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Swine welfare essentials:
Heat stress, nutrients, and data collection

By Jeng-Hung Liu

Animal welfare and heat stress

What is animal welfare?

Animal welfare, also referred to as well-being, is the state of being of an individual animal, involving health and conditions of life. Animals with good well-being have five freedoms:

- Freedom from thirst, hunger, and malnutrition
- Freedom from discomfort
- Freedom from pain, injury, and disease
- Freedom to express normal behavior
- Freedom from fear and distress.

We can measure the well-being of swine based on five categories:

- **Physiology:** Endocrine (stress) levels, blood pressure, heart rate, respiration rate, body temperature
- **Health and immunity:** Overall level of immunity, disease incidence, wounds or scratches
- **Anatomy:** Bone strength and rate of injury, lameness (a failure of the livestock to walk normally — not getting up, swaying their hips, or toe-touching, meaning they are refusing to put weight on one of their four legs)
- **Performance:** Feed efficiency, water intake, body weight/condition, average daily gain, reproductive measures, and morbidity and mortality
- **Behavior:** Maintenance behaviors, normal postures, vocalizations, fear responses, socially oriented behaviors, abnormal behaviors

What is heat stress?

Heat stress occurs when the body cannot get rid of excess heat, which results in the body's core temperature rising and an increase in heart rate. Swine are vulnerable to heat stress due to their lack of sweat glands, relatively small lungs compared to their body size, and the subcutaneous fat present. Mature pigs are most comfortable when air temperatures are between 50-75°F.

As for Guam, the climate is typically hot and humid. The temperature usually varies from 76°F to 88°F, which means the grower-finisher pigs in Guam are constantly being exposed to the heat stress alert or danger zone and can very quickly move into life-threatening levels of heat stress. This would negatively impact feed intake, growth in feeder pigs, reproduction rates, and milk production in lactating sows, which can eventually lead to lower productivity, profitability, and sustainability of swine production.

Signs of heat stress in swine:

- Reduced appetite
- Increased respiration and heart rate
- Depression/weakness or laziness
- Increased water consumption
- Diarrhea
- Death

Impacts of heat stress in swine:

- Damage to the intestinal structure, which can lead to infection
- Reduction in growth performance (caused by reduction in feed intake and digestibility due to intestinal damage)
- Reproductive impacts: Lower sperm quality, decreased conception rates, decreased embryo viability and survival.
- Lower litter numbers and reduced weaning piglet weight due to poorer milking performance. Piglets born from heat-stressed sows tend to develop higher levels of back fat (Lucy and Safranski, 2017). If heat stress occurs in the last two to three weeks of gestation, the incidence of stillbirths increases.

PIG COMFORT ZONES			
	Effective critical temperatures (°F)		
Category	Weight (lbs.)	Lower	Higher
Newborn	2-6	93°	100°
Nursing	6-12	85°	95°
Weaned	12-18	80°	90°
Nursery	18-50	70°	85°
Grower	50-130	60°	75°
Finisher	130-275	55°	75°
Gestating gilts and sows	275+	55°	75°
Lactating gilts and sows	300+	55°	70°
Boars	300+	60°	75°

Table 2. Comfort zones for pigs at different stages (Froseth, 2016)

Heat at different ages in swine

Animals in early life stages can withstand higher temperatures before showing signs of heat stress. Generally, older and larger animals are more vulnerable to heat stress compared to younger and smaller animals. Sows in gestation, particularly late gestation, are at high risk of heat stress (Lucy and Safranski, 2017).

As pigs mature and grow larger, their body mass increases relative to their surface area. They retain heat more effectively and lose heat less rapidly to the environment. Consequently, their thermoneutral zone becomes narrower, they become more sensitive to fluctuations in temperature, and heat stress has a larger impact on older finishing swine, sows, and boars than on younger pigs (Martin, 2012).

Ways to mitigate swine heat stress in Guam

- Increase ventilation and airflow.
- Adhere to a feeding schedule to train the animals to eat at designated times. Avoid feeding during the peak heat of the day (10 a.m. – 4 p.m.) to encourage better eating habits. Additionally, body heat is produced during digestion, so it is recommended to feed early in the morning and/or late in the evening.
- Supplement the water supply with electrolytes and antioxidants. It is even better to provide cool water below 68°F.
- Monitor diets:
  - Increase dietary energy density (for instance, a higher corn-based diet from which sows can get more energy with a smaller amount of feed)
  - Minimize excess non-essential amino acids and fiber
  - Provide vegetable greens. Papaya, watermelon flesh, and rinds are all good sources of antioxidants, which can help reduce heat stress. However, they should be used as a snack/treat and not as a supplement to the diet.
- Have a cooling system and regularly check that it is in good order.
  - While it is common to assume that applying water to the animal (spraying or misting water) would help with cooling, Guam's high humidity prevents heat loss via evaporation, so this method could further aggravate heat stress. Additionally, if the water is too cold, it can cause the animal to go into a state of shock. In Guam's humid conditions, you should limit the usage of cooling that adds moisture to the air.
  - A cool cell would be an optimal form for cooling barns. Although it does use water as a form of cooling, it does not rely on evaporation. Instead, it cools the water and then blows air through the cold water, working similarly to an air conditioner.
- Make use of smartphone applications that can help predict heat stress in pigs. One example is HOTHOG, which was developed, tested, and released with collaborators from the University of Illinois at Urbana-Champaign, Purdue University, and the Oak Ridge Institute for Science and Education. Swine producers can use the information to take preemptive measures accordingly. The HOTHOG app:
  - shows local weather to predict the relative comfort or heat stress levels of pigs on an hourly, daily, or weekly basis.
  - allows producers to choose between open/early gestation, mid-gestation, or late gestation.
  - shows pig comfort levels as cool, comfortable, warm, mild, moderate, or severe.

Nutrition

- **Water:** Water is the most important nutrient. Water should be accessible and of good quality. Normally, growing pigs need 2-3 kg of water per kg of dry feed. It is advisable to adopt a water nipple system as it is a more hygienic and manageable option. Regularly cleaned and sanitized water dispensers minimize the risk of contamination from feces or urine while ensuring livestock have easy and continuous access to clean water.
- **Energy (supplemental fat):** Important in balancing swine diets. Requirements are influenced by weight, genetic capacity, and environment.
  - Main feed: Corn
  - Alternatives: Small grains (oats, barley, wheat, triticale), processing coproducts

(vegetable oils, corn gluten feed, corn gluten meal), and animal fats

- **Protein:** The most common feed available as sources of energy are low in protein. Protein supplementation is expensive, but it may be the most critical nutrient in swine rations. Newborn pigs have the highest protein requirement; however, milk is high in protein, so protein deficiency during the suckling period is not usually an issue. Early-weaned piglets are especially vulnerable to protein inadequacy. Too low of protein consumption causes reduced growth rates and feed efficiency. Severe protein deficiencies can cause growth failure, increased liver fat, severely low blood serum albumin, and edema in the jowl.
    - Main feed: Soybean meal
    - Alternatives: Whole soybeans, field peas, alfalfa meal, canola meal, linseed meal, plasma protein, bone meal, algae, corn gluten feed, corn gluten meal
- **Calcium (Ca) and Phosphorous (P):** The optimum ratio of Ca:P is between 1:1 and 2:1. Absorption of calcium from the diet is increased by Vitamin D and decreased by high dietary fat, acid pH, and phytin-P. Deficiency of either calcium or phosphorous will result in rickets in growing pigs and osteoporosis in adult pigs. Calcium deficiency during gestation may result in spontaneous long bone fractures, parturient paresis, or lameness.
- **Vitamin D:** Affects the absorption and utilization of calcium and phosphorous. Deficiency results in stiffness and lameness, with lameness being followed by reduced feed intake and growth depression.
- **Iron (Fe):** Pig milk from sows is very low in iron and placental transfer of iron is limited. Piglets not getting enough iron develop severe anemia and become pale, flabby, weak, and exhibit labored breathing. Piglets that are raised on the ground may have iron from digging; however, if piglets are raised in a confined (concrete) environment, it is common practice to give an iron shot (intramuscular) within the first two days of birth.

In Guam, some pig producers will supplement their pigs' diet with household and restaurant food waste as a cost-effective measure. However, there are important considerations to keep in mind when doing this. Producers must ensure that the food waste is thoroughly cooked to prevent the risk of parasites and liver fluke infestations. While the nutrients absorbed by the pigs may align with this supplementation approach, it is essential to recognize that excessive consumption may primarily consist of water content rather than the essential nutrients pigs need.

Boar nutrition

Boars should not be fed to appetite. Allowing boars to feed to appetite can cause leg weakness due to large body size, becoming too large for housing or to safely handle, reduced libido, and the physical inability to mount sows/dummies.

- Limit feed:
    - Non-breeding season: 4-6 lb. of feed/day
    - 10-14 days prior to breeding: Some recommend increasing feed amount by 50%.
    - Hold good condition without over-conditioning.
- Protein requirement:
    - 18% crude protein (CP) for 50-125 lb. boars
    - 16% CP for 125-200 lb. boars
    - 12-14% CP for mature boars (>200 lb.)
- Once boars reach 180 lb., reduce their ration energy content by adding fiber (include more alfalfa meal and replace corn with oats).
- Reduced nutritional levels = reduced semen volume.

Sow nutrition

Sows have an approximately 140-day reproductive cycle: pregestation followed by five phases. Nutritional needs differ in each phase.

Phase 1: Pregestation

Feed to appetite a grow/finish diet (regular feed + antibiotic growth-promoting agents) until ~225 lbs. At 225 lbs., separate from market herd, then restrict dietary energy to 60–75% of previous diet. This allows for more body growth but restricts fat deposition.

- Breeding (Day 0): Differs for sows vs. gilts
- Sows: Breed at the first estrus after weaning. High-energy lactation diet for the last ~4 weeks and reduced feed intake at weaning.
- Gilts: Breed after two to three estrus cycles, at least 250–300 lbs. and 6-7 months old. Increase their energy intake prior to and during breeding.

Phase 2: Gestation (Days 1–114)

Feed to body condition. Too thin or too fat will cause issues with pregnancy, parturition, lactation, and rebreeding. Ensure that sows maintain an optimal body condition, avoiding both excessive adiposity, which may precipitate complications during embryonic development, farrowing, and lactation, as well as excessive leanness, which may result in challenges, such as post-weaning reproductive failure, diminished conception rates and litter sizes, and increased vulnerability to bone fractures.

Phase 3: Farrowing (Day 114)
Increase dietary fiber to reduce constipation risk. Increase pre-parturition to increase the sow's appetite.

Phase 4: Lactation (Days 114–135)
Feed to appetite with high-energy feed. This results in greater weaning weights of both piglets and the sow, improves piglet survival, and allows for better rebreeding.

Piglet nutrition (first 21 days): Need to receive colostrum within the first 24-48 hours of birth, then milk starting at two days post-partum. Milk production peaks at three weeks and begins to limit piglet growth.

Phase 5: Weaning (Days 135–140)
Sows should return to a gestation diet (fed to body condition). Piglets move to the nursery.

Overly fat sows have increased embryonic mortality, farrowing difficulty, incidence of crushed pigs, and susceptibility to heat stress, and decreased lactation feed intake and milk production.

Biosecurity

What is biosecurity?

Biosecurity is an essential set of practices and measurements applied to minimize the risks of getting infections and bringing new pathogens into a pig farm and to contain the spread of disease within that farm.

Biosecurity includes the following components:

- **Bio-exclusion:** Preventing the entrance of pathogens into the farm (for example, preventing livestock from having contact with other domestic or wild animals or sharing feed and water sources, having new pigs quarantine and undergo tests, and requiring visitors to have 48 hours of downtime between farm visits).
- **Bio-management:** Controlling and reducing unwanted disease agents and increasing hygiene levels by disinfecting the room or farm regularly and getting pigs vaccinated.
- **Bio-containment:** Preventing further spread of disease outbreaks by quarantining the infected pigs and stopping the meat supply to consumers.

Swine disease can be spread in multiple ways:

- Replacing new gilts and boars
- Purchasing semen from unreliable sources
- Livestock having direct or indirect contact with other farm animals or wild animals
- Livestock having access to contaminated feed, water, bedding, or soil
- Via pathogens that are brought into the farm from a different site
- Via employees who do not follow the biosecurity procedures strictly
- Using contaminated equipment and vehicles on the farm.

Data collection

Use the following data collection sheets to help keep track of sow, boar, and overall barn data.

Daily Record for Swine

Year: **Month**:

Date	Temperature	Humidity	Condition of Pigs (✓)	Signs of Illness/ Injury/Abnormal Behavior (specify)	Inspection of Equipment (feeders/water/ ventilation systems)	Damages/ Need for Maintenance (specify)	Ensure Cleanliness (floors/ walls) (✓)	Presence of Pests/ Snakes (Y / N)	Water/ Food Quality (✓)	Comments
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2										
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Total for page 1										

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For more information on record keeping for swine, contact the Agriculture & Natural Resources office at the University of Guam Land Grant Extension Service at (671) 735-2080.

Monthly Record for Sows

Year: **Month**: **Day**:

ID of Sow	Weight	Insemination date	Farrowing date	Weaning date	How many piglets does she have?	How many piglets does she wean?	How big were they at birth?	How big were they at weaning?	Non-productive days	Gestation and lactation feed intake	Vaccination/ Treatments	Comments
Total for page 1												

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Monthly Record for Boars

Year:		Month:			
ID of Boar	Weight	Semen quantity	Semen quality	Vaccination/ Treatments	Comments
Total for page 1					

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