± 0.78 ^c	0.46 ± 0.06 ^c	1.98 ± 0.22 ^f	8.90 ± 0.06 ^b	85.31 ± 0.50 ^b	10.99 ± 0.41 ^b	7.25 ± 0.19 ^a	676.99 ± 11.66 ^a
10 th day	5.09 ± 0.55 ^a	14.19 ± 0.62 ^b	0.82 ± 0.06 ^a	3.09 ± 0.48 ^e	8.85 ± 0.03 ^b	85.30 ± 0.62 ^b	10.62 ± 0.23 ^c	7.23 ± 0.32 ^a	665.22 ± 14.51 ^{ab}
15 th day	5.11 ± 0.45 ^a	14.96 ± 0.65 ^a	0.80 ± 0.04 ^{ab}	4.39 ± 0.28 ^d	8.69 ± 0.03 ^c	82.91 ± 0.69 ^c	9.99 ± 0.21 ^d	7.17 ± 0.41 ^a	653.67 ± 23.76 ^b
20 th day	4.72 ± 0.66 ^b	15.07 ± 0.83 ^a	0.80 ± 0.04 ^{ab}	5.26 ± 0.30 ^c	8.46 ± 0.05 ^d	82.66 ± 0.46 ^c	9.72 ± 0.13 ^e	7.11 ± 0.29 ^a	625.47 ± 21.07 ^c
25 th day	4.70 ± 0.58 ^b	15.00 ± 0.68 ^a	0.77 ± 0.05 ^b	6.36 ± 0.44 ^b	8.34 ± 0.03 ^e	80.80 ± 0.49 ^d	9.32 ± 0.32 ^f	6.21 ± 0.13 ^b	619.38 ± 14.73 ^c
30 th day	4.65 ± 0.73 ^b	15.11 ± 0.80 ^a	0.76 ± 0.69 ^b	6.93 ± 0.48 ^a	8.27 ± 0.09 ^f	81.15 ± 0.73 ^d	9.56 ± 0.22 ^{ef}	6.05 ± 0.10 ^c	552.92 ± 10.18 ^d

^{a-f} Means in the same column with a different superscript are significantly different ($P < 0.05$).

Study on the process for shell removal from cooked fresh eggs

The purpose of this study was to investigate the effects of alkali soaking, drying, alkali soaking and drying treatment, salt solution boiling and cooling methods on the fresh egg for the peelability of boiled fresh eggs. The results showed that the peeling integrity rate of the contrast group (25°C, storage for 5 days) was 100 %, which was significantly higher than that of the control group (boiled fresh eggs) (< 5 %). The pH of egg white of fresh eggs immersed with 4, 6, 8, and 10% NaOH for 1-3 hours was 8.4-8.8, 8.6-9.1, 8.6-9.1 and 8.8-9.2, respectively. The peeling integrity rate was 13.3-40%, 13.3-53.3%, 33.3-60% and 33.3-60%. Those revealed the pH of egg white increased with the increase of soaking time and NaOH concentration, and that was the cause of boiled fresh egg peelability increased. But the boiled fresh eggs soaked with 6% NaOH for 3 hours and with 8 or 10 % for 2 or 3 hours have shown slight alkalization. There was no significant difference between the peeling integrity rate of boiled fresh eggs after drying at 40°C for 1-4 hours and that of the control group, while the peeling integrity rate of fresh eggs dried for 6 hours increased to 20%. The peeling integrity rate of boiled eggs treated with alkali soaking and then dried for 1-3 hours was less than 30%, which was lower than that of those used for alkali soaking only. That indicated the fresh eggs were not conducive to the peelability of boiled fresh eggs after alkali soaking and then drying treatment. The fresh eggs were dried first and then alkali soaked. Although the peeling integrity rate can be increased to 73.3%, most of the boiled eggs have shown slight alkalization. In this experiment,

soaking with 4% NaOH for 3 hours (treatment A), soaking with 8% NaOH for 1 hour (treatment B), and drying for 2 hours and then soaking with 4% NaOH for 1 hour (treatment C) had better peeling integrity rate of boiled fresh eggs, and were 40%, 33.3% and 60%, respectively. The cooked fresh egg using salt solution had no significant effect on the peeling integrity rate of boiled eggs in treatment A, B and C, while the ice water cooling method could further improve the peelability of treatment A, B and C. The pH value of treatment C was lower than that of treatment A and B, and close to that of fresh eggs, the hardness of treatment C was higher than that of treatment A and B.

(Y. C. Chen and L. T. Wu)



The peelability of boiled fresh eggs immersed with 4% NaOH for 1 hour (left) and 2 hours (right)



The peelability of boiled fresh eggs dried at 40°C for 4 hours (left) and 6 hours (right)

Development of the domestic cream cheese process

This project was to establish the production process of cream cheese. First, establish a basic production process, then try to make cream cheese and adjust the process conditions, and finally investigate the effect of different doses of edible acid on the quality of cream cheese. The results show that compared with the acidification-heating cream cheese process, the heating-acidification process requires shorter time, simpler steps and a more delicate cheese taste, so it was a better process. Adding 3.34% citric acid solution (concentration 10%) to cheese milk

was a better dosage of edible acid, which has the advantages of stable yield and good sensory evaluation performance. The cream cheese in this study was a fresh cheese with a short shelf life. To improve shelf life, it was necessary to introduce professional homogeneous filling equipment or use preservatives. This study also tried to make fermented cream cheese, but the yield was unstable, so the basic production process still needs further research.

(R. H. Yeh, C. Y. Kuo and L. T. Wu)



This study utilizes low pH and high temperature conditions to coagulate milk



The cream cheese has a soft and creamy texture and a rich milky aroma

Development of Tremella polysaccharides used in dairy curd products

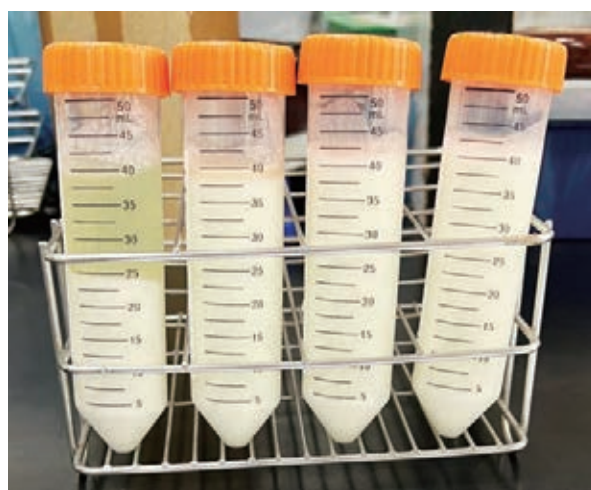
This study intends to take advantage of the characteristics of Tremella fungus (TF) rich in polysaccharides, natural plant-derived gums and dietary fiber, and apply it to the research and development of curd-related products. The extraction conditions for TF filtrate have been established in the previous year. Using an autoclave at 121°C and heating for 15 minutes, the viscosity of fresh TF filtrate can reach 277.50 m.Ps, which was better than the viscosity value of 229.63 m.Ps in a 95°C water bath for 4 hours. Subsequently, we chose to use an autoclave for high pressure heating and completed the trial production of Tremella fermented milk. The appropriate TF filtrate content of yogurt milk was 10-50%; the appropriate TF filtrate content of yogurt was 5-15%. It can produce a product with uniform texture and a shelf life of 2 weeks. TF filtrate content of 5- 10% has the effect of doubling the number of lactobacilli in yogurt. According to sensory evaluation analysis, yogurt with 5% TF filtrate content has the best overall acceptability. Tremella yogurt (TY) and Tremella yogurt drink (TYD) were co-cultured with the macrophage cell line Raw264.7 to analyze the expression of cytokines TNF- α and IL-10, thereby analyzing the regulation of Th1 and Th2 in TY and TYD. After inducing the inflammatory response with LPS, the performance of the pro-inflammatory cytokines IL-1 β and IL-6 was measured to understand the ability of TY and TYD to resist LPS-induced inflammation. Although 1% and 0.1% whole TY and TYD have a certain ability to regulate the balance of Th1 and Th2, they were not effective in inhibiting inflammation. However, although 1% and 0.1%

TY and TYD supernatant samples have poor ability to regulate the balance of Th1 and Th2, the supernatant sample has the effect of inhibiting inflammation.

(C. Y. Kuo, R. H. Yeh, Y. C. Wu, M. J. Chen and S. H. Yang)



Tremella fungus filtrate (TF filtrate) (The left was particle-containing filtrate, the right was particle-free filtrate)



TF filtrate could reduce the dehydration phenomenon of yogurt (from left to right were the control group - pure yogurt, containing 10% TF filtrate, containing 30% TF filtrate and containing 50% TF filtrate)

Amendment and establishment of carbon footprint product category rule for fresh milk

In order to assist the fresh cow milk and fresh goat milk industries in conducting product carbon footprint inspections, this project was based on the "Guidelines for the Development, Reference and Revision of Carbon Footprint Product Category Rules" announced by the Ministry of Environment, and submitted to the Environmental Protection Department (restructured from the Ministry of Environment in September 2023) applied to amend the Fresh Milk Carbon Footprint Product Category Rules (CF-PCR), which was revised and approved at the 7th Working Group Meeting of the 2nd Council to Promote Product Carbon Footprint Management Review, and the document number 22-063 was obtained. The Exchange completed the Fresh Milk Carbon Footprint Product Category Rules (CF-PCR). The revised draft of the product category rules for carbon footprint of milk (expanding the scope of application of the original fresh milk CF-PCR) products was revised and announced on the department's product carbon footprint information website, and consultations between relevant stakeholders and experts were held on September

28, 2023. During the meeting, dairy-related experts, PCR committee members, dairy industry-related associations and upstream and downstream manufacturers were invited to participate in the video conference and received many revision opinions. Based on the opinions of the members, the second version of the draft was revised, and the product life cycle was significantly revised as shown in the figure. The second version of the draft was announced on the Product Carbon Footprint Information Network on December 12, and was provided to the Ministry of Environment for review in accordance with the procedures. It was expected that after the announcement in 2024, it can be used by the domestic fresh cow milk and fresh goat milk industries as a calculation guide when taking inventory of product carbon footprints and as a rule basis for applying for carbon labels, thereby enhancing the agricultural sector's ability to adapt to climate change and moving towards the 2040 Taiwan Agricultural Net The goal of zero emissions.

(C. Y. Kuo, R. H. Yeh, L. T. Wu and Y. C. Wu)



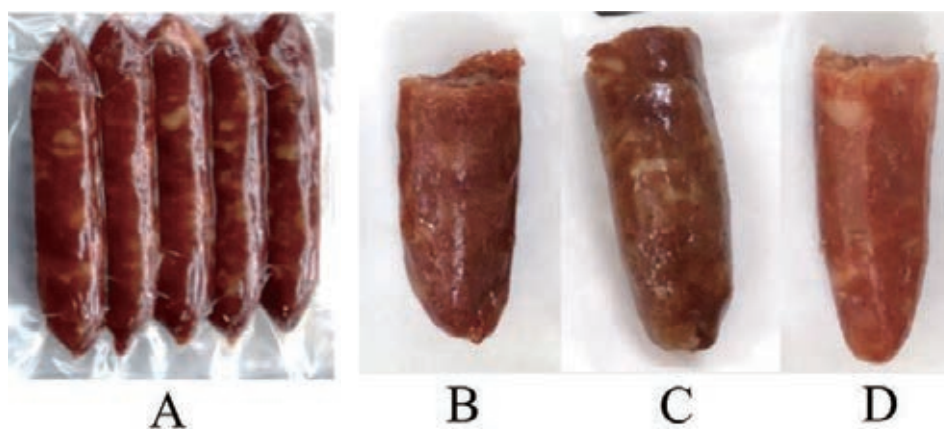
Establish the carbon footprint product category rule for fresh milk in Taiwan

Research and analysis of pork processing technology that can be preserved at room temperature ①

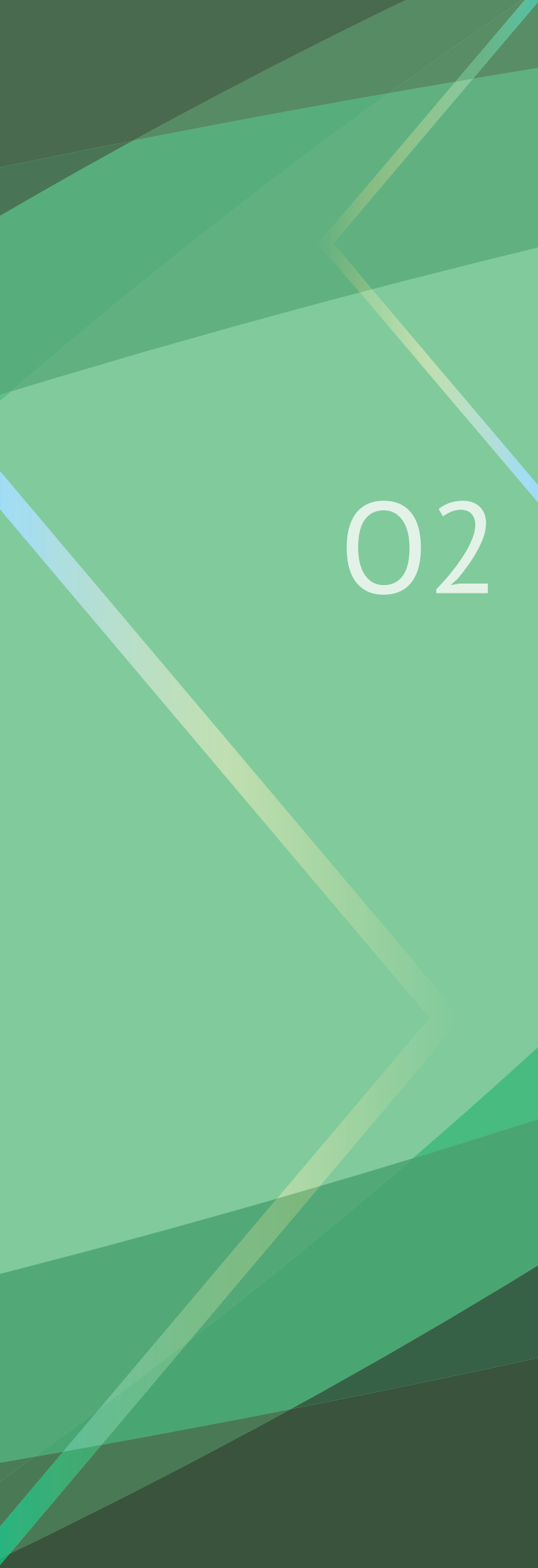
This experiment was conducted to improve the formulation and the effect of different packaging materials on the quality of the sterilized sausages stored at room temperature. Sausages with dry weight loss rates of 20% and 25% were subjected to sterilization treatment at 121°C for 25 minutes. The results showed that the brightness value (L^*) and pH value (6.15) of sausages packaged in cans were lower, while hardness and toughness were significantly higher than the other two groups ($P > 0.05$). The redness value (a^*) was lowest in sausages packaged in transparent soft bags, and the pH value was highest in sausages packaged in aluminum bags (pH 6.27). The thiobarbituric acid reactive substances value (TBARS) of various packaging ranged from 2.93 to 3.67 mg/100g. With the extension of storage time, the TBARS of sausages packaged in aluminum bags decreased, while those packaged in transparent plastic bags

and cans showed an increasing trend. Sausages in each group could be stored for more than 3 months at room temperature, with undetectable total plate count, coliform count, mold, and yeast (< 10 cfu/g). With the change in dry weight loss, the color and texture of cooked sausages could be significantly improved, and the sensory evaluation results were also better. In terms of heavy metal detection, lead, cadmium, and tin contents were all below the detection limit, and the products packaged in iron cans were also undetectable, demonstrating food safety. Based on the comprehensive testing of color, shear value, and sensory evaluation of the product, vacuum packaging with aluminum bags after sterilization was recommended for sausages with a 25% drying weight loss rate to achieve better preservation quality.

(R. J. Tu, Y. C. Wu, M. R. Lee and W. S. Chen)



The sausages, which weight loss was 25%, with original formula (A), improved formula (B and C) or bought from the market (D) followed with different packaging conditions, such as aluminum bag, transparent plastic bag, and aluminum bag, respectively



02


Research Projects in Progress

Animal Genetics and Physiology

- 1 The exchange regarding breeding and genomic selection study in poultry
- 2 Feasibility study on export of Taiwan's breeding stocks and materials to Vietnam and the Philippines
- 3 Pregnancy risk assessment of embryonic mortality and abortion in dairy cattle
- 4 Breeding techniques on dam for white mule duck production
- 5 The study of porcine induced pluripotent stem cells on the human vascular diseases (III)
- 6 Study on the application of waterfowl iPSC cell line in vaccine production
- 7 Establishment of biomedical image database in Lanyu pigs
- 8 Evaluation and improvement of KHAPS and Duroc cross breed
- 9 Advances in swine reproductive technology in Taitung
- 10 Establishment of genetic markers and application of multiomics techniques on black pigs
- 11 Establishment of genetic markers and application of multiomics techniques on black pigs: Gut microbiota analysis on black pigs using metagenomics and culturomics techniques
- 12 Selection and application of genetic markers associated with excellent economic traits in breeding pigs
- 13 Study on pregnancy-associated glycoprotein concentration in raw milk and its relationship among parity and litter size
- 14 Establish of production and fattening systems in commercial Nubian crossbred goats
- 15 Analysis of genetic structure of White Roman goose
- 16 The improvement egg count and eggshell color of black velvet silkie chicken
- 17 Selection of hybrid chicken with heat-tolerance from LRI native chickens breeds
- 18 Selection of the pure cockfighting breed
- 19 Constructing genetic selection index in better feed efficiency Brown Tsaiya
- 20 The conservation of Taiwan buffalo and gene diversity analysis
- 21 Preservation and application of genetic resources in Taiwan Yellow Cattle
- 22 Cells bank applicat and maintenance of the minipig breed diversity
- 23 Breeding of biomedical miniature pig

RESEARCH PROJECTS IN PROGRESS

- 24 Maintenances and utilization of diversity in Chinese geese
- 25 Integration and application of farm animal genetic resources database
- 26 The establishment of disease-tolerance traits testing database for breeding stocks and its value-chain innovation
- 27 The study of gene diversity analysis of registered goats
- 28 Cryopreservation and application of excellent deer semen
- 29 Application of breeding ducks in egg drop syndrome vaccine production
- 30 Study on the relationship between goat heat tolerance and heat stress gene polymorphism
- 31 Genetic parameters of residual feed intake in White Roman goose
- 32 The development of genotyping platform of candidate genes associated with eggshell quality traits in breeding chicken
- 33 Participatory breeding platform and performance recording of livestock cross-domain breeding in response to climate change
- 34 Participatory breeding platform and whole flock performance recording of cross-domain breeding poultry breeds in response to climate change
- 35 The effect of different semen collection methods on the semen quality of Lanyu pigs
- 36 Study on the relationship of egg production traits and the RNA expression of egg production tissues of silkie chicken
- 37 Investigation of the influence of hot and cold seasons on semen traits and heat shock proteins of Holstein bulls in Taiwan
- 38 The associate between HSPs and semen traits after freezing of goat
- 39 The investigation and analysis of physical, growth performance and reproductive traits under international demands in Lanyu pig
- 40 The variation of vaginal mucus conductivity and pH on the success rate of artificial insemination in goats
- 41 Research and application of frozen semen technology in breeding goose
- 42 Production and field distribution of frozen semen of elite dairy bull
- 43 A new breeding strategy to generate more high milking performance cows through shorten the generation interval of herd
- 44 Application of molecular marker-assisted selection in duck semen products
- 45 The highly efficient production and industrial application of frozen semen from breeding deer

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- 46 Improving the adaptability for poultry industry under climate change environment
 - 47 Research on improving the ability of livestock to cope with climate change
 - 48 Development of heat stress selection marker testing platform
 - 49 Maintenance and production improvement in minimal diseases geese
 - 50 Study on stable supply and production efficiency improvement of minimal disease Muscovy duck
 - 51 Study on monitoring pathogen of biomedical Lanyu pig
 - 52 Effects of deer velvet extract from Formosan sambar deer on adipogenesis in mice
 - 53 Performance improvement of KHAPS and Duroc cross breed
 - 54 Study on pregnancy-associated glycoprotein concentration in raw milk and its relationship among parity and litter size
 - 55 Establish of platelet production and fattening systems in commercial Nubian crossbred goats
 - 56 Evaluation of platelet rich plasma on cattle wound healing
 - 57 Selection and application of genetic markers associated with excellent economic traits in stock pigs
 - 58 Study of genetic change in White Roman goose selected for high egg production
 - 59 A new model for improving the reproductive efficiency of breeding geese - Study on 3 laying periods in 2 years of White Roman geese
 - 60 The improvement egg count and eggshell color of black velvet silkie chicken
 - 61 Breeding of Ji-An native chicken with heat tolerance
 - 62 Selection the medium and large LRI native chicken
 - 63 The genetic analysis of the stress resistance genes and immune factors in Taiwan swamp buffaloes
 - 64 Integration and application of farm animal genetic resources database
 - 65 Maintenance of miniature pig genetic diversity by cell bank
 - 66 Preservation and application of genetic resources in Taiwan Yellow Cattle
 - 67 Maintenances and utilization of diversity in Chinese geese
 - 68 Application of molecular markers in population management of Brown Tsaiya duck
 - 69 The study of gene diversity analysis of registered goats
 - 70 Application of breeding ducks in egg drop syndrome vaccine production

RESEARCH PROJECTS IN PROGRESS

- 71 Genetic parameters of residual feed intake in White Roman goose
- 72 Study on the relationship between goat heat tolerance and heat stress gene polymorphism
- 73 The establishment of disease-tolerance traits testing database for breeding stocks and its value-chain innovation
- 74 The development of genotyping platform of candidate genes associated with eggshell quality traits in chicken breeding stock
- 75 Improve the birth and market weight uniformity of black pigs
- 76 Establish production models for improving the number of hatched chicks and the uniformity of marketed body weight in Taiwan colored broiler
- 77 Development and application of tools for feed efficiency selection in meat duck breeders
- 78 The investigation and analysis of physical, growth performance and reproductive traits under international demands in Lanyu pig
- 79 Study on cryopreservation of porcine embryo by hollow fiber vitrification
- 80 Establishment of assisted reproductive technologies in Lanyu pig
- 81 Study on the relationship of egg production traits and the RNA expression of egg production tissues of silkie chicken
- 82 Production and field distribution of frozen semen of elite dairy bull
- 83 Research and application of frozen semen technology in breeding goose
- 84 Application of molecular marker-assisted selection in duck semen products
- 85 The highly efficient production and industrial application of frozen semen of breeding deer
- 86 The variation of vaginal mucus conductivity and pH on the success rate of artificial insemination in goats
- 87 A new breeding strategy to generate more high milking performance cows through shorten the generation interval of herd
- 88 Establishment of minimal disease Muscovy duck's population and supply system
- 89 Study on monitoring pathogen of biomedical Lanyu pig
- 90 Maintenance and production improvement in minimal diseases geese
- 91 The study of porcine induced pluripotent stem cells on the human vascular diseases (IV)
- 92 Study on the application of waterfowl iPSC cell line in vaccine production
- 93 Establishment of biomedical image database in Lanyu pigs II

Animal Nutrition

- 1 The effects of traditional herbal medicine for diarrhea and growth performance in pigs
- 2 The effects of nutritional and environmental strategies for growth promotion and diarrhea reduction on weaned piglets
- 3 Evaluation of precision and safe nutrition management on sow
- 4 Effect of high-efficiency feeding technology on production efficiency of suckling and weaned piglets
- 5 Studies on improvement of pig production in different feeding strategies
- 6 Strategy of nutritional adjustment for high feed efficiency in pigs under heat stress
- 7 Study on reproductive efficiency and endocrine profiles after hormone treatment in sows
- 8 Association study of pig gut microbiota and economical traits underlying different feeding strategies
- 9 Development of specialized diet in black pig
- 10 Developing the characteristic feeding system of Lanyu Pig
- 11 Application of composite of feed additives to reduce use of antibiotics in regulating immune balance for sows and piglets
- 12 Effect of vegetable diet on laying performance of Brown Tsaiya duck
- 13 Effects of dietary energy and protein on egg production and reproductive performances of LRI White Silky Chickens
- 14 Development of mix-probiotics feed additive for improving chickens production performance and health
- 15 Through nutritional strategy-adding different content of soybean oil to enhance the goat milk composition in the hot season
- 16 Effects of dietary supplementation of Bacillus and reducing crude protein level on growth traits, carcass traits, and intestinal morphology of broilers
- 17 The study of de novo fatty acid concentration and change on bulk tank milk of domestic dairy farm
- 18 Study of total mixed ration on antlers production for Formosan Sambar Deer
- 19 Exploring the intestinal microbial composition associated with feed efficiency and development of microbial feed additives in pigs
- 20 Study on effects of Bacillus licheniformis on immune traits and intestinal villi traits in ducks

RESEARCH PROJECTS IN PROGRESS

- 21 Research of formula technology of low methane emission for lactating cow and goat
- 22 Development of feed additives for reducing gastrointestinal fermentation gases in ruminants
- 23 Development of a multistage low-protein formula for pigs to reduce nitrous oxide emissions
- 24 Application of feed nutrition regimen and feeding management reducing methane emissions from the gastrointestinal tract of pigs
- 25 Development of low nitrogen formulations and production models to reduce nitrous oxide emissions in chickens
- 26 Establishing of micro-ecological bank and screening of strains to mitigate methane emission in ruminant livestock
- 27 Using the in vitro digestion system to study the effect of Bacillus species-fermented products on methane emission from digestive tracts in pig
- 28 Evaluation of the optimal nutritional strategies for growing-finishing pig
- 29 The effects of nutritional and environmental strategies for growth promotion and diarrhea reduction on weaned piglets
- 30 Feeding value of forages from Pheng-Hu
- 31 Feasibility evaluation of using deer fecal as a source of micro-organisms for the in vitro digestibility
- 32 Application of composite of feed additives to reduce use of antibiotics in regulating immune balance for sows and piglets
- 33 Effects of dietary energy and protein on egg production and reproductive performances of LRI White Silky Chickens
- 34 Duck house environment monitoring and investigation on Brown Tsaiya and mule duck production performance of feeding diet with different nutrient concentration
- 35 Effects of different feed sources on rumen microbiota and milk de novo fatty acid composition of dairy cattle
- 36 Development of mix-probiotics feed additive for improving chickens production performance and health
- 37 Through nutritional strategy-adding biotin and organic zinc to enhance the goat milk composition in the hot season
- 38 Effects of dietary supplementation of Bacillus and reducing crude protein level on growth traits, carcass traits, and intestinal morphology of broilers
- 39 Exploring the intestinal microbial composition associated with feed efficiency and development of microbial feed additives in pigs

Forage Crop


- 1 Commericlization of forage corn pellet
- 2 Adapted operations for livestock (dairy cows, White Roman geese, ostriches and dairy goat) and forage in response to high temperature climate
- 3 Industrial diffusion and adjustment of the high quality forage processing technologies
- 4 Feeding value of forages from Pheng-Hu
- 5 Breeding of napiergrass new lines
- 6 Establishment of physiological index for heat and drought tolerance of forage crop
- 7 Breeding of nilegrass (*Acroceras macrum*) elite lines
- 8 Cultivar breeding of forage soybean for intercropping
- 9 Development of shrubs as forage for small ruminants
- 10 Evaluation of quality-protein maize for forage use
- 11 Change of anti-nutrients and evaluation of utilization benefits of forage sorghum
- 12 The development of pelletized forage technology
- 13 Development of small-package hay products for goats and deer
- 14 Development of the forage utility system with the residue substrate of king mushroom cultivated by napiagrass
- 15 Collection and preservation of forage germplasm - The study on DNA molecular markers applied to the breeding of Napiergrass
- 16 Development of automatic feeder using domestic forage
- 17 Value-adding and promotion of agriculture by-product as feed resources
- 18 Industrial diffusion and adjustment of the high quality forage processing technologies
- 19 Breeding of nilegrass (*Acroceras macrum*) resilient lines
- 20 Establishment of physiological index for heat, drought and salt tolerance of forage crop
- 21 Evaluation of cereal grain forages as winter
- 22 Breeding of Napier grass varieties-fiber quality improvement of purple lines
- 23 Cultivar breeding of forage soybean for intercropping
- 24 Development of shrubs as forage for small ruminants

RESEARCH PROJECTS IN PROGRESS

- 25 Carbon sink of perennial grassland irrigated with livestock manure digestate
- 26 Study on the benefits of forage sorghum for irrigation with livestock wastewater
- 27 Development of small-package hay products for goats and deer
- 28 Establishment of grass-legume mixture film-packed silage model
- 29 Collection and preservation of forage germplasm - The study on DNA molecular markers applied to the breeding of Napier grass

Livestock Management

- 1 Holding the 6th fatty pig international conference
- 2 Taiwan and Denmark agricultural net zero conference III- Enhancing livestock production efficiency and the strategy of carbon-reducing feeding management
- 3 Double T Dairy Industry : Taiwan - Thailand - Smart dairy farming with machines and technologies for herd management
- 4 The cooperation project about developing and applying automatic dairy cattle gait tracking system
- 5 Development of non-invasive dairy disease detection services
- 6 Development of intelligent system for duck hatching eggs candling
- 7 Conduct a novel intelligent agriculture AI vision recognition of duck fertilized eggs
- 8 Developing a system at sow productivity by the internet of things (IOT)
- 9 Promote agricultural innovation incubation cross-domain and multi-service cooperation
- 10 Impact and abatement of heat stress on milk production to dairy industries using agrometeorology
- 11 The platform of strategy for livestock under climate change
- 12 Establish a production model for reusing spent mushrooms cultivation media as waterfowl feedstuff
- 13 Research development and promotion of chicken manure processing products
- 14 Value-added industrial application of microalgae in livestock wastewater treatment
- 15 Application of pig manure liquid digestate for microalgae and live food cultivation in aquaculture
- 16 Evaluation of the co-digestion efficiency of agrolivestock residual materials

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- 17 The establishment of a circular economy model for the pig-raising circular area
 - 18 Value-adding and promotion of agriculture by-product as feed resources
 - 19 Establishment of a regional agricultural and animal husbandry recycling business model
 - 20 The optimization of herbivore herd technology
 - 21 Counseling plan for elevating of production efficiency and promoting the transformation of the pig industry
 - 22 The optimization of breeding stock supply chain systems in Hualien and Taitung area and evaluation of management efficiency on automatic labor saving equipment
 - 23 Evaluation of the application of wet pad cooling system pig house and automated labor-saving equipment to improve the efficiency of pig farm management
 - 24 Effect of exercise ground at night on milk performance and locomotion score of Holstein dairy cows under the high temperature-humidity index (above 72)
 - 25 Construction reproductive management modeling of dairy cattle under hot and humid environment
 - 26 The effect on cow mastitis of different cow bed between auto and traditional milking system
 - 27 Application of total bacterial count and rapid pathogen test in raw milk
 - 28 Effects of conventional milking and automatic milking robot on later transition dairy cattle
 - 29 Smart grazing of beef cattle
 - 30 Investigation of the survival rate of meat-type geese in central and south areas in Taiwan
 - 31 Feeding regimens for White Roman goose breeders in the closed-house system
 - 32 Evaluation of the ostrich growth performance with different litter materials during the growing period (0-60 days)
 - 33 The counselling of quail breeding farms and the establishment of related standard operation procedures (SOPs)
 - 34 Determination of selenium species and accumulation in egg of laying hens
 - 35 Investigate the effect of pig house with high-bed on pig growth performance and waste reduction
 - 36 Improved evaluation of livestock wastewater irrigation on farmland
 - 37 Research of livestock wastewater nitrogen and phosphorus reduction technology
 - 38 Application research and development of chicken manure processing fertilizer products
 - 39 The carbon footprint of pig production by life cycle assessment
 - 40 Establishment of high quality rabbit production and supply system for biomedical research

RESEARCH PROJECTS IN PROGRESS

- 41 The analysis of training effectiveness and the status of engaged in livestock husbandry
- 42 Study on the financial management and innovative guidance model of new farmers in the livestock industry in Taiwan
- 43 Research and development of cow care robot and healthy reproductive automatic perception system for dairy farm
- 44 Developing the RFID scales systems for automatic grouping animals by the difference of their body weight
- 45 Development of robot assisted-technology for pig farming
- 46 Building a behavior system of sow and piglet by image recognition during parturition
- 47 Using AR interface to build inspection barn and field robot
- 48 Exchange the technology of conservation and utilization of waterfowl germplasms with Hungary
- 49 Strengthen the bilateral cooperation between Taiwan and ASEAN in the research of livestock and poultry breeding
- 50 Developing a system at sow productivity by the internet of things (IOT)
- 51 Development of non-invasive dairy disease detection services
- 52 Development of intelligent system for duck hatching eggs candling
- 53 Conduct a novel intelligent agriculture AI vision recognition of duck fertilized eggs-machine learning algorithm optimization and feedback mechanism establishment
- 54 A decision analysis system for health management of dairy cattle
- 55 Analysis on the field adaptability of the cleanliness in dairy cattle houses
- 56 Dairy cattle voiceprint recognition system and cloud service system
- 57 Analysis and application of body condition health monitoring of dairy cattle
- 58 Assessment of livestock industry carbon reduction strategies
- 59 Research and development of greenhouse gas mitigation technology for livestock manure treatment
- 60 Study on carbon reduction benefits of biogas utilization in livestock farm wastewater treatment
- 62 Development of intelligent energy-saving mode for livestock and poultry houses and evaluation of carbon reduction benefits and production performance
- 63 Effects of optimizing the cooling cycle equipment for swine on its production performance
- 64 Comparison of carbon emissions per unit of goose production in different type of goose house and optimization of cooling system

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- 65 Evaluation of rooftop-type solar photovoltaic houses for livestock productivity and carbon reduction benefit
 - 66 The platform of strategy for livestock under climate change
 - 67 Adapted operations for livestock (dairy cow, swine and layer hen) and forage in response to high temperature climate
 - 68 The development of geographical identification technologies for milk and velvet antler
 - 69 Evaluation of the efficiency of co-digestion of livestock wastewater and agricultural by-products
 - 70 Construction of demonstration zone for full recycling utilization of agricultural surplus resources in dairy farms
 - 71 Establishment and demonstration of the circulation mode of self-production and marketing beef cattle farms in Chiaya
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 - 75 Mentoring program to improve pig production efficiency
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 - 79 The relationship of heat regulation physiological markers and production traits
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 - 83 Evaluation of the application of wet pad cooling system pig house and automated labor-saving equipment to improve the efficiency of pig farm management
 - 84 Feeding regimens for White Roman goose breeders in the closed-house system
 - 85 Evaluation of the ostrich growth performance with different litter materials during the growing period (0-60 days)
 - 86 The counselling of quail breeding farms and the establishment of related standard operation


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- 87 Determination of selenium species and accumulation in milk of goat by HPLC-ICPMS
- 88 Investigate the effect of pig house with high-bed on pig growth performance and waste reduction
- 89 Improved evaluation of livestock wastewater irrigation on farmland
- 90 Research of livestock wastewater nitrogen and phosphorus reduction technology
- 91 Application research and development of chicken manure processing fertilizer products
- 92 The carbon footprint of pig production by life cycle assessment
- 93 Establish of demonstration site for transformation of layer farm and treatment of chicken manure
- 94 Establishment of the production and supply system of optimized experimental rabbits
- 95 The analysis of training effectiveness and the status of engaged in livestock husbandry
- 96 Study on the financial management and innovative guidance model of new farmers in the livestock industry in Taiwan
- 97 Standardized and healthy poultry production system optimization to ensure the food safety

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- 1 Improvement of domestic mozzarella cheese process
- 2 Effect of different drying methods on the qualities of Chinese style sausage
- 3 Development of prepared poultry gel product using aged chicken feet
- 4 Development of softened meat production technology
- 5 Development of leisure product with salted duck egg white
- 6 Studies on the manufacture of meat essences products using spent quails layers
- 7 Black pork phosphate-free meat balls and special low-nitrite hot dog production technology
- 8 Research and analysis of pork processing technology that can be preserved at room temperature
- 9 Comparison of carcass and beef characteristics of Taiwan Yellow Cattle and its crossbreds
- 10 Effect of different drying methods on the qualities of Chinese style sausage
- 11 Development of wet-aging technology for domestic pork and beef
- 12 Development of leisure product with salted duck egg white

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- 13 Study on the process for shell removal from cooked fresh eggs
 - 14 Development of the domestic cream cheese process
 - 15 Development of Tremella polysaccharides used in dairy curd products
 - 16 Carbon footprint product category rule (PCR) establishment of bee products
 - 17 Amendment and establishment of carbon footprint product category rules (PCR) for processed eggs
 - 18 Amendment and establishment of carbon footprint product category rule for fresh milk
 - 19 Investigation on meat quality of Taiwan Native Goat
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Scientist sent abroad for advanced study, investigation, or participation in international symposia

Position	Name	Subject	Country	Date
Assistant Researcher	Hsiu-Lien Lin	PHD study in National Research Institute for Agriculture, Food and the Environment (INRAe) and University of TOURS. The title of thesis is Chicken sperm cryopreservation: improving the use of glycerol as a cryoprotectant	France	Sep. 24, 2019 - Feb. 28, 2023
Assistant Researcher	Hsiao-Yun Kuo	World Poultry Congress 2022	France	Sep. 14, 2021 - Aug. 11, 2022
Assistant Researcher	I-Heng Chang	World Poultry Congress 2022	France	Sep. 14, 2021 - Aug. 11, 2022
Assistant Researcher	Yu-Jing Liao	Agricultural Elitist Training Project for COA–Pluripotency improvement of porcine induced pluripotent stem cells	United States	Jan. 27 - Oct. 26, 2022
Director General	Jeng-Fang Huang	2022 ICAR / Interbull Annual Conference	Canada	May 29 - Jun. 6, 2022
Researcher and Chief of Division	Jen-Wen Shiau	2022 ICAR / Interbull Annual Conference	Canada	May 29 - Jun. 6, 2022
Director General	Jeng-Fang Huang	USDA/ARS/AIT – COA/ TECRO 2022 Bilateral Cooperation Meeting on Agricultural Science and Technology	United States	Jul. 29 - Aug. 7, 2022
Assistant Researcher	Chia-Te Chu	USDA/ARS/AIT – COA/ TECRO 2022 Bilateral Cooperation Meeting on Agricultural Science and Technology	United States	Jul. 29 - Aug. 7, 2022

TECHNICAL SERVICE

Position	Name	Subject	Country	Date
Assistant Researcher	Tzu-Hsuan Huang	USDA/ARS/AIT – COA/ TECRO 2022 Bilateral Cooperation Meeting on Agricultural Science and Technology	United States	Jul. 29 - Aug. 7, 2022
Associate Researcher	Tien-Chun Wan	USDA/ARS/AIT – COA/ TECRO 2022 Bilateral Cooperation Meeting on Agricultural Science and Technology	United States	Jul. 29 - Aug. 7, 2022
Associate Researcher and Chief	Szu-Han Wang	USDA/ARS/AIT – COA/ TECRO 2022 Bilateral Cooperation Meeting on Agricultural Science and Technology	United States	Jul. 29 - Aug. 7, 2022
Researcher and Chief of Division	Jeng-Bin Lin	19th AAAP 2022	Korea	Aug. 21-27, 2022
Researcher	Tsui-Miao Chen	19th AAAP 2022	Korea	Aug. 21-27, 2022
Assistant Researcher	I-Heng Chang	19th AAAP 2022	Korea	Aug. 21-27, 2022
Assistant Researcher	Hsiao-Yun Kuo	19th AAAP 2022	Korea	Aug. 21-27, 2022
Researcher	Der-Yuh Lin	Assist the International Cooperation and Development Fund, Taiwan ICDF, to define the mission of the "Saint Kitts and Nevis Laying Industry Sustainable Development Plan"	Federation of Saint Kitts and Nevis	Aug. 21-29, 2022
Assistant Researcher	Lin-Liang Peng	Study of pig breeding and production technique in France	France	Sep. 17 - Oct. 4, 2022

Position	Name	Subject	Country	Date
Assistant Researcher	Chia-Jung Hsieh	Bilateral cooperative conference in strengthening of the animal germplasm banking and genetic resources conservation between COA-LRI and USDA- ARS	United States	Sep. 22, 2022
Associate Researcher	Hsin-Jung Lee	Poultry manure reuse experience and livestock recycling practice	the Philippines	Oct. 3-8, 2022
Assistant Researcher	Tzu-Hsuan Huang	Poultry manure reuse experience and livestock recycling practice	the Philippines	Oct. 3-8, 2022
Assistant Researcher and Chief	Ching- Yi Lien	Study abroad of breeding and genetic selection in goose	Poland	Oct. 7-21, 2022
Assistant Researcher	Ting-Yung Kuo	Feasibility study on export of Taiwan's breeding stocks and materials to Vietnam and the Philippines	the Philippines	Nov. 20-25, 2022
Assistant Researcher	Chia-Jung Hsieh	Feasibility study on export of Taiwan's breeding stocks and materials to Vietnam and the Philippines	the Philippines	Nov. 20-25, 2022
Assistant Researcher	Ting-Yung Kuo	Feasibility study on export of Taiwan's breeding stocks and materials to Vietnam and the Philippines	Vietnam	Nov. 29 - Dec. 4, 2022
Assistant Researcher	Chia-Te Chu	Feasibility study on export of Taiwan's breeding stocks and materials to Vietnam and the Philippines	Vietnam	Nov. 29 - Dec. 4, 2022
Associate Researcher and Chief	Szu-Han Wang	APO - Workshop on IoT Applications in Livestock Management	Thailand	Feb. 19-24, 2023
Researcher and Director	Hsiu-Chou Liu	Technical consulting in Indonesia Karawang agriculture demonstration area	Indonesia	Mar. 8-11, 2023

TECHNICAL SERVICE

Position	Name	Subject	Country	Date
Director General	Jeng-Fang Huang	2023 ICAR / Interbull Annual Conference	Spain	May 21-28, 2023
Researcher and Director	Jen-Wen Shiau	2023 ICAR / Interbull Annual Conference	Spain	May 21-28, 2023
Assistant Researcher	Chia-Jung Lee	Production technology optimization diffusion technology - Animal physiology and behavior research applied to animal welfare assessment	United States	May 10-24, 2023
Associate Researcher	Tien-Chun Wan	Developing meat preservation strategies	United States	May 10-24, 2023
Researcher and Chief of Division	Ching-Yun Kuo	Developing meat preservation strategies	United States	May 10-24, 2023
Assistant Researcher	Ya-Ling Lin	Exchange the technology of conservation and utilization of waterfowl germplasms with Hungary	Hungary	May 29 - Jun. 9, 2023
Assistant Researcher	Ting-Wen Chuang	Exchange the technology of conservation and utilization of waterfowl germplasms with Hungary	Hungary	May 29 - Jun. 9, 2023
Researcher and Chief of Division	Jeng-Bin Lin	Agricultural Waste Management For Sustainable Food Production	Malaysia	Jul. 9-13, 2023
Associate Researcher	Hsin-Jung Lee	Study of the biorefinery technology on nitrogen and phosphorus extracted from livestock waste water	United States	Aug. 18-27, 2023
Assistant Researcher	Ya-Ling Huang	Study of the biorefinery technology on nitrogen and phosphorus extracted from livestock waste water	United States	Aug. 18-27, 2023

Position	Name	Subject	Country	Date
Assistant Researcher	Chi-Huai Huang	Strengthening climate actions through circular agri-food economy	Thailand	Sep. 12-16, 2023
Assistant Researcher	Chia-Te Chu	International exchange and diffusion strategies of agricultural science and technology achievements -Whole genome sequencing technology for highly economic animal improvement of the benefits of gene selection	United States	Sep. 24 - Oct. 8, 2023
Associate Researcher	Chun-Hsuan Chao	International exchanges and cooperation on livestock and diffusion of R&D achievements and technologies-Strategies for reduction of the impact of heat stress on production in farm animals	United States	Sep. 24 - Oct. 8, 2023
Assistant Researcher	Hsi-Wen Hung	Study on novel carbon-reducing feed additives and application of respiration chamber to measure livestock methane emissions	Netherlands	Sep. 29 - Oct. 8, 2023
Assistant Researcher	Yi-Huei Hsieh	Study on novel carbon-reducing feed additives and application of respiration chamber to measure livestock methane emissions	Netherlands	Sep. 29 - Oct. 8, 2023
Associate Researcher	Tsung-Yu Li	Develop new biological feed additives in tropical areas as a precise resistance reduction strategy to improve animal production efficiency and research of animal physiology and behavior applied to animal welfare assessment	United States	Dec. 10-21, 2023

Position	Name	Subject	Country	Date
Associate Researcher	Herng-Fu Lee	Develop new biological feed additives in tropical areas as a precise resistance reduction strategy to improve animal production efficiency and research of animal physiology and behavior applied to animal welfare assessment	United States	Dec. 10-21, 2023



Mar. 01, 2022

First Season Academic Seminar

Y. C. Wu	Effect of Swill-Pigs on the Quality of Pork
F. C. Liu	Basic Ingredients of Food Waste and Advice on the Use of Pigs
S. C. Chang	Effects of Food Waste and Byproducts as Feed Sources on the Growth and Carcass Traits of Black Pigs

May 27, 2022

The 1st Video Conference of Forage Crops in 2022

S. R. Chang	Effects of Drying Conditions on Quality of Dry Napiergrass
P. Y. Chen	Evaluation of Irrigation of with Cattle Manure Digestate on the Forage Yields and N Uptake Efficiency for Pangolagrass and Nilegrass
Y. M. Shih	Reviews of Plant Tissue Culture of Forage in Taiwan
M. L. Chang	The Regulation Analysis of Sucrose Phosphate Synthases (Sb SPSs) in Sorghum and Genes Expression During Seedling

May 27, 2022

Second Season Academic Seminar

D. J. Huang	Estimation of Greenhouse Gas Emissions from Livestock Industry
C. I. Chen	Monitoring and Estimating of Ecosystem Carbon Budget

Aug. 16, 2022

Third Season Academic Seminar

L. C. Lin	Intelligent Agriculture Prospective Solutions and Research Development
Y. T. Shen	Applied Acoustic Analysis for Intelligent Agriculture

Aug. 19, 2022

The Weed Science Symposium "Net Zero Carbon Emissions and Zero Distance from Weeds"

C. H. Lu	CO ₂ Fixation Capacity and Production Strategies for Energy Conservation and Carbon Reduction of Domestic Forage
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Sep. 06, 2022

Annual Poultry Feeding and Management Academic Seminar in 2022

H. Yu	Introduction to Poultry House Construction Planning
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H. Yu	Improvement of Hot Stress in Poultry Houses
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Sep. 22, 2022

Taiwan-U.S. Bilateral Cooperation Meeting – Strengthening the Operation of Animal Breed Banks and Maintenance of Genetic Resources

Harvey Blackburn	U.S. Perspectives on How Animal-GRIN Facilitates Gene Banking and Animal Genetic Resources Conservation
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C. J. Hsieh	The Operation of Animal Germplasm Bank and Genetic Resources Conservation of Farm Animals in Taiwan
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Sep. 27, 2022

Challenges and Responses to Precision, Net-Zero Emissions and Environmental Protection Issues in Livestock and Poultry Feeding Seminar

T. T. Li	The Benefits of Precision Nutrition in Chicken Feeding - for Feed Additives as an Example
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H. W. Wei	A Brief Analysis of the Concept of Precision Nutrition
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C. C. Chen	Feed Formula Design Adjustments Based on the Principle of Net Zero Carbon Emissions
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Oct. 11, 2022

Academic Seminar on Sharing Experience in the Implementation of International Cooperation Projects

Y. C. Liao	Experience of Agricultural Elitist Training Project in the USA
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J. W. Hsiao	International cooperation of International Committee for Animal Recording
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C. J. Hsieh	The Taiwan-U.S. International Cooperation Program Implementation Experience
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Nov. 08, 2022

Lecture on Whole-Genome Association Analysis and Genome Selection

Hervé Chapuis	Genomic Selection: General Principles & Some French Applications
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Hervé Chapuis From Linkage Analysis to GWAS

Nov. 09, 2022

Annual Poultry Friendly Breeding Promotion Seminar and Observation Meeting in 2022

Y. T. Li Chicken Feed Preparation and Feeding Management

Y. T. Li Chicken Manure Treatment and Resource Utilization in Chicken Farms

H. E. Tseng Observation of Xingeng Poultry Farm

Nov. 14, 2022

Taiwan–Denmark Net Zero Agriculture 2050, Part III-Improve livestock production efficiency, Corporate Action Strategies and Consumer Awareness

C. F. Lee Strategy for Low-Carbon Livestock Industry in Taiwan –Feeding Agricultural Byproducts to Mitigate Methane Emissions from Enteric Fermentation

Y. K. Hung Circular Economy in Agriculture and ESG Practices

Søren Tingaard Climate Neutral Meat – Ambition and Pathways of Danish Crown (online)

Sussie Ketit,
John Lin Building Carbon Free Solutions for Smart Farms – Journey of SKIOLD Danish Model Farms in Philippines, Taiwan and Vietnam

Marianne H.
Madsen Carbon Reduction from Feed Perspective (online)

Nov. 18, 2022

The 2nd Video Conference of Forage Crops in 2022

P. Chung The Expression and Transcriptome Analysis of Napier Grass Taishu No. 8 (TS8) Under Waterlogging Stress

L. C. Tsai The Physiological Index for Drought Tolerance of Napiergrass

P. A. Tu Agricultural Meteorological Information in the Application of Grass Production and Dairy Cow Management

Dec. 05, 2022

Keynote Speech

C. H. Chou Prospects for Biological Phylogeny and Phylogeny: A Half-Century of Phylogenetic Substance Research

TECHNICAL SERVICE

Dec. 14, 2022

Fourth Season Academic Seminar

Y. C. Lin	Microbiome in Livestock and Climate Change Adaptation
J. T. Hsu	International Development of Adjustment Strategies for Climate Change in Cattle and Goat Industries
S. Y. Wang	Climate Change and Livestock: Is Livestock Really the Culprit of Climate Change?

Mar. 15, 2023

First Season Academic Seminar

C. H. Chen	Cyclic Economic and Nove Feed Ingredient - Challenge & Predicament
Z. Y. Xu	Carbon Reduction Application of Asparagopsis sp. in Animal Husbandry
C. C. Hung	Benefits and Risks of Seaweed as Chicken Feed and Application for the Reduction of Greenhouse Gas Production

Mar. 17, 2023

Keynote Speech

C. K. Chen	Investigation and Monitoring Results of Agricultural Pond Water Resources and Environmental Conditions at Taiwan Livestock Research Institute and Tainan District Agricultural Research and Extension Station
C. J. Chang	From Bordeaux Mixture to Bordeaux- The Working Experiences with the World Trade Organization Extended the International Vision to Agricultural Chemicals (Experience Sharing of Civil Service Career)

May 15, 2023

Second Season Academic Seminar

H. L. Lien	Investigation of Estimation Methods of the Methane Emission Factor and GHG emission Reduction Potential for Pig Husbandry in Taiwan
H. C. Fang	The Sustainable Development of Taiwan's Animal Husbandry-The Case of Hanbo Livestock Farm
H. C. Huang	The Moisture Removal Drying Mode for Chicken Manure Treatment

May 31, 2023

Keynote Speech

T. C. Lu	The Role of Goats in the World, Society, Science, and Sustainability
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Jun. 09, 2023

Keynote Speech

C. H. Chen	Talking about the Grass Family
C. H. Chou	Biological Engendered or Rivalry for Sustainable Development

Jun. 19, 2023

Keynote Speech

H. M. Huang	Experimental Research on the Secrets of Organizational Performance and Service Quality Highlights
L. K. Huang	Practical Application of Patent Search and Application

Jul. 03, 2023

The Conference of Agricultural Forecast in 2023

C. W. Wang	2050 The Trend of Agriculture on Net Zero and Reduce Carbon Emissions
C. H. Li	International Net Zero Carbon Emissions Strategy and Carbon Rights Recognition Mechanism

Aug. 09, 2023

Ecological Compost Recycling Symposium

Y. M. Lo	Ecological Compost, Emission Reduction and Carbon Sequestration
P. T. Kao	Recycling and Re-Use of Animal Manure: From Feed to Feed

Sep. 26, 2023

Seminar on Livestock and Poultry Breeding and Breeding Stock Maintenance in Response to Climate Change

C. N. Mingala	Bio-Banking of Animal Genetic Resources Related to Adversity Climate Change in the Philippines
G. Calderon	The Philippines National Dairy Authority Programs on Tropical Dairy Climate-Change Adaptations and Mitigations
E. J. Cuasay	Climate-Resilient and Future Ready Innovative Pig Pen Design

S. Baguio	Development of Climate Resilient Native Chicken and Duck Breeds of the Philippines
M. C. Wu	National Genetic Improvement System for Climate Adaptive and Resilient trait of Farm Animal Breeds in Taiwan
M. Villanueva	Buffalo Farming for Rural Development and Its Adaptation in Philippines
M. De Vera	The Philippine Native Animals: Resiliency and Adaptability to Climate Change
R. De Castro	Development of Climate Resilient Native Pig Breeds of the Philippines
P. T. K. Dzung	Designing Animal Genetics Related to Climate Change Adaptation in Vietnam
C. Yang	Pig Breeding and Supplement Related to Climate Change in Taiwan

Oct. 03, 2023

Third Season Academic Seminar

H. E. Chen	Metaverse XR and Application of Intelligent
Y. T. Shen	Application of Visual Recognition in Agricultural Application Practice Sharing

Oct. 11, 2023

Keynote Speech

R. J. Chen	EU food additive-free and animal antibiotic-free breeding verification
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Oct. 16, 2023

Keynote Speech

H. C. Su	Sustainable Development and Animal Welfare
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Nov. 07, 2023

Keynote Speech

L. T. Chuang	Strategy and Plan of Circle Agriculture
Y. Y. Lai	Resource Cycle Policy

Nov. 17, 2023

Fourth Season Academic Seminar

Y. P. Chen	Improving the Competitiveness of Domestic Dairy Products: Innovative Research on Fermented Milk
H. H. Wu	Current Situation of Taiwan's Deer Industry and Countermeasures for CPTPP
C. C. Hsieh	Health-Care Functions and Future Research and Development of Formosan Sambar Velvet Antler

Training classes of The Farmer's Academy

Program	No. of Trainee	Duration
2022		
Reproductive physiology and artificial insemination of dairy cattle (advanced)	10	5 days
Introduction of livestock (One)	13	3 days
Introduction of livestock (Two)	13	3 days
Poultry industry introduces smart agriculture (advanced)	10	5 days
Management of deer (advanced)	9	3 days
Management and artificial insemination of beef cattle (advanced)	5	5 days
Goat management (advanced)	8	3 days
Management and artificial insemination of pig (advanced)	8	3 days
Forage species identification and feed management (advanced)	35	3 days
Animal products processing (advanced)	15	5 days
Biosafety and management of poultry (advanced)	23	5 days
Professional manager of dairy cattle (advanced)	13	5 days
2023		
Management and artificial insemination of dairy cattle (advanced)	14	5 days
Management and artificial insemination of pig (advanced)	12	5 days
Biosafety and management of poultry (advanced)	26	5 days
Introduction of livestock	32	12hr
Introduction of livestock	27	12hr
Professional manager of pig (advanced)	18	5 days
Forage species identification and feed management (advanced)	38	3 days
Management and artificial insemination of goat (advanced)	12	3 days
Goat milk product processing (advanced)	13	3 days
Professional manager of dairy cattle (advanced)	14	5 days

**Taiwan Livestock Research Institute
Ministry of Agriculture
Biennial Report 2022 - 2023**

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