LIGHT FEEDLOT SHADE STRUCTURE: AN ENGENEER-DESIGN

STRUTTURE OMBREGGIANTI LEGGERE PER RECINTI DI ALLEVAMENTO: UNA PROPOSTA TECNICA

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SUMMARY

An ideal shade structure would be durable, cheap, and would be able to be taken down easily and folded for storage in winter. Moreover, the tension cables of the structure would create no boundaries for animal circulation. Two types of shade structures are used by the feedlot industry: iron sheets attached to cables or shade cloth. Shade cloth is not the preferred roofing material as the stitching can deteriorate, requiring replacement of the cloth or stitching every 3-5 years. New technologies are now offering life spans of up to 10 years. However, shade cloth can be affected by hail damage, bird chewing or pen cleaning machinery exhaust pipes that can burn holes in the cloth. Cloth must be placed well above machinery. Current feedlot shade designs have evolved over time. Most are of simple design to minimise capital and ongoing maintenance costs. However, even though the structures are agricultural, structures of such size should be engineer-designed and certified. This includes the structural connection details, especially where tensioned cables are involved, and the fixing details for the corrugated cover sheeting. Constraint for support poles and for tension cables become one of the major structural part to achieve safety in working loose during high winds or a storm.

Key words: shade structure, shade cloth, structural details.

RIASSUNTO

Una struttura ombreggiante ideale dovrebbe essere durevole, economica e facilmente smontabile per riporla durante la stagione invernale. Inoltre i cavi di ancoraggio non dovrebbero creare impedimenti alla libera circolazione degli animali. Due tipi di coperture ombreggianti sono utilizzate abitualmente: le lamiere grecate in acciaio zingato o i teli ombreggianti. I teli ombreggianti non sono il materiale preferito poiché le cuciture si deteriorano rapidamente e necessitano un rimpiazzo dopo 3-5 anni. Nuove tecnologie costruttive hanno però allungato la vita utile a 10 anni. Comunque i teli ombreggianti sono passibili di danni causati dalla grandine, dagli uccelli, o dai tubi di scappamento dei macchinari utilizzati per la pulizia dell'area sottostante, che possono produrre delle bruciature: per questo i teli dovrebbero essere posti ad una altezza ben al di sopra dei macchinari stessi. Le attuali tendenze progettuali si sono evolute nel tempo partendo da semplici richieste di economicità e bassi costi di gestione. Comunque, anche se le strutture sono utilizzate in agricoltura, esse dovrebbero essere progettate e certificate. Soprattutto nei particolari costruttivi di connessione quando sono utilizzati dei cavi in tensione,

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e nei particolari di fissaggio delle lamiere. Le fondazioni per i montanti e per i cavi di tensione divengono così una delle parti più importanti per raggiungere una sicurezza contro rotture durante condizioni di vento forte o tempeste.

Parole chiave: strutture ombreggianti, teli ombreggianti, particolari costruttivi.

INTRODUCTION

The impact of heat stress is prominent on dairying in hot climate Mediterranean areas. Solar radiation and elevated ambient air temperature are the primary sources of heat gain from the environment. High relative humidity and a lack of air movement worsen the situation. Evaporative cooling with water in the form of fog, mist or

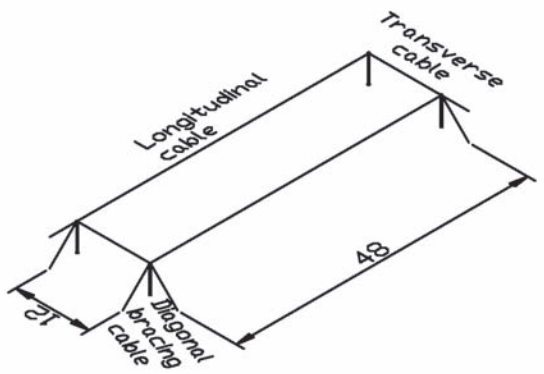

Fig. 1. Position of the tension cables.

sprinkling with natural or forced air movement is an active and effective method for altering the environment (Armstrong, 1994; Bucklin et al., 1991; Beede et al., 1987) The provision of shade is classified as a passive method; nevertheless it can be of great relevance in the cattle management. (Wiersma, 1982; Mitlöhner et al., 2001a-b; Muller & Botha, 1997)

In hot climate areas during the hottest hours of the day, animals seek the protection of shade. Two options are available: natural or artificial shade. Regardless of the type of artificial shade structures there are a number of factors to consider with respect to design, maintenance, and initial cost.

Major design parameter for shade structures include: 1) orientation and location on feedlot, 2) floor space, 3) height, 4) ventilation, 5) roof material and slope, 6) structural connection details, 7) feeding and water facilities, and 8) waste management

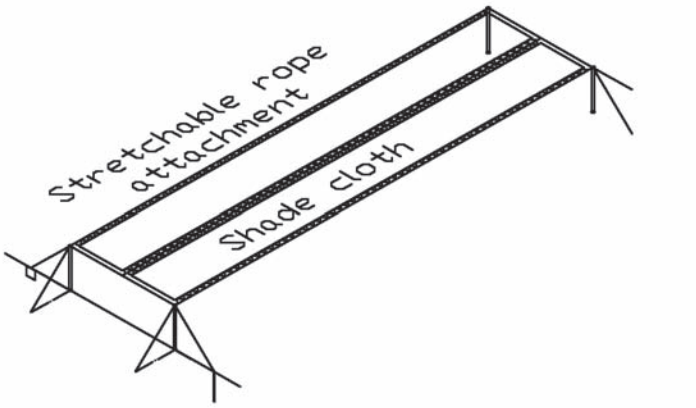

Fig. 2. Position of the stretchable rope attachment.

system (Shearer et al., 1999).

The aim of this paper is to deal with the engineer-design of a light and easy to remove shade structure.

DESCRIPTION OF THE STRUCTURE

A simple structure would be designed to support light dead loads and especially great wind loads.

As such, shade cloth provides the lowest load of roof material. Two types of shade

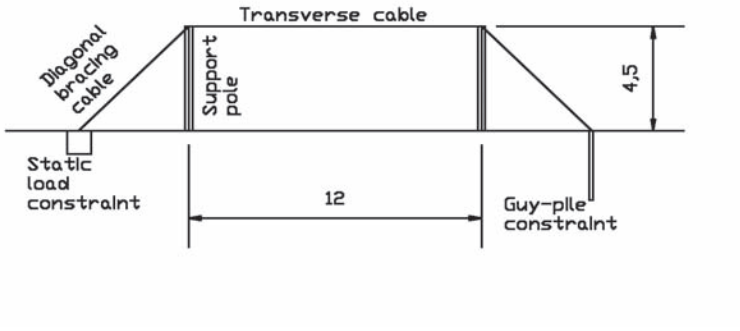

Fig. 3. Size and nomenclature of the structure details.

structures are used by the feedlot industry-iron sheets attached to cables or shade cloth that is either permanently fixed or furlable (Anonymous, 2002).

Shade cloth is generally less expensive than solid roofing material. However, shade cloth durability may not be as good as that of solid roofing materials. If shade cloths are removed and stored during the winter mice can damage the stored material. Natural air movement under a shade structure is affected by the ease with which air can move through the structure. As such, shade cloth does have the advantage of allowing air to pass directly through the material, whilst structures constructed from galvanised sheeting require openings to assist air movement.

To restrain the structure from movement caused by wind, a system of support poles and tension cables would be designed in accordance to local laws (i.e., in Italy, D.M. L.P. 16-01-1996. Norme tecniche relative ai "Criteri generali per la verifica di sicurezza delle costruzioni e dei carichi e sovraccarichi").

Structural details have incorporated concrete pillars to protect the base of the main steel poles from corrosion caused by manure on the pen floor. The proposed structure is designed to provide a simple and easily implemented way to change the roof covering. The proposal (Fig. 1) is based on fixed tension cables and exchangeable shade cloth.

The fixed cables are integral to the structure and should be of a strong, durable material, such as marine steel. The appropriate stretching of the fixed cables and the covering cloth is very important – to minimize flapping caused by the wind – and can be aided by, for example, a simple rope stretchable attachment at the cable-cloth interface (Fig. 2). Clamps with buttonholes provide a good attach system. When the proposed structure is used to cover a large area, the tensioning can be made easier by the addition of tensioning turning wheel to the tension cable that is attached to the boundary of the structure.

The proposed covering method transfers the wind loads to the structure securing the shade cloth at the edges of the structure. Therefore, structure size would be a single or a multiple of the shade cloth width, positioning a tension cables between a cloth and its neighbour-cloth. As such, changing the covering sheets is simple and easily done, as all the work is done at the cloth-edges, which are readily accessible.

The proposed structure is characterized by low cost, and simple and easy erection and maintenance, and it should be suitable for feedlot shade structure. As shown in Fig. 3, the proposed structure is modular and comprises the following components:

a) longitudinal cables placed at the same height to form eaves configuration

b) transverse cables that serve as integral stabilizers of the structure and also to transfer the wind loads

c) tension bracing cables that assures the transfer of wind load to the footings

d) support poles that are used to provide vertical support for the longitudinal cables

e) constraints for support poles and , above all, for tension cables

Two kinds of constraint are under evaluation: the static load type or the guy-pile type (Fig. 3). The static load type is a permanent constraint that require a large use of concrete, while the guy-pile type provides an anchorage by screwing or hammering a

pile in the ground. In theory these kind of piles are removable, but it depends on their good state.

CONCLUSIONS

The evaluation of the major design parameter for shade structures led to focus on constraints, support poles, and tension cables to provide an inexpensive and rapid to build up structure. Moreover, modular size of the structure with respect to shade cloth width was discussed. The appropriate stretching of the covering cloth is very important – to minimize flapping caused by the wind – and can be aided by a simple rope stretchable attachment at the cable-cloth interface. Further study should be directed towards detailed design of various structural elements and a quantitative evaluation on a commercial scale.

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