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Helping Farmers to Manage and Reduce Heat Stress in Pigs: A Training Manual for Extension Workers and Technical Staff in Uganda

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Helping Farmers to Manage and Reduce Heat Stress in Pigs: A Training Manual for Extension Workers and Technical Staff in Uganda

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Cover Image: A pig being transported in Uganda (Credit: ILRI/K. Dhanji)

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Glossary of common terminology

Adapting: The process of adjusting to change (both experienced and expected), which is long term (for example, over a decade or longer).

Annual per capita pork consumption: The yearly consumption of pork by each person, derived by dividing the quantity of pork consumed by the total population.

Average daily gain: The average amount of weight a market animal will gain each day during the growing period.

Boar: Mature intact (uncastrated) male.

Climate change: A long-term change in global or regional climate patterns, attributed largely to the increased levels of atmospheric greenhouse gases produced by anthropogenic activities.

Conceiving: The process of creating an embryo by fertilizing an egg.

Coping: A way of responding to an experienced impact with a short-term vision (for example, one season).

Creep: Solid feed given to young farm animals in order to wean them.

Cross-bred pig: The type of pig created when the two parent pigs are of different breeds.

Exotic pig breed: Breeds that are not autochthonous or locally-adapted. Exotic breeds comprise both recently introduced breeds and continually imported breeds.

Farrow: a litter of piglets.

Feed or fodder: Food given to a pig in the course of pig rearing, including concentrates, forage, hay and silage.

Finishing/fattening pig: Pig growth stage following grower stage, at end stage of rearing.

Forages: Crops that are grown to be utilized for feeding livestock, including pigs.

Free-range in pig production: Pigs kept outdoors, with freedom of movement.

Gilt: A female pig that has never produced offspring.

Growing pig: Pig growth stage after weaner stage, but still in the early stages of rearing.

Hay: Grasses, legumes or other herbaceous plants that have been cut and dried to be stored for use as livestock feed, including pig feed.

Heat stress in pigs: A series of behavioral and biological responses by a pig after exposure to excessive environmental heat.

Homeothermy: Maintaining a relatively constant body temperature that is independent of the temperature of the surrounding environment.

Intact pig: A male pig that has not been castrated.

Lactating pig: A female pig that is producing milk, usually suckled by the piglets.

Local pig breed: Locally-adapted breeds, i.e. breeds that have been in the country for a sufficient time (normally 40 years and six generations of the respective species) to be genetically adapted to one or more of traditional production systems or environments in the country.

Piglet: A young pig before weaning.

Pigsty: A housing, enclosure or pen for a pig or pigs.

Silage: A type of fodder made from green foliage crops that have been preserved by acidification achieved through fermentation.

Stress: Stress covers the behavioural and biological responses to a wide range of abiotic (non-living) stressors such as social interactions or rough handling, common farm practices (castration) such as dehorning, teeth clipping, improper feeding, and exposure to adverse climatic, exercise, transport conditions, etc.

Sow: Adult female pig that has farrowed one or more litters of piglets.

Temperature-humidity index (THI): Is an index that combines air temperature and relative humidity in an attempt to determine the perceived equivalent temperature (how hot it feels). The body normally cools itself by perspiration, which evaporates and carries heat away from the body. However, when the relative humidity is high, the evaporation rate is reduced, so heat is removed from the body at a lower rate, causing it to retain more heat than it would in dry air.

Temperature-humidity Index (THI) thresholds: Is the THI at which different levels of heat stress are expected.

Weaner: A newly weaned pig.

Figure 1: *Piglets at a farm in Mukono (Credit: Kabir Dhanji/ILRI)*

About this guidebook/what to expect from this manual

This manual looks at the widespread issue of heat stress in pigs being reared in hot climates and presents best practices to help farmers recognize, alleviate or mitigate heat stress situations in pig rearing, with a particular focus on Uganda.

This manual is targeted to extension officers and technical staff working to support smallholder pig keepers in Uganda. The objectives of this manual are to:

1. Create awareness amongst technical and extension staff working in pig production about climate change and the related heat-stress implications for pigs, and the need to take action.
2. Build the capacity of technical and extension staff in pig production on practical skills and techniques to support farmers in taking appropriate actions to reduce heat-stress related suffering of their pigs, improve their pigs' wellbeing and protect their investment.

Figure 2: *A technical officer and a researcher communicating with pig farmers in Lira (Credit: Paul Zaake/CIAT)*

1. Introduction

Pig production is an important source of income and food for a large proportion of the population in Uganda. In terms of meat production, it is second to beef (Figure 3). As of 2017, Uganda had approximately 4.2 million pigs (UBOS, 2019). In 2013, the country had the highest per capita consumption of pork in East Africa, estimated at 3.4 kilograms per person per year (FAOSTAT, 2020).

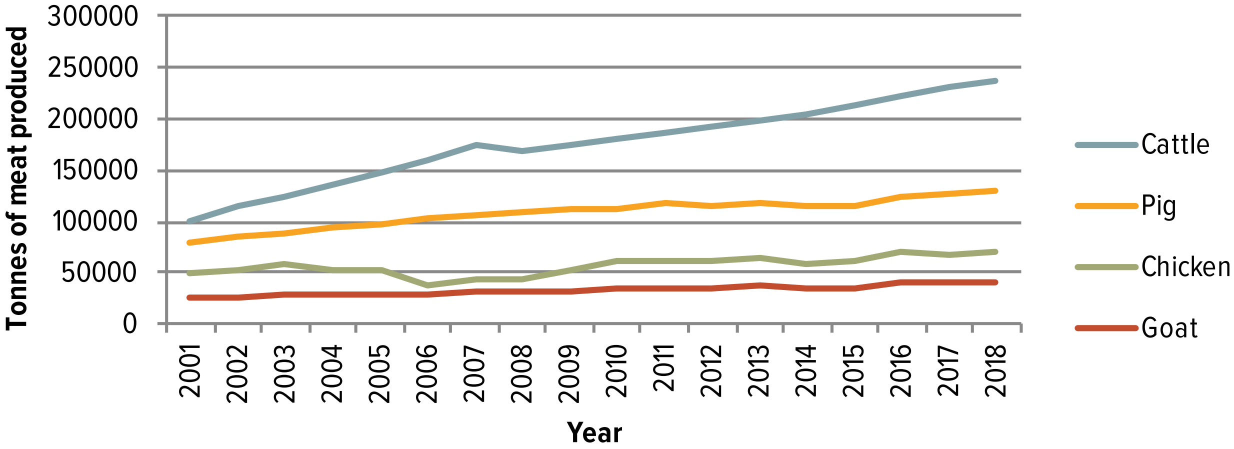

Figure 3: *Meat produced/slaughtered (tonnes) per animal type per year in Uganda between 2001 and 2018 (Source: FAOSTAT, 2020).*

In the face of climate change, temperature and humidity are increasing (Section 2), which is worsening heat stress in animals. Heat stress includes a series of conditions whereby the pig's body is under stress from overheating (Section 3). Heat stress reduces growth, reproduction and makes pigs vulnerable to diseases, resulting in potential economic losses. In the USA, annual losses due to heat stress in the livestock industry is estimated at nearly US$1 billion for swine (Key and Sneeringer, 2014). There are various actions that can be taken to reduce heat stress in pigs, and these should be employed (Section 4).

2. Climate change impacts in Uganda

Uganda's climate is changing and seasonal mean temperatures have increased over the last 50 years. Average temperatures are projected to increase by 1 to 3^{0}C by the 2060s, and 1.4 to 4.9^{0}C by the 2090s (McSweeney et al. 2007). The increase in temperature is expected to become more notable over time (KNMI, 2020; Figure 4).

Climate change can affect the livestock production systems in many ways, with potential heat stress being one of the major adverse expected impacts (Rojas-Downing., et al., 2017). Climate change will significantly increase humidity,

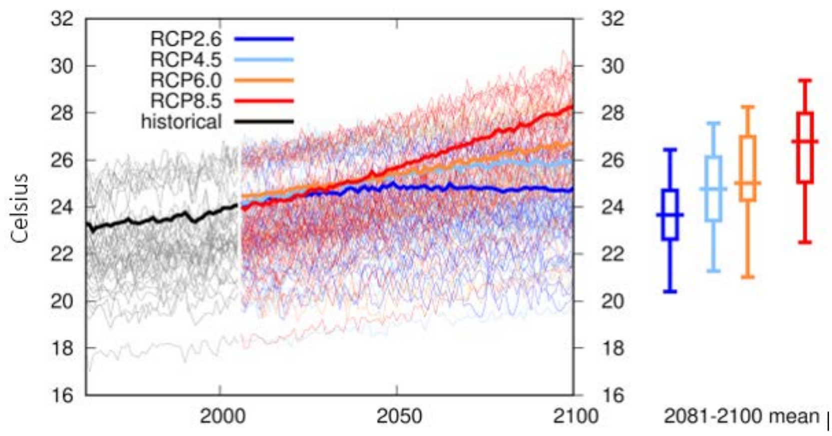

Figure 4: *Temperature increase since 1962 (black line) in Uganda. Future projections up to 2100 are indicated in red (worst case scenario if no action is taken) and deep blue (favorable scenario, if we act now) (Source: KNMI, 2020).*

magnifying the effects of environmental temperature and thus increasing the likelihood of heat stress being experienced by animals. In addition to heat stress, animals may be exposed to other stress conditions such as under-feeding, lack of water availability or restricted use of water due to changes in climatic conditions. In order to cope with these adverse conditions, pigs develop adaptive survival mechanisms. These adaptive mechanisms may be biological adjustments in their physiology, or they may be behavioral. A better understanding of the behavioral responses of pigs to stressful climatic conditions will enable the farmer to monitor and assess those responses so that they can take immediate steps to identify and minimize the stressful conditions faced by their pigs. They can then keep their animals in a comfort zone by employing better management strategies.

The heat-stress risk to pigs, from the combination of higher temperatures and humidity, is likely to increase in future. The maps in Figure 5 show the frequency (percentage of time) of severe heat stress conditions during the historical (1981-2010) and future projected (2071-2100) periods for pigs in Uganda. The redder the district is, the more it is associated with severe heat stress. Districts labeled in blue will be affected with low heat stress level if any. Based on model projections, 96% of all districts will experience severe heat stress for pigs between 2071 and 2100 (Mutua et al., 2020).

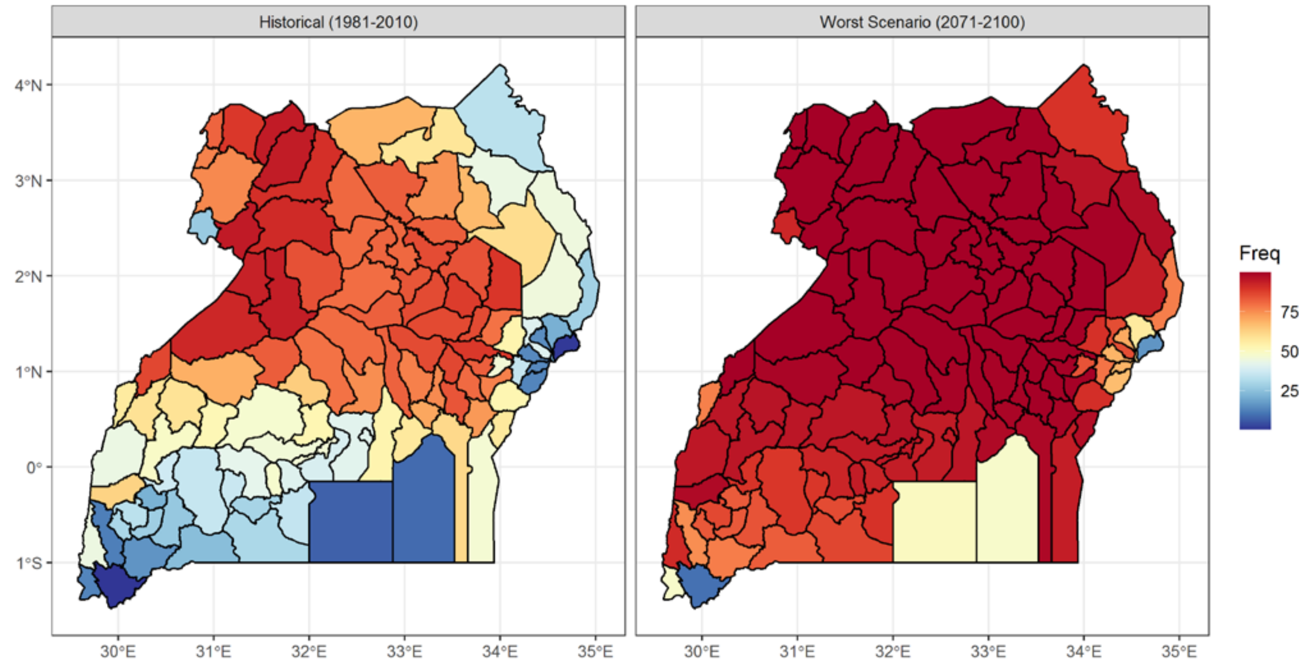

Figure 5: *Comparison of heat stress in the past (1981-2010) (left) with future (2071-2100) (right) under worst case scenario (Source: Mutua et al. 2020).*

Various studies conducted over recent years have already documented the occurrence of pig heat-stress in Uganda. In Kitayunjwa Subcounty in Kamuli, heat stress was the major cause of pig death, explaining 34% of all pig deaths (Dione et al., 2014). A study by Zaake (2019) of Ojwina and Barr sub-counties in Lira, found 51.5% of the pigs to be heat stressed at the time of the study.

3. Heat stress

3.1 Factors influencing heat stress in pigs

Heat stress denotes a series of behavioural and biological responses by a pig after exposure to excessive heat. Responses include reduced feed intake, which has a negative impact on growth and other production parameters.

When heat from the sun adds to heat from the body arising from metabolic activities inside the pig, the pig's body temperature can exceed a threshold beyond which the pig is unable to maintain homeothermy (constant body temperature). This situation is referred to as "heat stress".

Heat stress results from failure of a pig to thermo-regulate within a given environment. Indices that predict physiological comfort of livestock within a given environment have been developed (Buffington et al., 1983). One such index is the temperature-humidity index (THI), which describes the physiological comfort of livestock by integrating air temperature and relative humidity. In addition to humidity, other factors including ventilation and flooring may interact with the ambient temperature to result in the so-called "effective temperature", which will determine whether or not the pig enters into a state of stress.

Iowa State University has developed a temperature-humidity index that combines the effects of both temperature and relative humidity to classify three heat-stress levels (alert, danger and emergency) for grower-finisher pigs, as shown in Figure 4. While this chart does not directly relate to the pig breeds being reared in Uganda, nor the Ugandan pig production system, it effectively illustrates how combinations of temperature and humidity can be associated with different levels of pig heat stress. This chart shows that the lowest level of heat stress alert starts with 24 and ≥75% relative humidity. In addition, at temperatures above 27⁰C, coupled with any relative humidity, there will be a heat-stress alert, danger or emergency situation. These conditions regularly occur during afternoons in the dry season in Uganda. Heat stress can also occur at temperatures below 27⁰C depending on either the relative humidity (Figure 6) or if the pig is considered to be in a high-risk category (Figure 7).

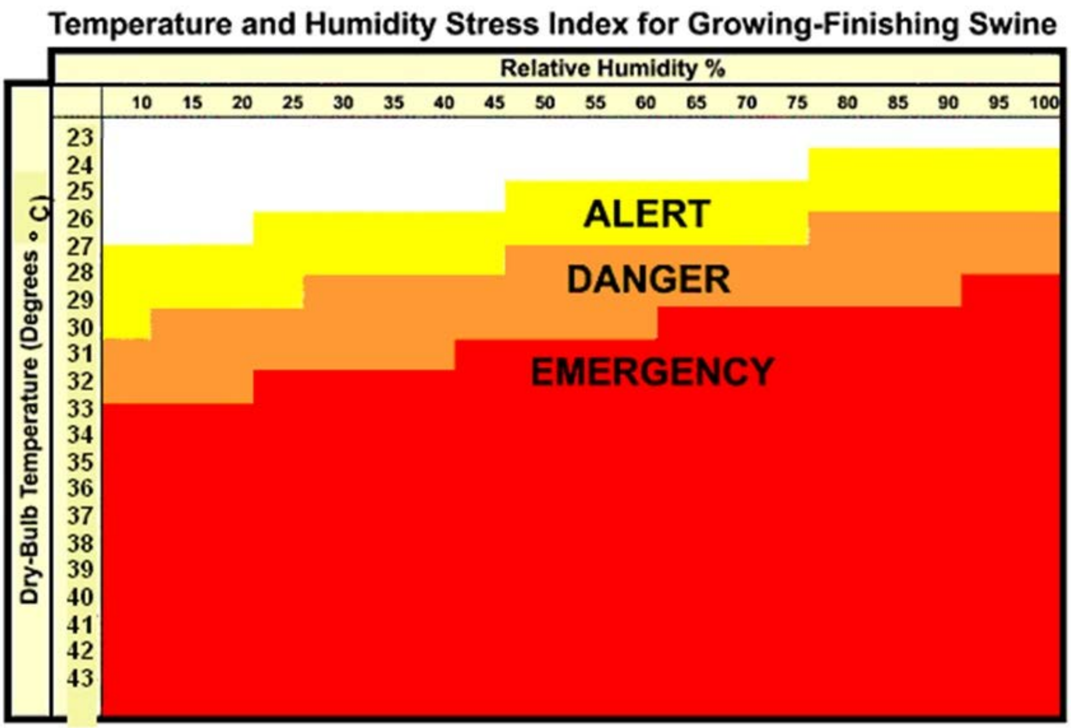

Figure 6: *Temperature and humidity index for growing-finishing pig/swine. (Source: adapted from Iowa State University)*

Most animals can avoid entering into the state of heat stress because they have the ability to maintain their body temperature and form an inbuilt cooling system to eliminate internal heat to the outside of the body. They do so by sweating and panting using their lungs. Unfortunately, pigs cannot do the same, because they do not have functioning sweat glands and therefore cannot sweat. They also have relatively small lungs and a thick subcutaneous fat layer that counteracts heat loss through conduction and convection. These physiological limitations make pigs more prone to heat stress.

Factors that affect metabolism and environment of the pig influence heat stress (Zaake, 2019). Farmers should be concerned about heat stress for all pigs, but particularly for those that are at a very high risk, as illustrated in Figure 5 and discussed further below.

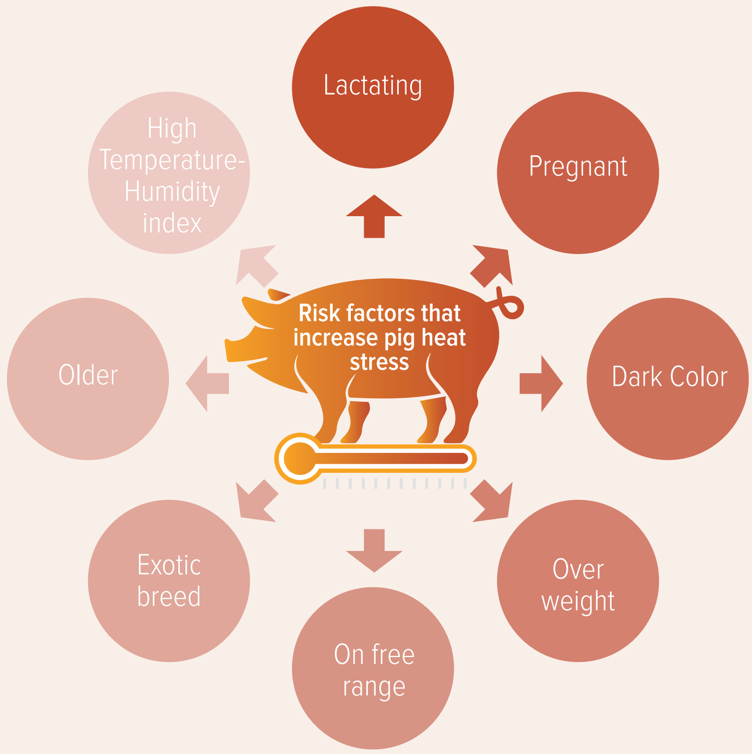

***Figure 7:** Illustration of risk factors that increase heat stress (THI is Temperature Humidity Index)*

The other factors that influence heat stress are described in detail here:

Reproduction phase (lactating and pregnant): Lactating and pregnant pigs tend to suffer high heat stress because of high metabolic function during these two phases of the reproduction cycle.

Breed and colour: Whilst the difference in heat tolerance between local and exotic pigs in Uganda has not been explicitly studied, it is likely that the local breed is more heat tolerant. Fully-white pigs, which are typically either cross- or exotic breeds, were reported to have higher heat stress than those that were not fully-white (Zaake, 2019). A review done in the US reported that the new genetic lines of pigs produce nearly 6% to 41% more heat than their counterparts in the early 1980s, due to the increased metabolic activity of the genetically-improved pigs (Brown-Brandl at al., 2011).

Size: Bigger pigs are generally more prone to heat stress and the consequent reduction in growth performance is greater than for smaller pigs. A meta-analysis of secondary data from multiple publications by Renaudeau, Gourdine and St-Pierre (2011) reported that average daily gain (ADG) in weight starts decreasing when 75kg-pigs were exposed to ambient temperatures of above 23°C, whilst for 50kg- and 25kg-pigs the ADG started to decrease at temperatures of 25°C and 27°C, respectively. Fatter pigs are associated with higher heat stress because of high metabolism and the thicker sub-cutaneous fat that counteracts heat loss.

Management: Pigs kept in a well-designed pigsty, or pigs that can find other sources of shade, are protected from harsh solar radiation. By contrast, pigs kept in sties that are hot, poorly ventiated, overcrowded or that do not have access to shade, are exposed to high solar radiation and high heat load, which greatly increases their risk to heat stress.

3.2 Recognizing a heat-stressed pig

The six common indicators for heat stress are physiological and include: (i) high rectal temperature, (ii) high skin temperature, (iii) high vaginal temperature, (iv) high tympanic (inner ear) temperature, (v) high respiration rate and (vi) high pulse (heart) rate (see Figure 8). Thresholds for selected heat-stress indicators are shown in Table 1, however, additional research is needed to validate these thresholds.

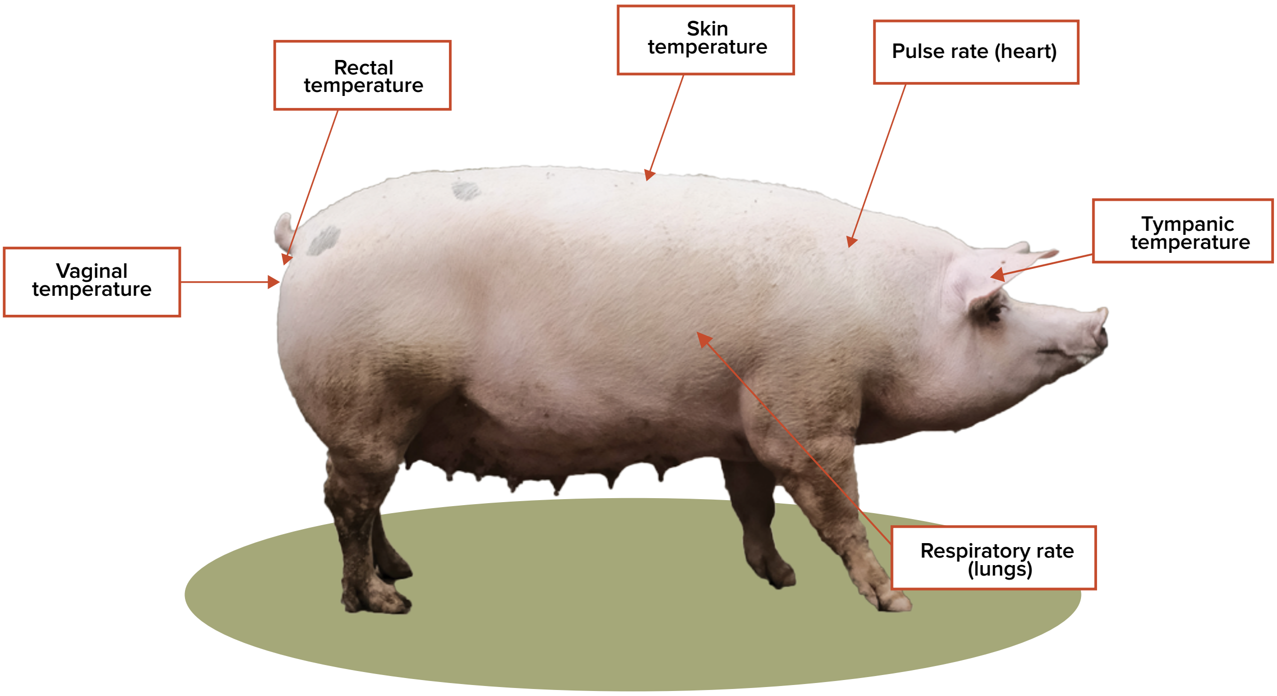

Figure 8: *Illustration showing the different parts for measuring heat stress indicators*

Table I: Putative thresholds for selected heat-stress indicators

No.	Indicator	Heat stress
	Rectal temperature	Above 39.4⁰C
	Skin temperature	Above 36.0⁰C
	Vaginal temperature	Above 39.4 ⁰C
	Respiration rate	Above 20 breaths per minute
	Heart rate	Above 110 beats per minute

Figure 9: *Infra-red digital thermometer. Credit: CIAT/P. Zaake*

An infra-red thermometer (Figure 9) measures skin temperature. By restraining the pig and with proper training in the use of a digital thermometer, measurements can be made to find rectal (Figure 10), vaginal and tympanic temperatures. Respiration rate can be measured simply by human observation when the pig is at rest and involves counting the number of breaths for one minute by counting how many times the chest rises. Pulse rate can be measured by counting the number of times the heart beats each minute. Both respiration rate and pulse rate can be measured by using a stethoscope. Measurements of respiratory rate and pulse rate depend much more on the examiner and thus require closer and longer contact with the pigs. These parameters must be measured when the pig is fully comfortable and not struggling, otherwise an erroneous figure will be recorded.

A farmer who is familiar with her/his pigs can compare what is normal and what is not normal. Typically, a farmer can observe a heat-stressed pig based on behavioural changes, for example the pig will seek shade (as shown in Figure 11), drink a lot of water, experience reduced feed intake, breathe very fast and sometimes it may start panting.

Other effects of heat stress may be evident in production efficiency in terms of weight gain per unit of feed energy, growth rate and reproductive efficiency.

Figure 10: *A research team member measuring rectal temperature of a pig in Lira, Uganda (Credit: CIAT/P. Zaake)*

Figure 11: *A pig reared under free range seeking shelter at the farmers' house from the sun and heat on a hot afternoon in January 2018 (Credit: CIAT/P. Zaake)*

3.3 Effects of heat stress on pigs

Reduced growth: A pig experiencing high temperature (heat stress) consumes little feed each day and gains little weight, therefore growing slowly. A review by Patience et al. (2015) at Iowa State University (USA) reported that heat-stressed pigs will experience feed intake decline by about 1% (growing pigs) and 2% (finishing pigs) for every degree of heat increase. The biological consequences of heat stress (reduced weight gain, lower reproductive performance etc.) are all associated with economic losses.

Poor reproduction efficiency: During high-temperature spells, the pig may not even mate because the heat reduces libido in male pigs (boars), and fertility in female pigs (gilts and sows). Even when mating occurs, the female pig (gilt if she has never produced before or sow if she has farrowed) may not conceive. If the female pig conceives while suffering from heat stress, the fetus may grow slowly or not survive. Heat stress reduces the number of piglets produced at one farrowing/birth (litter size), increases the likelihood of still-birth (number of dead piglets at birth) and increases the number of weak piglets (Renaudeau, et al., 2011; Kumar, 2011).

Poor quality of pork: The pork from heat-stressed pigs will be of poor quality, including being fatty (high unsaturated to saturated fatty acids ratios), smeary, low protein and with low shelf life due to rapid oxidation (White et al., 2018).

Weak immunity and death: Heat stress lowers a pig's immune system resulting in increased susceptibility to disease.

When pigs experience heat stress (even for as little as two to six hours), blood is diverted to the skin and results in reduced blood flow in the interior body (gut, stomach, spleen and liver). The intestine's tight junctions are disrupted and permeability increases, which significantly compromises the intestinal defense systems. This makes it easy for harmful (pathogenic) bacteria such as salmonella bacteria and swine dysentery-causing bacteria to invade the body (Pearce, 2011). Hot environments also promote high multiplication of bacteria. Thus, heat stress can create secondary infection if sanitary conditions are poor.

If heat stress continues, pigs start to drink excessive amounts of water (increasing loss of electrolytes) and accumulate acids produced within the body (causing a loss of acid/base balance). This may eventually result in diarrhea or death in severe cases.

4. Helping farmers to mitigate heat stress

In face of climate change, farmers must adapt their practices to cope with pig heat stress. It is important to note that the farmer should immediately contact the area veterinary practitioner in the event that heat stress persists after initiating the coping strategies, which we list below.

4.1 Providing plenty of clean drinking water

To manage heat stress, the pig should have access to a larger quantity of drinking water at all times in order to cool down. As a general rule, you should provide pigs with drinking water equivalent to 10% of their body weight, however, heat-stressed pigs typically drink up to six times more than normal. Wherever appropriate, it is good practice to mix 1kg of feed with 2.5 liters of water as this has a co-benefit of reducing heat stress.

4.2 Well-designed and strategically-positioned pigsties

Figure 12: *Models of optimal pig sheds with grass/hay-thatched roofs, and roof orientation that creates shade to protect against solar radiation (adapted from FAO, 2009)*

A pigsty can be constructed using whatever materials are available to make simple pig-housing structures as illustrated in Figure 12. To prevent heat stress, a pigsty should optimally have a natural grass/papyrus/thatched roof. Incase an iron sheet/metal/tin roof is to be used, there is need to ensure that the pigsty is positioned in a completely shaded area. In addition to strategic positioning, a pigsty should be well designed. Pigs should be reared in a well-ventilated clean pigsty, for example by increasing the roof height, by having walls with aeration spaces/holes/windows or by being open sided to allow the air to circulate around the pig. The pigsty should be constructed with its longest axis in an East-West direction (protected from the afternoon sun; only allow morning and evening sunlight to enter). Shade (preferably tree shade) should be provided to pigs to reduce exposure to solar radiation so it is important to plant trees as shown in Figure 13.

Figure 13: *A pigsty strategically constructed under trees to maximize shade for cooling during the day (Credit: CIAT/P. Zaake)*

4.3 Provision for cooling off: allowing the pig to wallow/swim/bathe

Studies show the positive value of supporting pig behavioural mechanisms of swimming/wallowing/self-mud-coating with regard to temperature regulation, because it helps cooling. Pigs should therefore be allowed to cool themselves by wallowing, swimming or bathing in water.

For health reasons, farmers should not allow pigs to wallow in swamps, water source points, behind bathrooms and at utensil washing points, as shown in Figure 14. This is because contaminated water causes worm infestation (for example *Taenia solium and Askaris Lumbricoides*) in pigs, in addition to other diseases.

Figure 14: *Places where pigs should not wallow to avoid infections: urinal pit (top left); bathroom pit (top right); utensil washing place (bottom left); water swamp (bottom right). Photos taken in January 2018 in Lira, Uganda (Credit: CIAT/P. Zaake)*

Farmers should construct wallows either by digging out soil or by making a concrete wallow. Figure 15 shows a pig wallowing in a soil/earth wallow. Concrete wallows are better because they offer high water-use efficiency, retaining the water for longer, but dug-out wallows allow pigs to coat themselves with mud. The mud coat dries on the pig's skin forming a protective insulation against solar radiation and has the added benefit of reducing lice on the pig's skin.

Figure 15: *A pig cooling off in an earth wallow during a period of heat stress, on a hot day in January 2018 (Credit: CIAT/P. Zaake)*

4.4 Pouring water on the pig's body

When water is poured on a pig's body, as shown in Figure 16, it effectively helps the pig to cool down. After pouring water on the animal's skin, heat conveyed to the exterior of the body helps the water to evaporate and, during the process, heat is absorbed directly from the body of the animal and the surrounding air. We therefore recommend pouring water on the pig for 1-2 minutes every 20-30 minutes to allow moisture to evaporate off the pigs' skin before starting the process again. However, farmers should avoid pouring water on an extremely heat-stressed pig as a cold shock might seriously harm the animal. An extremely heat-stressed pig should be taken to a shaded area or shade can be brought to wherever the pig is located to allow it to cool down slowly. In the case of extreme heat stress or when the situation does not improve after the coping measures have been implemented, a veterinary doctor should be called.

Figure 16: *Water being poured on the pig for cooling during a period of heat stress on day in January 2018 (Credit: CIAT/P. Zaake)*

4.5 Pouring water on the ground

Pigs like lying on the ground. However, during periods of heat stress, even the ground is extremely hot. So, it is important to pour some water on the ground where the pig typically lies. However, this practice is limited in that it requires a concrete floor and a hygienic pigsty, otherwise it may expose the pig to bacteria and increase the pig's risk of disease.

4.6 Appropriate space per pig

The space per pig in a pigsty or pen should be enough to allow the air to flow around each pig to enable it to cool effectively, as shown in Figure 17. Provide enough space in the pen according to the size of the pigs, so that all the pigs can lie down and still access feeders, water troughs and the dunging area without coming into contact with each other. General guidance on the optimum space per pig is provided in Table 2.

Table 2: Optimum spacing per pig category

Pig category	Optimum spacing (square meters)
Weaner piglet	0.3–0.5
Fattening pig	0.5–1.0
Pregnant sow	1.5–2.0
Lactating sow	4–6
Breeding boar	6–8

Figure 17: *Appropriate pig space requirement for easy aeration (Credit: ILRI/K. Dhanji)*

4.7 Choosing adaptive breeds

Local breeds are more adapted to local climatic conditions than exotic breeds. Currently, farmers increasingly prefer more productive (quick growth, high litter size) breeds. However, there is need to select for breeds that are both productive and less sensitive to heat stress.

Local breeds are expected to be acclimatized to local conditions and therefore less affected by heat stress. However local breeds may be less productive. The main purpose of breed improvement is to introduce a positive characteristic into a local breed. For example: by crossbreeding an indigenous sow with an exotic boar the offspring is likely to inherit the body shape and good growth rate from the father and the tolerance to environmental stress from the mother. Therefore, it is important to select crossbreeds that have both benefits of high production levels and resistance to heat stress. When exotic breeds are reared, heat stress prevention and mitigation strategies need to be intensified. Figure 18 shows a boar kept for community breeding purposes.

Figure18: *A boar kept for community breeding purpose at a farm in Lira, Uganda (Credit: CIAT/P. Zaake)*

4.8 Optimal feeding times

Typically, heat stress reduces feed intake, which is associated with reduced pig growth. It is important to counteract this by feeding the pig during cool times of the day (early morning and/or late evening). Firstly, it allows the pig to grow well by giving it adequate feed and, secondly, it reduces the risk of heat stress as a result of metabolism. Avoid feeding between 10.00am and 4.00pm (the hottest period of the day). The feed should be given in two equal parts: one half in the morning (9am) and the other half in the evening (5pm), as illustrated in Figure 19.

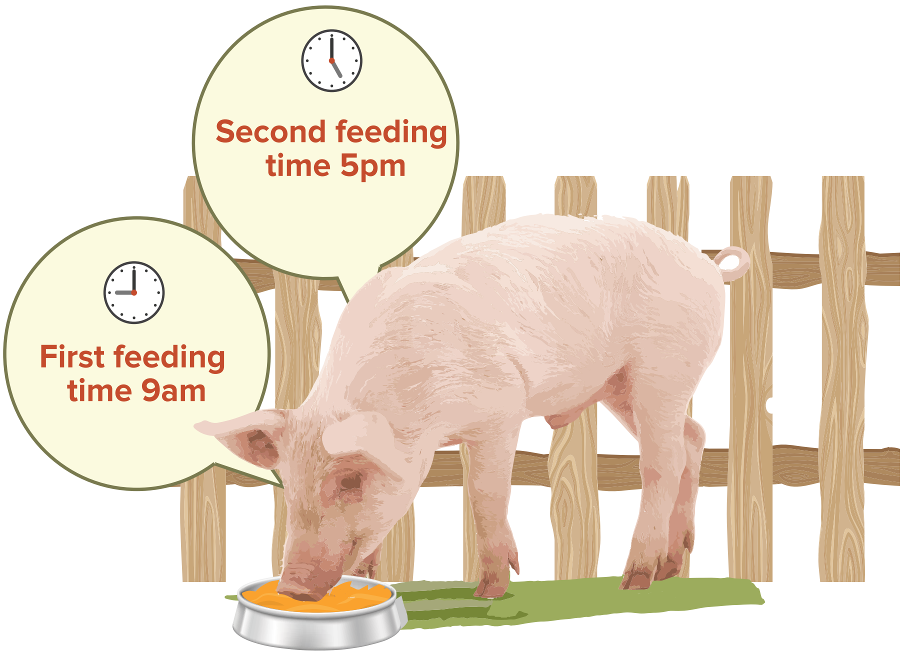

Figure 19: *Recommended pig feeding times at cooler times of the day to increase feed intake.*

4.9 Forages and feeds

There are several strategies that can be recommended to farmers for improving feeding and maximizing intake during times of heat stress, especially the dry season. During dry season, it is recommended to have a more energy-dense diet to compensate for decreased feed intake under heat stress (Li et al., 2017). When feeding concentrates for heat stress management, a decrease in the level of undigested protein and an increase in the use of more synthetic amino acids based on the ideal protein concept is recommended in order to facilitate production of less metabolic heat (Morales, et al., 2018). Farmers should also grow drought-tolerant varieties of forages (like sweet potato vines, *Cratylia argentea*, *Fleminigia macrophylla*, *Canavalia brasiliensis*, *Centrosema brasilianum*, *Lablab purpureus*, *Vigna unguiculata*), which can withstand the dry conditions associated with periods of heat stress. Other alternatives include diversification and conservation of available feeds and forages. Feeds can be conserved for example as hay (conservation process illustrated in Figure 20) and silage (process illustrated in Figure 21). During the dry season, supply the pigs with feeds that are available throughout the year (such as banana peel and leaf, papaya leaf, brewers' waste, maize bran, cottonseed meal, sunflower meal, sugar cane, oyster shells, limestone, and ground sun-dried fish) as well as those available only during dry season (for example jack fruit and mango) (Carter et al., 2015; Carter et al., 2016). Generally, it is cost effective to feed a commercial diet until the pigs reach 10.9kg and/or 11.9kg in body weight, before shifting to feeding forage-based diets such sweet potato silage (Carter et al., 2017).

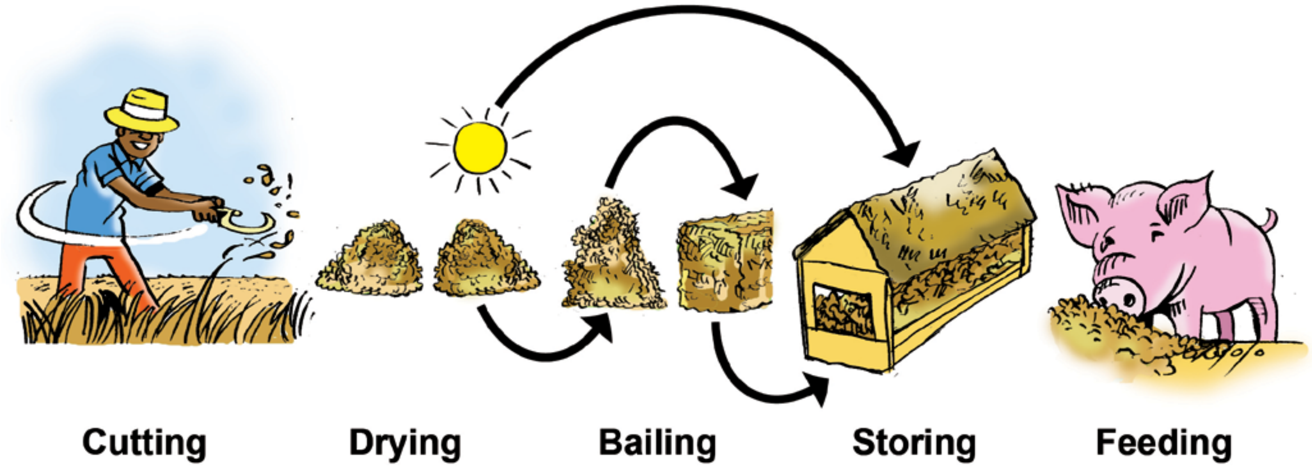

Figure 20: *Steps for making hay (adapted from FAO.org)*

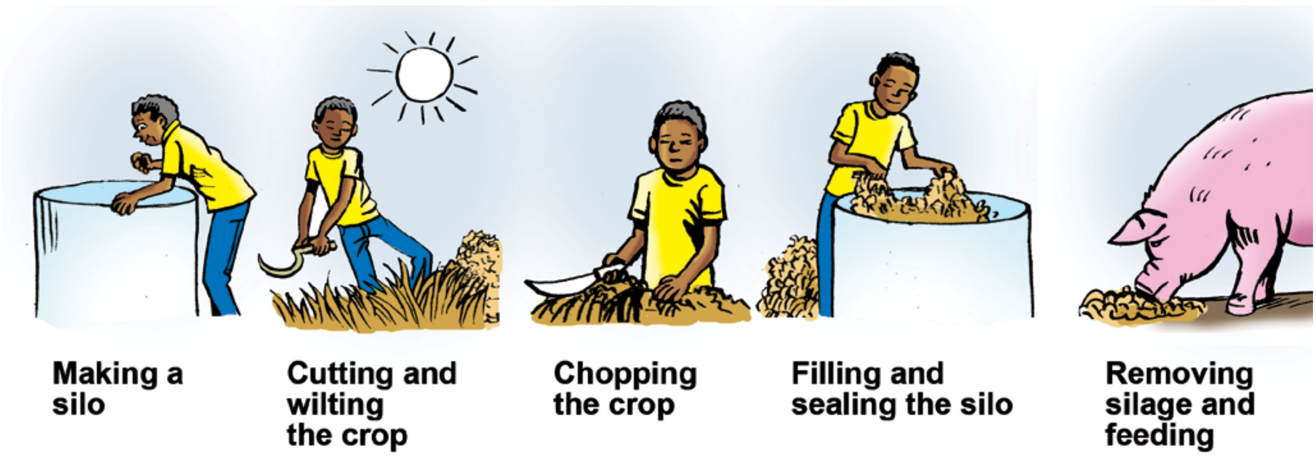

Figure 21: *Steps for making silage (adapted from FAO.org)*

4.10 Time and method of pig transportation

Pig transportation for mating, slaughter or other purposes should be done during the cool hours of the day. Ensure that the pigs have been hydrated and sprinkled with water before transporting them, whatever the environmental condition (either cool or hot). Transport trucks should not be overcrowded and should be equipped with cooling mechanisms for example shade, open-sided for air circulation, allow pouring water onto the pigs and providing water for drinking, among others.

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Conclusion

This training manual provides an overview of the need to act against heat stress in pigs, which is enhanced by increasing temperature and humidity due to climate change.

This technical manual can assist in training extension and technical staff in heat stress detection and management in pigs, which is steadily increasing due to higher temperatures and humidity as a consequence of climate change. Technical staff and extension officers can increase awareness and capacity among pig farmers, with a particular focus on best practices for reducing, coping and adapting to heat stress, as summarized in Figure 22.

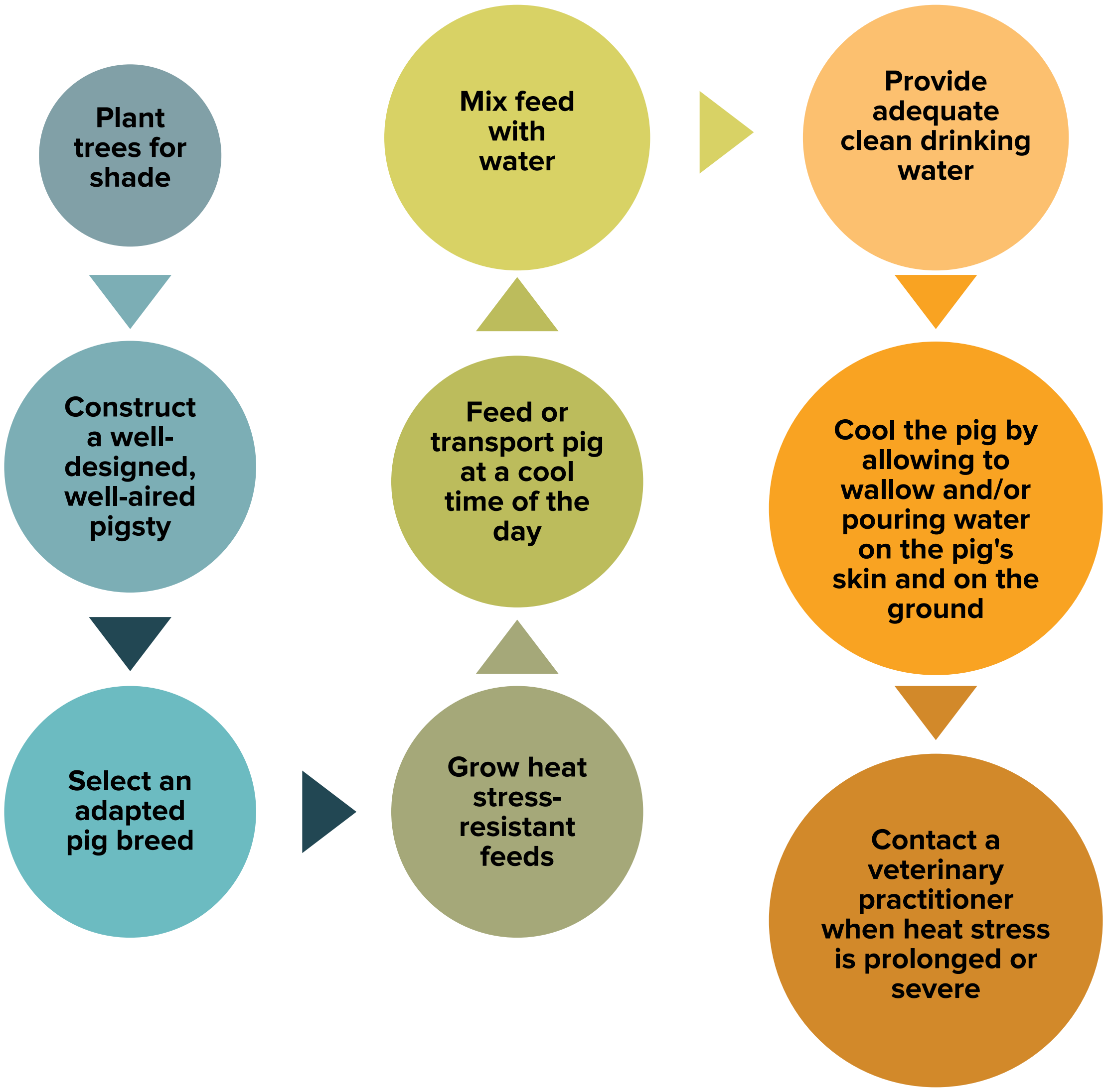

Figure 22: *Summary of adaptation measures for coping with heat stress in pigs*

Heat stress-related extension and technical services should be prioritized by stakeholders, including local government, local council authorities, district development partners, the local private sector, pig farmers' cooperatives/associations, non-government organizations and community-based organizations, to empower pig farmers to act autonomously in reducing the suffering of their livestock, improving their pigs' wellbeing and protecting sources of income.

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Appendix: Leaflet for farmers on best practices for management of heat stress in pigs

HEAT STRESS IN PIGS

Recognizing a heat-stressed pig

- High respiratory rate (breathing or panting fast)
- High rectal/skin/vaginal temeprature
- Behavioral changes like pig seeking shade, drinking a lot of water, and reducing feed intake

Heat stress can lead to:

Pig death, slow growth, poor reproductivity, poor pork quality, reduced income

What can I do to reduce heat stress in my pigs?

- Provide ample water for drinking
- Keep the pig in the pigsty/shelter or other shade
- Have a high-raised roof to improve ventilation
- Have a natural grass/papyrus thatched roof
- Feed pigs during cool hours (early morning/late evening)
- Let the pigs wallow/swim in water
- Pour water on the pigs before high heat stress
- During high heat stress, pour water on ground
- Increase space between the pigs and let pigs rest
- If heat stress persists, report heat stressed pig to area Veterinary Doctor or District Veterinary Doctor (DVO)

Well-designed pigsty

Pour water on pigs

Allow pigs to wallow

Provide shade

Give pigs water

Grass thatched roof

Spacing and resting

Free range

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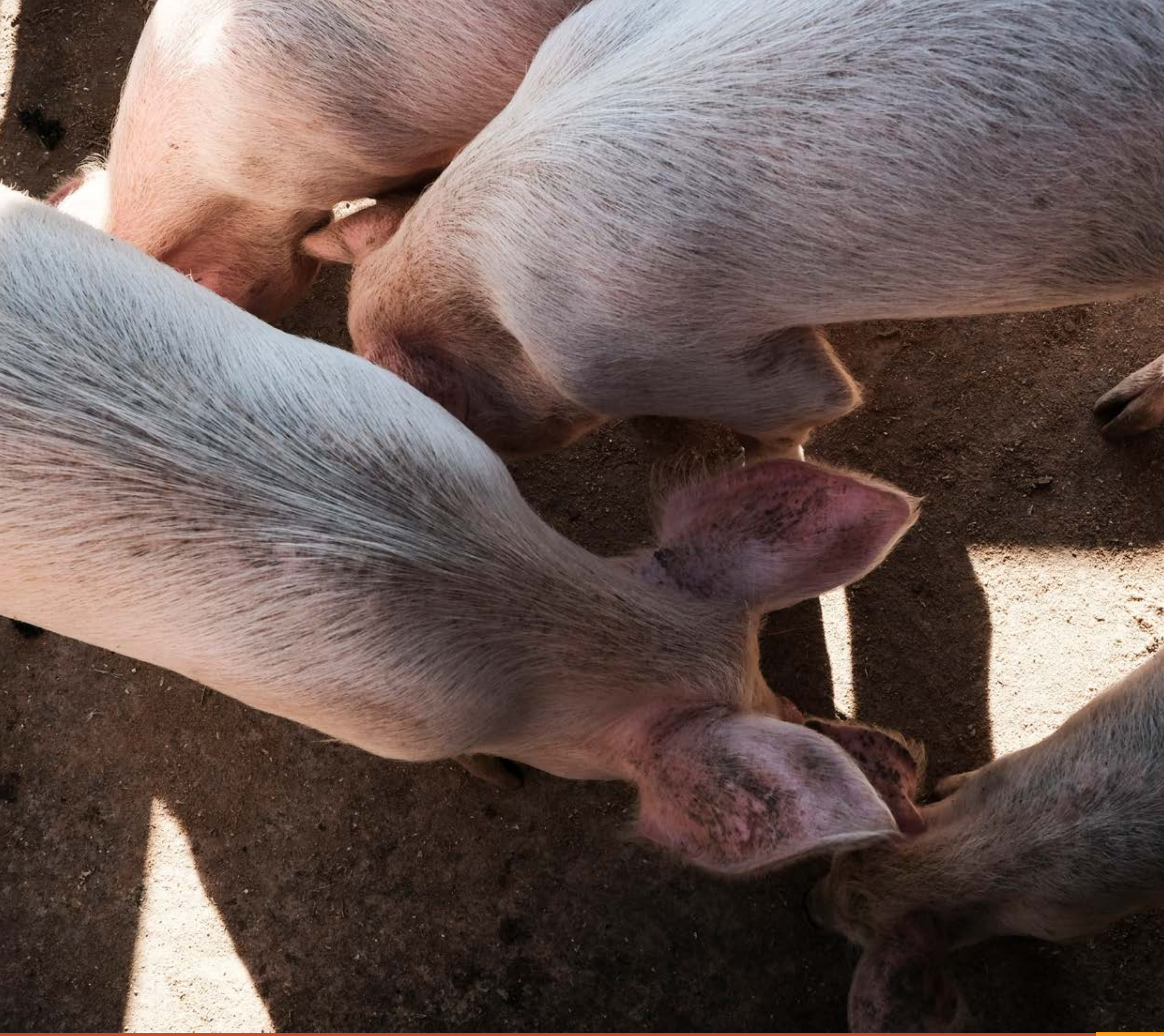
Leaflet 1: *Leaflet on best practices for mitigating heat stress in pigs. Images depict optimal management to alleviate heat stress in pigs. (Source: CIAT/Zaake et al., 2018)*



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