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Evaluation of management practices and their effects on production parameters in swine farms in the tropic

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1 Introduction

Pig farms face losses in different production areas and such losses are mainly related to inadequate management practices and lack of knowledge about the use of technologies that do not require large investments, but rather orderly attention to the production process (Tucker et al., 2021). Assistance during farrowing decreases piglet mortality at birth, and therefore, improves litter sizes at birth (Kirkden et al., 2013). Ensuring colostrum ingestion in the first hours of life and a heat source (39 °C) are core strategies to promote the viability of piglets until weaning (Pandolfi et al., 2017; Koketsu et al., 2021). There are reports that litter size is associated with mortality before weaning and that the decrease in piglet mortality during the lactation stage from 18% to 8% increases farm productivity in terms of the weaned piglets, averaging 2.2 piglets (Koketsu et al., 2021). On the other hand, Alonso-Ríos et al (Alonso-Ríos et al., 2021). suggested that the use of pre-starters favors the adaptation of piglets from a liquid to solid diet and results in higher weaning weights with fewer digestive problems. Another factor that affects and is related to sow fertility is the length of lactation, which influences the return to estrus and ovulation (Pearodwong et al., 2019). Production in Guerrero is carried out in 72% backyard conditions and only 28% of the farms are semi-technical, demonstrating that it faces problems of low production, sustainability, profitability, and competitiveness, due to the low use of technology. The objective was to evaluate the effects of the adoption of nine management practices and technologies by pig farmers who received technical assistance and training for three consecutive years, on changes in the productive and reproductive parameters of the participating farms.

2 Methods used

The present study covered 3 years of technical assistance and training on pig farms in the communities of Rincón de la Cocina and Tierra colorada, in the Municipality of Tepecuacuilco de Trujano, Guerrero, Mexico. It is located in the Northern Region of the state of Guerrero, located at 18° 18' 00" N, 99° 29' 00" W". The predominant climate is subhumid-warm with temperatures ranging from 24.8°C to 31.5°C. The annual precipitation is 700 to 1,100 mm, and with an altitude of 849 m above sea level. We worked with 30 pig farmers organized in the "GGAVATT Rincon de la Cocina" and provided training and advice on the nine technologies for 3 years. The nine management practices and technologies are implementation of records (productive, reproductive, and economic), adequate management of the piglets, monitoring of the puerperium, balancing and preparation of diets by stage, use of pre-starters, implementation of artificial insemination (AI), vaccination schedules, deworming schedules, and selection of females for replacement. Their percentage of adoption was then determined.

For the purposes of this study, each technology or practice was previously defined and standardized based on technical manuals, official regulations, and scientific literature, in order to ensure uniformity in its implementation and evaluation among the production units (PUs) (Tucker et al., 2021). Adequate control required the systematic implementation of productive, reproductive, and economic records (Alves et al., 2022). Proper piglet management included practices at birth and during lactation (immediate drying and cleaning of the piglet, disinfection of the navel, consumption of colostrum in the first hours of life, brooder at 39°C, supply of iron dextran, tail and tusk cutting, castration, use of pre-starters, and weaning at 28 days) (Tucker et al., 2021). Adequate nutrition by production phase was defined as the formulation and supply of balanced diets by growth stage (pre-starter, lactation, weaning, growth, development, and finishing) according to the nutritional requirements of the species established by the National Research Council (NRC) National Research Council, (2012), considering crude protein, metabolizable energy, minerals and vitamins, as well as appropriate practices for the preparation, storage, and supply of feed. Postpartum monitoring included daily supervision of the sow's food and water intake, assessment of uterine involution, maintenance of hygiene in the maternity area, and application of preventive health measures during the first 24 h postpartum (Tummaruk et al., 2023). The selection of replacements was based on the recommendations of Flowers (2020). The implementation of artificial insemination (AI) was implemented when producers applied estrus detection protocols, observed the use of certified semen doses, hygienic handling of the material, timely insemination, and service records, with the objective of improving reproductive efficiency and avoiding health risks associated with natural mating (Compagnoni et al., 2019). Vaccination schedule was defined as the programmed application of preventive biologicals according to the animal productive stage, considering the mixed porcine bacterin (Pasteurellosis, Colibacillosis, and Salmonellosis in swine: MSD Animal Health; Reg. SAGARPA B-0273-133) and the Gesta-vac vaccine (Parvovirus, Leptospira, and Erysipelas; Reg. SAGARPA B-2083-004) (Alarcón et al., 2021; Arutkumaran et al., 2025). The deworming schemes consisted of the application of internal and external anthelmintics (Alarcón et al., 2021; Tummaruk et al., 2023). The technologies were related to changes in each pig farmer's productive and reproductive parameters. The parameters at the beginning and end of the assistance and training period were taken as a reference. With the information obtained, a database was generated in Excel (Microsoft Office, 2013) for subsequent analysis through descriptive statistics (measures of central tendency). The methodology used for technology transfer was that implemented by the "GGAVATT Rincón de la Cocina". The significance of the observed changes was compared with the Tukey statistical tests for quantitative variables and Chi square for qualitative variables; in both cases, an alpha of ≤0.05 was used.

3 Data reports

Nine management practices and technologies were implemented, grouped into six categories, of which 100% were transferred to the group, but each one was adopted in different proportions, as presented in Table 1. The results show that the pig farmers were unaware or had little knowledge of the technologies at the beginning of assistance and technical training, which in some way, is reflected in the low use of technological innovations. It is assumed that thanks to the transfer of technologies implemented by the GGAVATT Rincón de la Cocina, technical and productive results in the PUs were improved (Table 2).

Among the most adopted technologies, three stood out, and they were records (productive, reproductive, and economic) with 76.7%, use of deworming calendars (76.7%), and diet balancing and preparation by growth stages (56.7%). The use and evaluation of records should be mandatory in daily practice in order to make decisions about productive and reproductive management, since with their evaluation, we can determine the behavior of the pigs in

TABLE 1 Technologies transferred and adoption percentage by pig farmers.

Category	Transferred technology	Adoption percentage	
		Initial	Final
Administration	Records (productive, reproductive, and economic)	0.0%	76.7%
Management	Proper management of piglets	3.3%	46.7%
	Postpartum monitoring	0.0%	40.0%
Nutrition	Balancing and preparing diets in stages	0.0%	56.7%
	Use of pre-initiators	3.3%	43.3%
Reproduction	Artificial insemination in sows	0.0%	46.7%
Health	Use of vaccination schedules	0.0%	43.3%
	Use of deworming calendars	10.0%	76.7%
Genetics	Selection of replacement females	10.0%	26.7%

TABLE 2 Changes in production parameters in pig farms, as a result of technological adoption.

Indicator	Initial	Final	Test (p-value)
Fertility (%)	68	82	Chi square ($p < 0.014$)
Breastfeeding (days)	42	28	Tukey ($p < 0.0001$)
Piglet birth weight (kg)	1.12	1.41	Tukey ($p < 0.0001$)
Piglets weaned per litter (n°)	8.0	11.2	Tukey ($p < 0.0012$)
Piglet mortality (%)	18	6	Chi square ($p < 0.009$)
Interval between births (days)	186.6	154.2	Tukey ($p < 0.0001$)
Weight at first breeding (kg)	81.3	112.9	Tukey ($p < 0.0001$)
Daily weight gain (g)	450	650	Tukey ($p < 0.0001$)
Market weight (kg)	82.6	119.9	Tukey ($p < 0.0001$)
Age to market (day)	296.6	187.5	Tukey ($p < 0.0001$)
Fattening mortality (%)	10	5	Chi square ($p = 0.100$)
Cost benefit relation (USD)	1:1.1	1:1.28	–
Weaning–gestation (days)	30.4	11.8	Tukey ($p < 0.0001$)
Live born piglets/litter (n)	10.8	11.9	Tukey ($p = 0.1000$)
Piglet weight at weaning (kg)	5.8	7.4	Tukey ($p < 0.0001$)

the farm and detect productive problems and be able to solve them. The records should be simple and easy to fill out, tabulate, and interpret; provide only minimum but necessary information. The second technology was related to health (43.3% implemented a vaccination schedule and 76.6% deworming) and was of utmost importance, since it is recommended that PUs adopt biosafety measures to reduce the risks of spreading diseases between and within the herd, or, where appropriate, prevent it from spreading to different areas (García-Contreras et al., 2012). The improvement of swine health will only be effective if a comprehensive biosafety program is designed, planned, and put into practice, where vaccine prophylaxis is a key point but is not the only one. Vaccination, as the only measure to prevent, control, and eradicate diseases, does not comprehensively cover the diversity of health aspects that occur on the farm; however, it is part of a whole and is only a complementary measure to combat epidemics. The fight against diseases must be carried out in an integrated way, through several methods such as hygienic measures of cleaning and disinfection, vector control, animal management that improves well-being and avoids stress, personnel hygiene, control of visits, animal quarantine, isolation and protection of buildings, and sanitary vacuum.

In feeding, the balancing and preparation of diets by productive stages can result in a practice with great economic benefits for producers, if we consider that feeding represents approximately 65% of production costs (Gaillard et al., 2020). Therefore, priority was given to this technology where progress was achieved in 56.7% of the producers (Table 1). It is not enough for a diet to meet the nutritional needs of pigs; the formulation must follow official norms National Research Council, (2012). Likewise, the food must be easy to preserve and provide at different stages. Once the formulation is completed, the next step is to ensure that it is prepared under conditions that guarantee its safety, traceability, and low cost (García-Contreras et al., 2012).

The use of artificial insemination (AI) had an adoption rate of 46.7%, highlighting its main advantages: economic savings from not purchasing animals for direct mating, which in turn reduces the need for facilities, feed, labor, and drugs. In addition, AI facilitates the rapid dissemination of genetic progress through the use of sires of higher reproductive value and reduces the risks of transmitting infectious diseases through sexual contact (Compagnoni et al., 2019).

The technology or management practice that included the most steps to follow was the proper piglet handling, and this was adopted by 46.7% of the producers. The proper piglet management practices consisted of cleaning and drying at birth, cutting and disinfecting the navel at birth, and promoting suckling of piglets in the first hours of life. Tail cutting, fangs clipping, and the application of dextran iron on the third day also benefited the piglets. Environmental control practices (breeders that maintained the temperature at 39 °C) and facility hygiene prevented diarrhea and cases of hypothermic piglets. The castration of piglets on day 10, and weaning at 28 days, 5 days before the piglets were started with a solid diet (pre-starter: 22% crude protein and 3.1 Mcal of metabolizable energy), were practices adopted by 43.3% of the pig farmers. Producers who implemented practices related to piglet management observed decreased mortality and improved parameters in this stage of piglet growth (Table 2).

Forty percent of the producers carried out postpartum monitoring, which consisted of monitoring nutrition and feeding based on sow milk production, the number of piglets, and the positive or negative energy balance during lactation. They also monitored the microclimate for both sows and piglets, and managed uterine involution by supporting the sow with injectable prostaglandins and long-acting antibiotics during the first 24 h postpartum. Observing the following steps are important: Stimulate the consumption of feed, fiber, and water after the sow farrows. Maintain biosafety in the maternity ward. Monitor sow feed consumption, defecation, and urination daily. Keep the farrowing beds clean, eliminate sows with high parity, extreme thinness, and repetitive problems beyond the fifth farrowing. These practices improved fertility parameters and shortened the interval between farrowing, weaning–gestation (days) in the sows, and indirectly, also improved the weight and the number of births and the number of weaned piglets (Table 2) (Tummaruk et al., 2023). The adoption rate for the selection of replacement females increased from 10% to 26.7%. It has been shown that the age at first estrus (before 220 days), body weight upon entry into the PU at 139 kg, and a daily weight gain (DWG) of 600 g/day are significantly associated with the reproductive performance and longevity of reproductive or breeding females. As a result, delivery is achieved before 365 days of life, with a reduction in non-productive days. All these emphasize the importance of raising future breeders under a controlled diet and not as pigs destined for fattening.

With respect to the parameters as indicators of progress, all technologies had a beneficial impact (Table 2): fertility increased by 14%, breastfeeding days decreased by 33.4%, birth weight increased by 0.290-kg average per piglet, and the weaned piglet's number per litter increased by 3.2 after adoption. Changes were also observed in the mortality rates, with deaths among lactating piglets decreasing by 12% and mortality in the fattening area reduced by up to 5%. The farrowing interval was shortened by 32 days. As a result of using AI and following adequate management of replacement females, breeding weight was increased to 112.9 kg and the daily weight gain increased by 30.7% (from 450 to 650 g). Finished pigs reached an average weight of 119.9 kg at a mean age of 187.7 days. With all these results, the cost/benefit ratio improved from 1:1.1 to 1:1.28 (in USD), which indicated that for each dollar invested, the producer recovered USD 1.28. All these data collected with the use of records, in addition to the pig farmer's education on technologies, are relevant to the adoption process. In any technology transfer process, it is essential to consider that producers' learning is shaped by their experiences, willingness to learn, and inclination to solve their own problems, as these factors influence continuous learning. It is also important to mention that 90% of the UPs used were family-owned (backyard production) and with limited use of technologies. One of the characteristics of this production system is self-employment, with the use of family labor. This system is relevant, and is part of the culture in rural areas. In addition, the system is a source of self-consumption, and they market their products locally, constituting a system of savings and additional income (Tummaruk et al., 2023). By the end of the training, the adoption of these technologies and practices by the UPs resulted in increased profits for the pig farmers, and they began to function as small family businesses, providing them with better economic returns.

The results of the study are not intended to establish a single management model applicable to all pig farms in the country or the world, because they have different problems and in diverse environments. Pig production has differences in reproductive, productive, and economic efficiency parameters, which makes it difficult to extrapolate results (Guan et al., 2022). The main limitations identified in the process were investment capacity, access to the inputs required for the implementation of some of the technologies and practices, and the level of education of each producer. These limitations are most likely not a problem for the swine production sector in other areas of the country where there is a more homogeneous level of development. In general, the recommendation is to validate the technologies and practices applied in each production unit, given that many developed technologies are exclusive to intensive systems and may not be adaptable to other production systems (Collins and Smith, 2022). In this study, the local application of the data was validated through continuous longitudinal evaluation (3 years) of the same production units before and after adoption. The external applicability of the data should be considered given that pig production systems in Mexico are heterogeneous, and the technologies evaluated correspond to low-cost practices and broad applicability to family production systems in tropical regions (Tummaruk et al., 2023), so the results can constitute a frame of reference for production units with similar characteristics.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The animal studies were approved by Comité de ética de la institución FMVZ-UAGro. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent was obtained from the owners for the participation of their animals in this study.

Author contributions

FQ-C: Writing – original draft, Writing – review & editing, Validation, Supervision. JO-P: Writing – original draft, Writing – review & editing. SR-H: Writing – original draft, Conceptualization, Resources, Writing – review & editing. MD-V: Supervision, Software, Writing – original draft, Writing – review & editing. AV-M: Writing – review & editing, Methodology, Writing – original draft. LS-S: Writing – original draft, Writing – review & editing, Validation, Supervision. AO-J: Writing – review & editing, Formal analysis, Writing – original draft. ER: Conceptualization, Writing – review & editing, Supervision, Writing – original draft. RJ: Validation, Writing – review & editing, Writing – original draft, Formal analysis. MC: Writing – review & editing, Software, Writing – original draft, Investigation.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Alarcón, L. V., Allepuz, A., and Mateu, E. (2021). Biosecurity in pig farms: a review. *Porc Health Manage.* 7, 5. doi: 10.1186/s40813-020-00181-z

Alonso-Ríos, L., Olivares - Pérez, J., Ortiz-Rodriguez, R., Rojas-Hernández, S., Quiroz-Cardoso, F., Cipriano-Salazar, M., et al. (2021). El nopal como aditivo alimenticio durante el destete en cerdos y el consumo de alimento versus peso vivo. *3er Congreso Internacional CienciasVeterinarias y Producción Animal Temascaltepec, M'exico*. 46–49.

Alves, L. K. S., Gameiro, A. H., Schinckel, A. P., and Garbossa, C. A. P. (2022). Development of a swine production cost calculation model. *Animals* 12, 2229. doi: 10.3390/ani12172229

Arutkumaran, S., Shanmathi, S., and Hemavathi, A. (2025). "The role of vaccination in controlling swine zoonosis," in *Emerging zoonotic threats from swine*. Eds. R. Deb, J. Nayak, G. S. Sengar and V. K. Gupta (Springer Nature Singapore), 307–333. doi: 10.1007/978-981-96-7407-7_17

Collins, L. M., and Smith, L. M. (2022). Review: Smart agri-systems for the pig industry. *animal* 16, 100518. doi: 10.1016/j.animal.2022.100518

Compagnoni, M., Tittarelli, C. M., and Williams, S. I. (2019). Inseminación Artificial en la especie porcina: dosis inseminante en relación al lugar de deposición. *Analecta Vet.* 39, 41. doi: 10.24215/15142590e041

Flowers, W. L. (2020). "Reproductive management of swine," in *Animal agriculture* (Elsevier), 283–297. doi: 10.1016/B978-0-12-817052-6.00016-1

Gaillard, C., Brossard, L., and Dourmad, J. Y. (2020). Improvement of feed and nutrient efficiency in pig production through precision feeding. *Anim. Feed Sci. Technol.* 268, 114611. doi: 10.1016/j.anifeedsci.2020.114611

García-Contreras, A., De Loera Ortega, Y., Yagüe, A., Guevara González, J., and García Artiga, C. (2012). Alimentación práctica del cerdo. *Rev. Complut Cienc Vet.* 6, 21–50. doi: 10.5209/rev_RCCV.2012.v6.n1.38718

Guan, R., Zhou, X., Cai, H., Qian, X., Xin, X., and Li, X. (2022). Study on the influence of different production factors on PSY and its correlation. *Porc Health Manage.* 8, 9. doi: 10.1186/s40813-022-00253-2

Kirkden, R. D., Broom, D. M., and Andersen, I. L. (2013). Piglet mortality: The impact of induction of farrowing using prostaglandins and oxytocin. *Anim. Reprod. Sci.* 138, 14–24. doi: 10.1016/j.anireprosci.2013.02.009

Koketsu, Y., Iida, R., and Piñeiro, C. (2021). A 10-year trend in piglet pre-weaning mortality in breeding herds associated with sow herd size and number of piglets born alive. *Porc Health Manage.* 7, 4. doi: 10.1186/s40813-020-00182-y

National Research Council, (2012). Nutrient requirements of swine: eleventh revised edition Vol. 13298 (National Academies Press), Washington DC. doi: 10.17226/13298

Pandolfi, F., Edwards, S. A., Robert, F., and Kyriazakis, I. (2017). Risk factors associated with the different categories of piglet perinatal mortality in French farms. *Prev. Vet. Med.* 137, 1–12. doi: 10.1016/j.prevetmed.2016.12.005

Pearodwong, P., Tretipskul, C., Soede, N. M., and Tummaruk, P. (2019). Factors affecting estrus and ovulation time in weaned sows with induced ovulation by GnRH administration in different seasons. *J. Vet. Med. Sci.* 81, 1567–1574. doi: 10.1292/jvms.18-0429

Tucker, B. S., Craig, J. R., Morrison, R. S., Smits, R. J., and Kirkwood, R. N. (2021). Piglet viability: A review of identification and pre-weaning management strategies. *Animals* 11, 2902. doi: 10.3390/ani11102902

Tummaruk, P., De Rensis, F., and Kirkwood, R. N. (2023). Managing prolific sows in tropical environments. *Mol. Reprod. Dev.* 90, 533–545. doi: 10.1002/mrd.23661