A Literature Study on
SHELTER FOR
RUMINANT LIVESTOCK

Commissioned by Red Meat Research and Development – South Africa

An investigation into the causes of livestock distress associated with climatic and weather factors, their interrelationships, effects, measurement and amelioration.

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SUMMARY

There is a very large body of information available on the subject of weather stress in ruminants from many hundreds of articles and other sources, coming from dozens of countries and spanning over 60 years. From this, the more recent, more comprehensive and more useful sources were selected for use in this review, with special attention to excellent existing reviews by the most reputable and respected, active authors.

The nature and scope of the literature sources is variable, uneven and unequal and address a very wide range of issues that affect the impact of adverse weather conditions on livestock production and wellbeing. This made it difficult to compare findings and consolidate them into reasonable conclusions; however in spite of this there are many useful principles and important consensus findings that can be implemented by the ruminant livestock industry.

A total of 29 valuable terms used in the evaluation of weather stress are defined, and 15 have formulas supplied on how they are calculated. One has 6 formulae quoted, illustrating the problem of comparing data. These terms are important in interpreting the implications of findings.

Of 40 factors that impinge on weather or thermal stress, 22 were of an environmental nature. The major ones were ambient (air) temperature (including extremes, duration, and variation), solar radiation (including duration and intensity), relative humidity, wind speed, and rain. Others were shelter (type, quality, and availability), topography, latitude, altitude, drinking water availability, nutrition, climate change, wallows and others (snow, hail, lightning, worry insects).

The major animal factors found were species, breeds, breeding, production, reproduction and adaption, while other important factors were individual animal and farm differences, body size, age, skin (surface area, sweat glands, counter current blood flow, blood vessel dilation, coat colour, coat length), body condition score, pregnancy, lactation, parity, acclimatisation and behaviour (coping with thermal distress).

The most useful animal measurements of heat stress found were respiration rate and rectal temperature. Others less useful, practical or specific were heart rate, skin temperature, thyroxin, cortisol, livestock behaviour, and a range of production and reproduction parameters. Behavioural changes are useful but difficult to measure. Single measurements of environmental climatic factors like ambient temperature are not recommended, the most commonly preferred indexes used are Thermal-Humidity Index (THI) for heat stress and Wind Chill Index (WCI) for cold stress, but more comprehensive index as like the Comprehensive Climate Index (CCI) are more fully descriptive of major factors involved.

The effects on livestock of heat or cold weather stress largely follow these measurements, however the increasingly deleterious effects on livestock production and reproduction outside thermoneutral zones can be used to persuade farmers to implement mitigating measures such as shelter provision.

Several practical measures to mitigate weather stress were found that can be implemented immediately, if not already done. The most important measure that can

be taken is breeding the right animal for the environment in which it is expected to thrive. The second is correct nutrition for ambient conditions and provision of potable drinking water. The third is the provision of appropriate shelter (for either heat or cold distress) that may be natural or artificial and available and sufficient to ameliorate conditions increasingly further outside the thermoneutral zone. Other measures found were ensuring the correct body condition score at times of thermal stress, provision of misting/sprinklers, use of ventilation fans, appropriate bedding, limiting movement, ensuring sufficient acclimatisation, catering for the needs of special animal categories, and noting warning signs that animals are going outside their comfort zones as a sign that action should be taken.

The ruminant livestock industries should implement the clear findings of this survey, inform their members, establish the availability of weather data nationally for use in warming systems, identify and fill research gaps, use standardised measurements and include mitigations of weather distress in their Codes of Best Practice.

CONCLUSIONS

There is a huge database of several hundred articles from many countries worldwide, but the information is of uneven value that is often fragmentary and thus difficult to compare and synthesize. Changes that occur decades, differences in measurements used and differences between regions complicate the complex picture that emerges.

Homotherms such as domestic ruminants have individual ranges of climatic circumstances over which they are capable of adjustment to cope with the environment; however species, breed and production levels or stages modify these ranges; this further complicates assessments and recommendations.

Weather stress and distress is episodic, not constant, and is to some degree rather unpredictable.

Thermal stress comprises both excessive heat and cold, and these have 40 factors that contribute to or influence the impact on animals. The major environmental factors for temperature stress are ambient (air) temperature, radiant heat, relative humidity, wind and rainfall, while the major animal factors are species, breed, adaption (fitness) to climate, production level, and stage of reproduction.

The main effects of weather stress on livestock are observed in rectal temperature, respiration rate, heart rate, thyroid function, cortisol, milk quality and quantity, reproductive performance, and behavioural changes. Inclusion or exclusion of measurements adds to the difficulty of drawing conclusions, and data can be interpreted differently.

Respiration rate and rectal temperature are the most practical, specific and dependable measurements of heat stress in ruminant livestock. Environmental indicators are best combined as indexes, for heat stress the Thermal-Humidity Index is commonly used while for cold stress the Wind Chill Index is preferred. However, these indicators omit some of the major influencing factors and thus there is room for improvement by using more complex indexes like the Weather Index or

Comprehensive Climate Index, but bearing in mind that the most common stress factor in South Africa is heat stress.

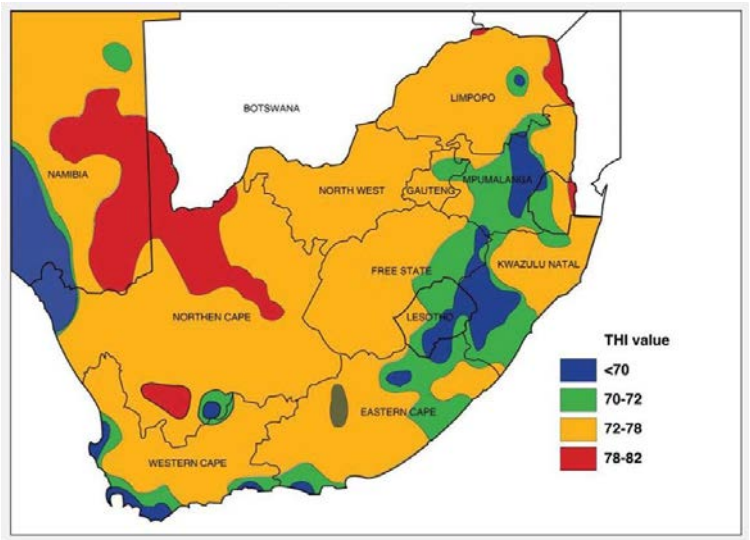
There is unequivocal evidence that as ruminant livestock are exposed to an environment that lies further outside their thermoneutral zones, this has an increasingly deleterious effect on both animal production parameters and welfare. This finding alone should convince the livestock industry to take action to minimise or control all the factors that give rise to thermal distress. Using standard defensible, practical indexes to indicate where action must be taken should be a priority.

Amongst the mitigative measures that must be encouraged, breeding animals that are well adopted to the environment (to cope with ambient weather conditions) should be a top priority. Provision of the correct nutrition to suit local circumstances as well as sufficient drinking water in hot weather are further practical measures that should be recommended.

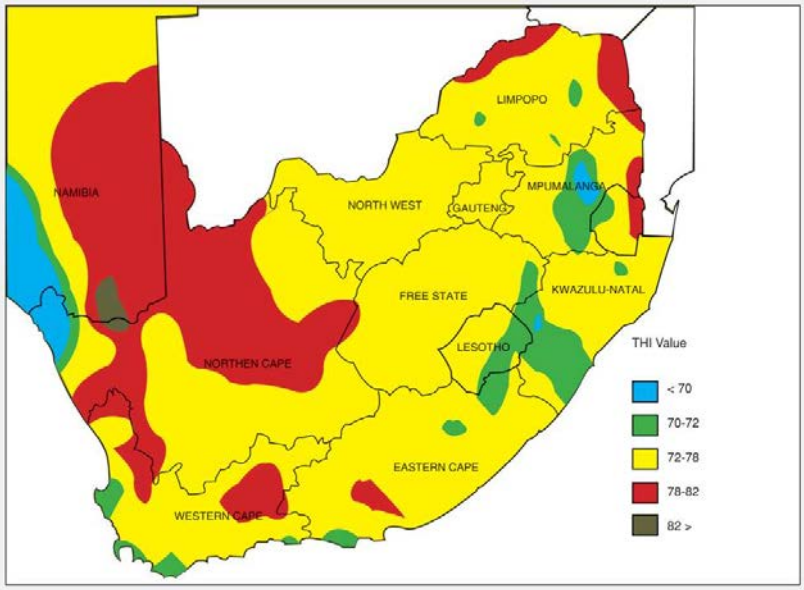
The provision of suitable shelter is the other major finding which should be provided when livestock are exposed to conditions that are increasingly outside their thermo-adaptive zone, in South Africa this is mainly shade to protect livestock from high solar radiation.

Existing research in South Africa needs to be supplemented by further work to fill gaps in our knowledge. Increasing concerns for the welfare of livestock are most likely to increase, and the industry should facilitate the appropriate actions that result in mitigation as well as minimisation of thermal distress, both from humane as well as farm efficiency considerations. The image of red meat and other products of ruminants must be protected by ensuring that they are kept in conditions that improve their welfare to the greatest extent possible. Consumers increasingly expect that the products they consume should come from animals kept in welfare-friendly environments.

The extent and distribution of danger areas appear in the accompanying figures (Du Preez 2015)



Figuur 1: Kartering van Suid-Afrika en Namibië volgens die lewende hawe klimaatveiligheidsindeks vir lakterende melkbeeste, vir die vyf warmste maande (November tot Maart) van die jaar.



Figuur 2: Kartering van Suid-Afrika en Namibië volgens die lewende hawe klimaatveiligheidsindeks vir lakterende melkbeeste, vir Januariemaand van die jaar.

TABEL 4: DIE MINIMUM VOORKOMENDE MAATREËLS WAT GENEEM BEHOORT TE WORD TER BESKERMING OF VERLIGTING VAN HITTE-STRES BY MELKBEESTE (SIEN FIGUUR 1, FIGUUR 2 EN FIGUUR 3).

TEMPERATUURHUMIDITEITSINDEKS-WAARDE	LEWENDE HAWE KLIMAATVEILIG-HEIDSINDEKS VIR MELKBEESTE	MINIMUM VOORKOMENDE MAATREËLS
70 of minder	Normaal (Figuur 1, blou)	Natuurlike of kunsmatige skadu
70 tot 72	Waarskuwing tot kritieke indeksvlak vir melkproduksie (Figuur 1, groen) Kritieke temperatuurhumiditeitsindeks vir melkproduksie is 72 en vir reproduksie 65	Bogenoemde asook versekerde ventilasie in skadu-areas. *Ad lib* drinkwater* wat in die skadu is
72 tot 78	Waarskuwing tot bo kritieke vlak vir melk-produksie (Figuur 1, oranje)	Bogenoemde asook besprinkeling (natspuit) en kunsmatige lugbeweging in die hou-area van die melkbeeste voor die melkportaal; dieetaanpassings**; oorweging van die melkras wat aangehou word***; dierever-sorging en bestuursveranderings
78 tot 82	Gevaarlik (Figuur 1, rooi)	Bogenoemde asook skaduvoorsiening en lugbeweging by voerbakke
82 en meer	Nood	Bogenoemde oorweging moet geskenk word of daar met melkbeeste geboer moet word

* Die voorsiening van koel drinkwater (± 20°C) is ideaal
** Die konsentraatgedeelte van die dier kan verhoog word met 'n afname in die ruvoer. Die melkkoei blyk 'n groter behoefte aan kalium te hê onder hittestrestoe-stande. Die diere moet indien moontlik gedurende die koeler periodes van die dag gevoer word. Voorsien voer wat 'n laer hitte-inkrement het. Vet het die laagste hitte-inkrement, gevolg deur koolhidrate en proteïene
*** Jerseys verdra hoër aanvoelbare omgewingstemperature beter as Holsteins
Beperk hantering van die diere wat stresvol is gedurende die warmste gedeelte van die dag. Oorweeg verandering van melktye. Dip en enting van die melkvee moet gedurende die koeler tyd van die dag of moontlik snags uitgevoer word

Minimum preventive measures for heat stress in dairy cows (du Preez 2015).

RECOMMENDATIONS

- The red meat industry needs to accept the importance of weather stress as it affects both animal production and animal welfare, particularly in the light of the likelihood of climate change that will worsen the situation.
- Ruminant livestock farmers will require a sustained awareness and information education campaign that emphasizes the effects of increasingly adverse weather

conditions on both production and welfare and the absolute necessity of taking the appropriate practical and cost-effective measures to minimise the risks of farming.

- A consensus approach is necessary to arrive at an agreed methodology for measuring environmental impacts on livestock using affordable, readily available and practical weather measurements converted to robust and dependable indexes, together with the determination of realistic categories that indicate the seriousness of thermal stress and the need for action.
- Industry should agree on a few simple, robust and practical ways to determine the degree of heat stress – respiration rate and rectal temperature are the most likely candidates.
- The SA Weather Service should be approached to investigate the feasibility and availability of using existing weather data to be converted to risk indexes for thermal distress, to be made available to the Red Meat Industry for rapid distribution to farmers as an alert that preventive action is needed (http://sarva2.dirisa.org/). In particular, ambient temperatures, relative humidities, sunshine hours, wind and rainfall forecasts will be useful to distribute early warning systems nationwide.
- The most important practical and affordable current ways of lowering the risk of thermal discomfort should be disseminated to farmers for their implementation, if not already in place. These include breeding the right animal (adapted to the environment), provision of potable drinking water (for heat stress), correct nutrition (for hot and cold conditions) and the provision of appropriate shelter for both heat and cold distress.
- Existing information is incomplete and the Industry should identify those aspects needing attention on further research. These include targeting livestock breeds that have been given scant attention, including beef cattle and wool sheep in inland areas or with high humidity. In particular there should be investigation into practical, robust, affordable and moveable livestock shelters in areas where this is shown or is likely to yield a satisfactory return on investment, both financial and for animal welfare.
- A set of industry norms should eventuate and ultimately be included in Codes of Best Practice for individual industries