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# LITERATURE CITED

- ABDELLATIF, M.A. & HORST, P. 1994.** Prediction equations for growth performance of Dahlem Red breeding types of chickens raised under high altitude conditions in the tropics. *Proc. 9<sup>th</sup> European Poultry Conference*, Glasgow, UK, p. 329.
- ADEGBOLA, A.A. 1988.** The structure and problems of the poultry industry in Africa. *Proc. XVIII World's Poultry Congress*, Nagoya, Japan.
- AHMAD, M.M., MATHER, F.B. & GLEAVES, E.W. 1974.** Effect of environmental temperature and dietary energy on dwarf and normal hens and normal roosters. *Poultry Sci.* 53, 927.
- AHVAR, F., PETERSEN, J., HORST, P. & THEIN, H. 1982.** Veränderungen der Eibeschaffenheit in der 1. Legeperiode unter dem Einfluß hoher Umwelttemperaturen. *Arch. fur Geflügelk.* 46, 1.
- de ANDRADE, A.N., ROGLER, J.C., FEATHERSTON, W.R. & ALLISTON, C.W. 1977.** Interrelationships between diet and elevated temperatures (cyclic and constant) on egg production and shell quality. *Poultry Sci.* 56, 1178.
- ANONYMOUS, 1970.** *Information release. Patterns of transit losses.* Livestock Conservation, Inc., Omaha, Neb. USA.
- AUSTIC, R.E. 1985.** Feeding poultry in hot and cold climates. In *Stress Physiology in Livestock*, Vol. III. Yousef, M.K. (Eds), Boca Raton, Florida, USA.
- BELL, A.E., MUIR, W.M., OLSON, D.W. & SEARCY, G.L. 1983.** Performance of dwarf and normal laying hens as influenced by protein level and cage density. *Poultry Sci.* 62, 2130.
- BELL, D.D. & ADAMS, C.J. 1992.** First and second cycle egg production characteristics in commercial table egg flocks. *Poult. Sci.* 71, 448.
- BLAKE, A.G., MATHER, F.B. & GLEAVES, E.W. 1984.** Dietary self-selection of laying hens inadequate to overcome the effects of high environmental temperature. *Poultry Sci.* 63, 1984.
- BLIGH, J. 1985.** Temperature regulation. In *Stress Physiology in Livestock*, Vol. I. Yousef, M.K. (Eds.), Boca Raton, Florida, USA.
- BORDAS, A. & MÉRAT, P. 1992.** Performances de ponte de poules de genotypes NaNa (cou nu homozygote), Nana<sup>+</sup> (cou nu heterozygote) et nana<sup>+</sup> (plumage normal) d'une lignee naine (dw) de type «oeuf brun» soumises a une chaleur constant ou avec des fluctuations. *Arch. fur Geflügelk.* 56, 22.

- BORNSTEIN, S., PLAVNIK, I. & LEV, Y. 1984.** Body weight and/or fatness as potential determinants of the onset of egg production in broiler breeder hens. *Br. Poult. Sci.* 25, 323.
- BOSEN, J.F. 1959.** Discomfort index. Reference Data Section. Air conditioning, heating and ventilation. American Society of Heating and Ventilation Engineers. Atlanta.
- BRAKE, J. 1993.** Recent advances in induced moulting. *Poult. Sci.* 72, 929.
- BRODY, T.B., SIEGEL, P.B. & CHERRY, J.A. 1984.** Age, body weight and body composition requirements for the onset of sexual maturity of dwarf and normal chickens. *Br. Poult. Sci.* 25, 245.
- CAHANER, A., DEEB, N. & GUTMAN, M. 1993.** Effects of the plumage reducing naked neck (Na) gene on the performance of fast growing broilers at normal and high ambient temperatures. *Poultry Sci.* 72, 767.
- CALDERON, V.M. & JENSEN, L.S. 1990.** The requirement for sulfur amino acid by laying hens as influenced by the protein concentration. *Poultry Sci.* 69, 934.
- CHERRY, J.A., GHITELMAN, M.Z. & SIEGEL, P.B. 1978.** The relationship between diet and dwarfism in diverse genetic backgrounds on egg parameters. *Poultry Sci.* 57, 171.
- CHRISTMAS, R.B., DOUGLAS, C.R., KALCH, L.W. & HARMS, R.H. 1979.** The effect of season of maturity of the laying hen on subsequent egg size at periodic intervals in the laying cycle. *Poult. Sci.* 58, 848.
- COWAN, P.J. & MICHIE, W. 1983.** Raised environmental temperature and food rationing as means of restricting growth of the replacement pullet. *Br. Poult. Sci.* 24, 11.
- CUMMING, R.B. 1992.** Village chicken production: problems and potential. *ACIAR Proceedings* 39, 21.
- DAGHIR, N.J. 1995.** Present status and future of the poultry industry in hot regions. Ch. 1 in *Poultry Production in Hot Climates*. N.J. Naghir (Eds.). CAB International, UK.
- DAVID, R.H., HASSAN, O.E.M. & SYKES, A.H. 1972.** The adaptation of energy utilization in the laying hen to warm and cool environment temperatures. *J. Agric. Sci.* 79, 363.
- DINAP, 1994.** Estudo do sub-sector pecuário em Moçambique. Ministério da Agricultura, Maputo.
- DINAP, 1998.** Relatório anual 1996-1997. Ministério da Agricultura e Pescas, Maputo.

- DUNN, I.C. & SHARP, P.J. 1990.** Photoperiodic requirements for LH release in juvenile broiler and egg-laying strains of domestic chickens fed ad libitum or restricted diets. *J. Rep. Fertil.* 90, 329.
- DUNN, I.C. & SHARP, P.J. 1992.** The effect of photoperiodic history on egg laying in dwarf broiler hens. *Poultry Sci.* 71, 2090.
- DUNNINGTON, E.A. & SIEGEL, P.B. 1984.** Age and body weight at sexual maturity in female White Leghorn chickens. *Poultry Sci.* 63, 828.
- DUNNINGTON, E.A., SIEGEL, P.B., CHERRY, J.A. & SOLLER, M. 1983.** Relationship of age and body weight at sexual maturity in selected lines of chickens. *Arch. Geflügelk.* 47, 87.
- EBERHART, D.E & WASHBURN, K.W. 1993.** Assessing the effects of the naked neck gene on chronic heat stress resistance in two genetic populations. *Poultry Sci.* 72, 1391.
- EMERY, D.A., VOHRA, P. & ERNST, R.A. 1984.** The effect of cyclic and constant ambient temperatures on feed consumption, egg production, egg weight, and shell thickness of hens. *Poultry Sci.* 63, 2027.
- ERNST, R.A. 1995.** Housing for improved performance in hot climates. Ch. 4 in *Poultry production in hot climates*. N.J. Dagher (Eds.). CAB International, UK.
- ETCHES, R.J., JOHN, T.M. & VERRINDER GIBBINS, A.M. 1995.** Behavioural, physiological, neuroendocrine and molecular responses to heat stress. Ch. 3 in *Poultry Production in hot climates*. N.J. Dagher (Eds.), CAB International, UK.
- FAO 1990.** *Production Yearbook*. Vol. 44, Rome, Italy.
- FORSSIDO, T. & JAAP, R.G. 1975.** Research note: An attempt to force molt small egg-type pullets. *Poultry Sci.* 54, 304.
- FRENCH, H.L. & NORDSKOG, A.W. 1973.** Performance of dwarf chickens compared with normal small-bodied chickens. *Poultry Sci.* 50, 1194.
- GLASS, A.R., HARRISON, R. & SWERDLOFF, R.S. 1976.** Effect of undernutrition and amino acid deficiency in the timing of puberty in rats. *Pediatric Research* 10, 951.
- GOWE, R.S. & FAIRFULL, R.W. 1995.** Breeding for resistance to heat stress. Ch. 2 in: *Poultry Production in Hot Climates*. N.J. Dagher (Eds.). CAB International, UK.

- GRIZZLE, J., IHEANACHO, M., SAXTON, A. & BROADEN, J. 1992.** Nutritional and environmental factors involved in egg shell quality of laying hens. *Br. Poult. Sci.* 33, 781.
- GROSSMAN, M. & KOOPS, W.J. 1988.** Multiphasic analysis of growth curves in chickens. *Poultry Sci.* 67, 33.
- GUILLAUME, J. 1976.** The dwarfing gene dw: its effect on anatomy, physiology, nutrition, management. Its application in poultry industry. *World's Poult. Sci. J.* 32, 285.
- HAAREN-KISO, A. 1991.** Bedeutung des Gens für Lockenfiedrigkeit (F) unter besonderer Berücksichtigung der Kombination mit anderen Majorgenen für das produktive Adaptationsvermögen von Legehennen an hohe Umgebungstemperaturen. Ph.D Thesis. Institute for Animal Production. Technical (Umboldt) University of Berlin.
- HAAREN-KISO, A.V., HORST, P. & VALLE ZARATE, A. 1988.** The effect of the Frizzle gene (F) for the productive adaptability of laying hens under warm and temperate environmental conditions. *Proc. 18<sup>th</sup> World's Poultry Congress*, Nagoya, Japan, 386.
- HAAREN-KISO, A.V., HORST, P. & VALLE ZARATE, A. 1992.** Genetic and economic relevance of the autosomal incompletely dominant Frizzle gene (F). *Proc. 19<sup>th</sup> World's Poultry Congress*, Amsterdam, the Netherlands, Vol. 2, 66.
- HAAREN-KISO, A.V., HORST, P. & VALLE ZARATE, A. 1994.** Direct and indirect effects of the frizzle gene (F) for the productive adaptability of layers. *Arch. Geflügelk.* 58, 248.
- HAHN, G.L. 1985.** Management and housing of farm animals in hot environments. Ch. 2 in *Stress Physiology in Livestock* Vol. II. Yousef, M.K. (Ed.). Boca Raton, Florida, USA.
- HANCOCK, C.E., BRADFORD, G.D., EMMANS, G.C. & GOUS, R.M. 1995.** The evaluation of the growth parameters of six strains of commercial broiler chickens. *Br. Poult. Sci.* 36, 247.
- HARMS, R.H. & RUSSELL, G.B. 1995.** Re-evaluation of the methionine and protein requirements of the broiler breeder hen. *Poultry Sci.* 74, 1349.
- HERREMANS, M. 1988.** Age and strain differences in plumage renewal during natural and induced moulting in hybrid hens. *Br. Poult. Sci.* 29, 825.
- HORST, P. 1981.** Breeding perspectives for fowls with improved adaptability to tropics. *Proc. IV International SABRAO Congress*, Malaysia.



- HORST, P. 1988.** Native fowl as reservoir for genomes and major genes with direct and indirect effects on production adaptability. *Proc. 18<sup>th</sup> World Poultry Congress*, Nagoya, Japan, p. 105.
- HORST, P. 1989.** Native fowl as reservoir for genomes and major genes with direct and indirect effects on the adaptability and their potential for tropically oriented breeding plans. *Arch. fur Geflugelk.* 53, 93.
- HORST, P. 1998.** Breeding possibilities in hot climates with special reference to developing countries. *Proc. European Poultry Conference*, Jerusalem, Israel.
- HORST, P. & PETERSEN, J. 1975.** Untersuchung zur Auswirkung hoher Umwelttemperaturen auf die Leistungsreaktion von Legehennen unterschiedlichen Körpergewichtes. *Arch. Geflügelk.* 6, 225.
- HORST, P. & PETERSEN, J. 1979.** Der Effekt des dwarf-genes auf das Akklimatisationsvermögen von Legehennen an hohe Umwelttemperaturen. *Arch. fur Geflügelkunde* 43, 242.
- HORST, P. & PETERSEN, J. 1981.** The effect of the dwarf gene on the adaptability of laying hens to high environmental temperatures. *Animal Research and Development* Vol. 13, 69.
- HORST, P. & BECKER, C. 1991.** Relationship between body development and laying productivity in fowls under permanent high and temperate environmental temperatures. . *Arch. Geflügelk.* 55, 25.
- HORST, P. & MATHUR, P.K. 1994.** Feathering and adaptation to tropical climates. *Proc. 9<sup>th</sup> European Poultry Conference*. Glasgow, U.K.
- HORST, P., MATHUR, P.K. & VALLE ZARATE, A. 1996.** Breeding policies for specific tropical environments using appropriate combinations of major genes. *Proc. 20<sup>th</sup> World's Poultry Congress*, New Delhi, 633.
- HUSSEIN, A.S. 1996.** Induced moulting procedures in laying fowl. *World's Poultry Sci. J.* 52, 175.
- KATANGOLE, J.B.D., OCHETIM, S. & HORST, P. 1990.** Effect of dwarf (dw-) and naked neck (Na-) genes on performance of layers under Zambian conditions. *Zambian J. Agric. Sci.* 1, 30.

- KESHAVARZ, K. 1998.** The effect of light regimen, floor space, and energy and protein level during the growing period on body weight and early egg size. *Poultry Sci.* 77, 1266.
- KITALYI, A.J. 1998.** Village chicken production systems in rural Africa. *FAO Animal Production and Health Paper No. 142.* Rome, Italy.
- KLING, L.J., HAWES, R.O., GERRY, R.W. & HALTEMAN, W.A. 1985.** Effects of early maturing of brown egg-type pullets, flock uniformity, layer protein level and cage design on egg production, egg size, and egg quality. *Poult. Sci.* 64, 1050.
- KOELKEBECK, K.W., PARSONS, C.M., LEEPER, R.W. & MOSHTAGHIAN, J. 1991.** Effect of protein and methionine levels in molt diets on postmolt performance of laying hens. *Poultry Sci.* 70, 2063.
- KOOPS, W.J. 1986.** Multiphasic growth curve analysis. *Growth* 50, 169.
- KWAKKEL, R. P., ESCH, J.A.W., DUCRO, B.J. & KOOPS, W.J. 1995.** Onset of lay related to multiphasic growth and body composition in White Leghorn pullets provided *ad libitum* and restricted diets. *Poultry Sci.* 74, 821.
- KWAKKEL, R.P. 1994.** Multiphasic growth in the layer pullet. *Ph.D. Thesis.* Wageningen University, The Netherlands.
- KWAKKEL, R.P., de KONING F.L.S.M., VERSTEGEN, M.W.A., HOF, G. 1991.** Effect of method and phase of restriction during rearing on productive performance. *Br. Poultry Sci.* 32, 747.
- KWAKKEL, R.P., DUCRO, B.J., KOOPS, W.J. 1993.** Multiphasic analysis of growth of the body and its chemical components in White Leghorn pullets. *Poultry Sci.* 72, 1421.
- KYARISIIMA, C.C. & BALNAVE, D. 1996.** Influence of temperature during growth on responses of hens to high and low temperatures during lay. *Br. Poult. Sci.* 37, 553.
- LEE, P.J.W., GULLIVER, A.L. & MORRIS, T.R. 1971.** A quantitative analysis of the literature concerning the restricted feeding of growing pullets. *Br. Poult. Sci.* 12, 413.
- LEENSTRA, F. & CAHANER, A. 1991.** Genotype by environment interactions using fast growing lean or fat broiler chickens, originating from the Netherlands or Israel, raised at normal or low temperatures. *Poultry Sci.* 70, 2028.



- LEESON, S., CASTON, L. & SUMMERS, J.D. 1991. Significance of physiological age of Leghorn pullets in terms of subsequent reproductive characteristics and economic analysis. *Poultry Sci.* 70, 37.
- LEESON, S. & CASTON, L.J. 1996. Response of laying hens to diets varying in crude protein or available phosphorus. *J. Appl. Poultry Res.* 5, 289.
- LEWIS, P.D., PERRY, G.C. & MORRIS, T.R. 1996. Effect of 5 h increases in photoperiod and in feeding opportunity on age at 1<sup>st</sup> egg. *Br. Poult. Sci.* 37, 15.
- LEWIS, P.D., PERRY, G.C., MORRIS, T.R., DOUTHWAITE, J.A. & BENTLEY, G.E. 1998. Effect of constant and changing photoperiod on plasma LH and FSH concentrations and age at first egg in layer strains of domestic pullets. *Br. Poult. Sci.* 39, 662.
- LEWIS, PD. & PERRY, G.C. 1996. Sexual maturation in the laying hen: interacting influences of light and nutrition. *The Veterinary Annual* 36, 431.
- LILLIE, R.J. & DENTON, C.A. 1967. Evaluation of dietary protein levels for White Leghorns in the grower and subsequent layer periods. *Poultry Sci.* 46, 1550.
- LILLPERS, K. & WILHELMSON, M. 1993. Age-dependent changes in oviposition pattern and egg production traits in the domestic hen. *Poultry Sci.* 72, 2005.
- LUITING, P. 1990. Genetic variation of energy partitioning in laying hens: causes of variation in residual feed consumption. *World's Poultry Sci. J.* 46, 133.
- MAHMOUD, K.Z., BECK, M.M., SCHEIDELER, S.E., FORMAN, M.F., ANDERSON, K.P. & KACHMAN, S.D. 1996. Acute high environmental temperature and calcium-estrogen relationship in the hen. *Poultry Sci.* 75, 1555.
- MARDER, J. & ARAD, Z. 1989. Panting and acid basic regulation in heat stressed birds. *Comparative Biochemistry and Physiology A* 94, 395.
- MARSDEN, A. & MORRIS, T. 1987. Quantitative review of the effects of environmental temperature on food intake, egg output and energy balance in laying pullets. *Br. Poult. Sci.* 28, 693.
- MARSDEN, A., MORRIS, T.R. & CROMATRY, A.S. 1987. Effects of constant environmental temperatures on the performance of laying pullets. *Br. Poult. Sci.* 28, 361.
- MATHUR, P.K. & HORST, P. 1989. Temperature stress and tropical location as factors for genotype x environment interactions. In: Genotype x environment interactions





in poultry production, *Les Coloques de l'INRA No. 50*, Philippe Merat (Ed.), Jouy-en-Josas, France.

**MATHUR, P.K. & HORST, P. 1992.** Improving the productivity of layers in the tropics through additive and non additive effects of major genes. *Proc. XIX World's Poultry Congress*, Amsterdam, The Netherlands.

**MAY, J.D. & LOTT, B.D. 1992.** Feed consumption patterns of broilers at high environmental temperatures. *Poultry Sci.* 71, 331.

**McCORMICK, C.C., GARLICH, J.D. & EDENS, F.W. 1979.** Fasting and diet effect on the tolerance of young chickens exposed to acute heat stress. *J. Nutrition* 109, 1797.

**MÉRAT, P. 1984.** The sex-linked dwarf gene in the broiler chicken industry. *World's Poult. Sci. J.* 40, 10.

**MÉRAT, P. 1986.** Potential usefulness of the Na (naked neck) gene in poultry production. *World's Poult. Sci. J.* 42, 124.

**MÉRAT, P. 1990.** Pleiotropic and associated effects of major genes. Ch 20 in: *Poultry Breeding and Genetics*. R.D. Crawford (Eds.). Elsevier, The Netherlands.

**MÉRAT, P., BORDAS, A. & BOICHARD, M. 1988.** Effect of ahemeral light cycles on laying performance of sex-linked dwarf hens. *Proc. 18<sup>th</sup> World's Poultry Congress*. Nagoya, Japan.

**MÉRAT, P. & BORDAS, A., 1991.** Caractéristiques de ponte comparées pour des poules naines (dw) et de taille normale (Dw+) dans une lignée Leghorn Blanche et dans un croisement de 1<sup>er</sup>. Génération Leghorn x Fayoumi. *Genet. Sel. Evol.* 23, 455.

**MÉRAT, P., MINVIELLE, F., BORDAS, A. & COQUERELLE, G. 1994.** Heterosis in normal and dwarf laying hens. *Poult. Sci.* 73, 1.

**MORRIS, T.R. 1967.** Light requirements of the fowl. Ch. 3 In *Environmental control in poultry production*. T.C. Carter (Eds.), Oliver & Boyd, Edinburgh, UK.

**MORRIS, T.R. & GOUS, R.M. 1988.** Partitioning of the response between egg number and egg weight. *Br. Poult. Sci.* 29, 93.

**MUKHERJEE, T.K., PANANDAM, J.M. & HORST, P. 1986.** Effect of the sex-linked dwarf (*dw*) and naked neck (*Na*) genes on quantitative traits. *Malays. Appl. Biol.* 15, 65.

**NJOYA, J. 1995.** Effect of diet and natural variations in climates on the performance of laying hens. *Br. Poult. Sci.* 36, 537.



- NJOYA, J. & PICARD, M. 1994.** Climatic adaptation of laying hens. *Trop. Anim. Hlth. Prod.* 26, 180.
- NORTH, M.O. & BELL, D.D. 1990.** Structure of the chicken. Ch. 2 in *Commercial chicken production manual*, 4<sup>th</sup> ed. Chapman & Hall, New York, USA.
- PAYNE, C.G. 1966.** Practical aspects of environmental temperature for laying hens. *World's Poult. Sci. J.* 22, 126.
- PECH-WAFFENSCHMIDT, V. 1992.** The effect of heat stress conditions on performance, physiology, and blood chemistry of laying hens of different feathering types, and nutritional considerations to improve the heat resistance. Dissertation, Technische Universitat Berlin, Germany.
- PECH-WAFFENSCHMIDT, V., BOGIN, E., AVIDAR, Y. & HORST, P. 1995.** Metabolic and biochemical changes during heat stress in relation to the feathering degree of the domestic hen. *Avian Pathology* 24, 33.
- PEGURI, A. & COON, C. 1991.** Effect of temperature and dietary energy on layer performance. *Poult. Sci.* 70, 126.
- PESTI, G.M., LECLERCQ, B. & COCHARD, T. 1994.** Lack of effect of the naked neck on the protein requirements of broilers. *Poultry Sci.* 73, 73 (Suppl.)
- PESTI, G.M., LECLERCQ, B., CHAGNEAU, A.-M., COCHARD, T. 1996.** Effects of the Naked neck (Na) gene on the sulfur-containing amino acid requirements of broilers. *Poultry Sci.* 75, 375.
- PROUDFOOT, F.G. & GOWE, R.S. 1974.** The influence of an increasing photoperiod, a modified natural daylength and feed restriction during the rearing period on the performance of five S.C.W.L. genotypes. *Poultry Sci.* 53, 518.
- PROUDFOOT, F.G., HULAN, H.W. & McRAE, K.B. 1984.** Effect of photoperiod, light intensity and feed restriction on the performance of dwarf and normal maternal poultry meat genotypes. *Can. J. Anim. Sci.* 64, 759.
- RAUEN, H.W., HORST, P. & VALLE-ZARATE, A. 1986.** Effect of the gene for feathering reduction and naked neck (Na) on the productive adaptability of laying hens under permanent high temperature. *Arch. Geflügelk.* 50, 235.
- REID, B.L. & WEBER, C.W. 1973.** Dietary protein and sulfur amino acid levels for laying hens during heat stress. *Poultry Sci.* 52, 1343.



- RENDEN, J.A. & McDANIEL, G.R., 1984. Egg characteristics and production efficiency of dwarf (*dw*) White Leghorn hens divergently selected for body weight. *Poultry Sci.* 63, 214.
- RICARD, F.H. 1976. Bases scientifiques de l'utilisation du gène de nanisme *dw* dans la production du poulet de chair. *Proc. 5<sup>th</sup> European Poultry Conference*. Malta, p.263.
- RICHARDS, S.A. 1976. Evaporative water loss in domestic fowls and its partition in relation to ambient temperature. *J. Agric. Sci.* 87, 527.
- RICKLEFS, R.E. 1975. Patterns of growth in birds. III. Growth and development of the Cactus Wren. *Condor* 77, 34.
- RICKLEFS, R.E. 1985. Modification of growth and development of muscles in poultry. *Poultry Sci.* 64, 1563.
- ROBINSON, F.E. & ROBINSON, N.A. 1991. Reproductive performance, growth rate and body composition of broiler breeder hens differing in body weight at 21 weeks of age. *Can. J. Anim. Sci.* 71, 1233.
- ROBINSON, F.E., ROBINSON, N.A. & HARDIN, R.T. 1995. The effect of 20-week body weight and feed allocation during early lay on female broiler breeders. *J. Appl. Poultry Res.* 4, 203.
- ROBINSON, F.E., WAUTIER, T.A., HARDIN, R.T., WILSON, J.L., NEWCOMBE, M. & McKAY, R.I. 1996. Effects of age at photostimulation on reproductive efficiency and carcass characteristics. 2. Egg-type hens. *Can. J. Anim. Sci.* 76, 283.
- ROLAND, D.A., SR., BRYANT, M.M. & RABON, H.W. 1996. Influence of calcium and environmental temperature on performance of first-cycle (Phase 1) commercial Leghorns. *Poultry Sci.* 75, 62.
- SAS<sup>®</sup> User's Guide: Statistics. 1994. SAS Institute, Inc. Raleigh, North Carolina, USA.
- SCANES, C.G. 1986. Pituitary gland. Ch. 17 in *Avian Physiology*, 4<sup>th</sup> ed. P.D. Sturkie (Eds.). Springer-Verlag, New York.
- SCANES, C.G., SHARP, P.J., HARVEY, S. GODDEN, P.M.M., CHADWICK, A. & NEWCOMER, W.S. 1979. Variations in plasma prolactin, thyroid hormone, gonadal steroids and growth hormone in turkeys during the induction of egg laying and moult by different photoperiods. *Br. Poult. Sci.* 20, 143.



- SCHUTTE, J.B., VAN WEERDEN, E.J. & BERTRAM, H.L. 1983.** Sulphur amino acid requirement of laying hens and the effects of excess dietary methionine on laying performance. *Br. Poult. Sci.* 24, 319.
- SCHUTTE, J.B., DE JONG, J. & BERTRAM, H.L. 1994.** Requirement of the laying hen for sulfur amino acids. *Poultry Sci.* 73, 274.
- SCOTT, T.A & BALNAVE, D. 1991.** Influence of temperature, dietary energy, nutrient concentration and self-selection feeding on the retention of dietary energy, protein and calcium by sexually-maturing egg-laying pullets. *Br. Poult. Sci.* 32, 1005.
- SMITH, A.J. 1973.** Some effects of high environmental temperatures on the productivity of laying hens (a review). *Trop. Anim. Hlth Prod.* 5, 259.
- SMITH, A.J. & OLIVER, J. 1972a.** Some nutritional problems associated with egg production at high environmental temperatures. 1. The effect of environmental temperature and rationing treatments on the productivity of pullets fed on diets of different energy content. *Rhodesian J. Agric. Res.* 10, 3.
- SMITH, A.J. & OLIVER, J. 1972b.** Some nutritional problems associated with egg production at high environmental temperatures. 4. Effect of prolonged exposure to high environmental temperatures on the productivity of pullets fed on high energy diets. *Rhodesian J. Agric. Res.* 10, 43.
- SMITH, M.O. & TEETER, R.G. 1993.** Effects of feed intake and environmental temperature on chick growth and development. *J. Agric. Sci.* 121, 421.
- SOMES, R.G. Jr. 1990.** Mutations and major variants of plumage and skin in chicken. Ch. 6 in: *Poultry Breeding and Genetics*. R.D. Crawford (Eds). Elsevier, The Netherlands.
- STOCKLAND, W.L. & BLAYLOCK, L.G. 1974.** The influence of temperature on the protein requirements of caged replacement pullets. *Poult. Sci.* 53, 1174.
- SUMMERS, J.D., LEESON, S. & SPRATT, D. 1987.** Rearing early maturing pullets. *Poultry Sci.* 66, 1750.
- THAYER, R.H., HUBBELL, G.E., KASBOHM, J.A., MORRISON, R.D. & NELSON, E.C. 1974.** Daily protein intake requirements of laying hens. *Poultry Sci.* 53, 354.

- TOUCHBURN, S.P., GUILLAUME, J. LECLERCQ, B. & BLUM, J.C. 1980.** Lipid and energy metabolism in chicks affected by dwarfism (dw) and naked neck (Na). *Poultry Sci.* 59, 2189.
- VAN ES, A.J.H. 1989.** Energy costs of protein deposition. Ch. 4 in *Protein deposition in animals*. P.J. Buttery & D.B. Lindsay (Eds.). Butterworths, London, U.K.
- WEATHERUP, S.T.C. & FOSTER, W.H. 1980.** A description of the curve relating egg weight and age of hen. *Br. Poult. Sci.* 21, 511.
- WENTWORTH, B.C. & RINGER, R.K. 1986.** Thyroids. Ch. 20 in *Avian Physiology*, 4<sup>th</sup> ed. P.D. Sturkie (Eds.). Springer-Verlag, New York.
- WHITTOW, G.C. 1986.** Regulation of body temperature. Ch. 9 in *Avian Physiology*, 4<sup>th</sup> ed., P.D. Sturkie (Eds.), Springer-Verlag, New York.
- YAHAV, S., GOLDFELD, S., PLAVNIK, I. & HURWITZ, S. 1995.** Physiological responses of chickens and turkeys to relative humidity during exposure to high ambient temperature. *J. Therm. Biol.* 20, 245.
- YAHAV, S., STRASCHNOW, A., PLAVNIK, I. & HURWITZ, 1996.** Effects of diurnally cycling versus constant temperatures on chicken growth and food intake. *Br. Poult. Sci.* 37, 43.
- YAHAV, S., LUGER, D., CAHANER, A., DOTAN, M., RUSAL, M. & HURWITZ, S. 1998.** Thermoregulation in naked neck chickens subjected to different ambient temperatures. *Br. Poult. Sci.* 39, 133.
- YAKANNOPOULOS, A.L., TSERVENI-GOUSHI, A.S. & NIKOKYRIS, P. 1994.** Egg composition as influenced by time of oviposition, egg weight, and age of hens. *Arch. Geflügelk.* 58, 206.
- YOUSEF, M.K. 1985.** Stress physiology: definition and terminology. Ch. 1 in *Stress Physiology in Livestock*, Vol. I. Yousef, M.K. (Eds), Boca Raton, Florida, USA.
- ZELENKA, D.J., SIEGEL, P.B., DUNNINGTON, E.A. & CHERRY, J.A. 1986.** Growth to sexual maturity of dwarf and non-dwarf White Rock chickens divergently selected for juvenile body weight. *Theor. Appl. Genet.* 73, 61.



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# ANNEXES

### Annex 1

Monthly average room temperatures and relative humidity during the study

Phase	Month/Year	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	Max.	Min.
<u>1996</u>					
G1	February	32.0	23.4	80.0	65.8
	March	31.0	21.9	80.9	64.4
	April	29.8	19.1	82.0	57.6
	May	27.5	15.2	80.5	57.5
	June	25.0	13.2	87.4	56.4
LC I-1 & G2	July	24.3	13.0	83.9	57.4
	August	25.3	14.8	82.4	58.1
	September	30.1	18.7	78.2	63.7
	October	31.1	20.1	71.5	59.8
	November	32.6	21.9	72.7	56.2
	December	33.4	23.4	79.7	63.8
	<u>1997</u>				
LC I-1 & LC I-2	January	32.2	24.0	81.9	65.0
	February	31.7	23.2	80.3	66.1
	March	31.7	22.8	81.7	65.2
	April	30.1	19.0	79.9	55.5
	May	27.1	16.1	81.0	60.0
	June	27.6	13.5	80.5	56.5
LC I-2 & LC II-1	July	25.3	14.6	85.7	59.4
	August	27.9	16.1	84.7	55.8
	September	28.4	18.9	83.9	63.8
	October	28.7	18.6	78.7	66.7
	November	30.5	21.1	79.4	67.6
	December	32.1	22.5	78.8	61.3
<u>1998</u>					
LC II-2	January	32.8	23.5	81.5	64.9
	February	32.4	23.7	80.9	65.9
	March	33.3	22.9	81.5	63.0
	April	31.7	21.2	86.4	63.5
	May	28.4	17.8	79.4	57.1

**Annex 2**

Comparative partial financial analysis of the genetic groups averaged over experiments (LC I)

**Scenario 1 - Eggs not graded**

	<i>Dw-</i>				<i>dw-</i>			
	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>
<b>A. GROSS INCOME</b>								
Eggs produced per hen	294	302	296	300	240	240	235	234
Egg loss, %	1,4	1,4	2,9	1,8	1,1	1,2	1,6	1,2
Eggs sold per hen	290	298	288	295	237	237	231	231
Gross income per hen	314.412	322.924	311.560	319.176	257.077	256.765	250.784	250.596
<b>B. ALLOCATED COSTS</b>								
Feed cost per hen	196.236	199.525	197.892	205.459	138.966	142.324	140.300	145.337
Net cost of hen	45.000	45.000	45.000	45.000	40.000	40.000	40.000	40.000
<b>C. GROSS MARGIN</b>								
Margin over feed cost per hen	118.176	123.399	113.668	113.717	118.111	114.441	110.484	105.259
Gross margin per hen	73.176	78.399	68.668	68.717	78.111	74.441	70.484	65.259
Mortality, %	11,1	12,3	6,5	12,7	5,4	5,8	8,5	4,0
Gross margin per hen housed	64.484	68.419	64.036	59.886	74.034	70.177	64.065	62.455
<b>D. GROSS MARGIN PER AREA</b>								
No. of birds per area	1,0	1,0	1,0	1,0	1,3	1,3	1,3	1,3
Gross margin per hen area	73.176	78.399	68.668	68.717	101.544	96.774	91.629	84.837
Gross margin per hen housed area	64.484	68.419	64.036	59.886	96.245	91.230	83.285	81.192



**Annex 3**

Comparative partial financial analysis of the genetic groups averaged over experiments (LC I)

**Scenario 2 - With extra benefits for feathering type**

	<i>Dw-</i>				<i>dw-</i>			
	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>
<b>A. GROSS INCOME</b>								
Eggs produced per hen	294	302	296	300	240	240	235	234
Egg loss, %	1,4	1,4	2,9	1,8	1,1	1,2	1,6	1,2
Eggs sold per hen	290	298	288	295	237	237	231	231
Gross income per hen	314.412	322.924	311.560	319.176	257.077	256.765	250.784	250.596
<b>B. ALLOCATED COSTS</b>								
Feed cost per hen	196.236	199.525	197.892	205.459	138.966	142.324	140.300	145.337
Price factor for feather coverage	1,0	1,1	1,2	1,1	1,0	1,1	1,2	1,1
Net cost of hen	45.000	42.000	39.000	42.000	40.000	37.000	34.000	37.000
<b>C. GROSS MARGIN</b>								
Margin over feed cost per hen	118.176	123.399	113.668	113.717	118.111	114.441	110.484	105.259
Gross margin per hen	73.176	81.399	74.668	71.717	78.111	77.441	76.484	68.259
Mortality, %	11,1	12,3	6,5	12,7	5,4	5,8	8,5	4,0
Gross margin per hen housed	65.090	71.387	69.852	62.644	73.932	72.989	70.021	65.529
<b>D. GROSS MARGIN PER AREA</b>								
No. of birds per area	1,0	1,0	1,0	1,0	1,3	1,3	1,3	1,3
Gross margin per hen area	73.176	81.399	74.668	71.717	101.544	100.674	99.429	88.737
Gross margin per hen housed area	65.090	71.387	69.852	62.644	96.112	94.885	91.027	85.187

**Annex 4**

Comparative partial financial analysis of the genetic groups averaged over experiments (LC I)

**Scenario 3 - Eggs graded**

	<i>Dw-</i>				<i>dw-</i>			
	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>
<b>A. GROSS INCOME</b>								
Eggs produced per hen	294	312	307	307	240	240	235	234
Egg loss, %	1,4	1,4	2,9	1,8	1,1	1,2	1,6	1,2
Eggs sold per hen	290	307	298	302	237	237	231	231
Gross income per hen	342.800	354.563	340.678	350.127	261.057	261.803	258.536	257.766
<b>B. ALLOCATED COSTS</b>								
Feed cost per hen	196.236	199.525	197.892	205.459	138.966	142.324	140.300	145.337
Net cost of hen	45.000	45.000	45.000	45.000	40.000	40.000	40.000	40.000
<b>C. GROSS MARGIN</b>								
Margin over feed cost per hen	146.564	155.038	142.786	144.668	122.091	119.479	118.236	112.429
Gross margin per hen	101.564	110.038	97.786	99.668	82.091	79.479	78.236	72.429
Mortality, %	11,1	12,3	6,5	12,7	5,4	5,8	8,5	4,0
Gross margin per hen housed	90.341	96.503	91.478	87.060	77.699	74.908	71.625	69.531
<b>D. GROSS MARGIN PER AREA</b>								
No. of birds per area	1,0	1,0	1,0	1,0	1,3	1,3	1,3	1,3
Gross margin per hen present area	101.564	110.038	97.786	99.668	106.718	103.322	101.707	94.157
Gross margin per hen housed area	90.341	96.503	91.478	87.060	101.009	97.381	93.113	90.391

### Annex 5

Comparative partial financial analysis of the genetic groups averaged over experiments (LC II)

#### Scenario 1 - Eggs not graded

	<i>Dw-</i>				<i>dw-</i>			
	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>
<b>A. GROSS INCOME</b>								
Eggs produced per hen	124	131	123	117	96	97	95	92
Egg loss, %	6,1	5,9	5,7	8,4	6,3	7,2	9,1	5,5
Eggs sold per hen	117	123	116	107	90	90	87	87
Gross income per hen	126.427	133.556	125.928	116.140	97.032	97.504	93.953	94.559
<b>B. ALLOCATED COSTS</b>								
Feed cost per hen	91.954	95.128	96.600	98.394	66.079	66.976	68.126	70.863
<b>C. GROSS MARGIN</b>								
Gross margin per hen	34.473	38.428	29.328	17.746	30.953	30.528	25.827	23.696
Mortality, %	4,9	2,9	8,1	10,3	9,0	6,1	10,2	6,5
Gross margin per hen housed	32.784	37.299	26.952	15.926	28.182	28.660	23.206	22.156
<b>D. GROSS MARGIN PER AREA</b>								
No. of birds per area	1,0	1,0	1,0	1,0	1,5	1,5	1,5	1,5
Gross margin per hen area	34.473	38.428	29.328	17.746	46.429	45.792	38.741	35.545
Gross margin per hen housed area	32.784	37.299	26.952	15.926	42.274	42.989	34.808	33.234

**Annex 6**

Comparative partial financial analysis of the genetic groups averaged over experiments (LC II)

**Scenario 3 - Eggs graded**

	<i>Dw-</i>				<i>dw-</i>			
	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>	<i>nana ff</i>	<i>Nana ff</i>	<i>nana Ff</i>	<i>Nana Ff</i>
<b>A. GROSS INCOME</b>								
Eggs produced per hen	124	131	123	117	96	97	95	92
Egg loss, %	6,1	5,9	5,7	8,4	6,3	7,2	9,1	5,5
Eggs sold per hen	117	123	116	107	90	90	87	87
Gross income per hen	143.028	151.276	142.478	131.711	105.708	105.751	102.115	103.423
<b>B. ALLOCATED COSTS</b>								
Feed cost per hen	91.954	95.128	96.600	98.394	66.079	66.976	68.126	70.863
<b>C. GROSS MARGIN</b>								
Gross margin per hen	51.074	56.148	45.878	33.317	39.629	38.775	33.989	32.560
Mortality, %	4,9	2,9	8,1	10,3	9,0	6,1	10,2	6,5
Gross margin per hen housed	48.571	54.497	42.161	29.900	36.082	36.402	30.539	30.444
<b>D. GROSS MARGIN PER AREA</b>								
No. of birds per area	1,0	1,0	1,0	1,0	1,5	1,5	1,5	1,5
Gross margin per hen area	51.074	56.148	45.878	33.317	59.443	58.162	50.983	48.840
Gross margin per hen housed area	48.571	54.497	42.161	29.900	54.123	54.602	45.808	45.665