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Buildings for Dairy Cattle Husbandry in Arid and Semi-Arid Areas

High summer temperatures in Near East countries present a large problem for dairy cattle husbandry. These predominant climatic conditions cause significant milk yield losses of about 70 percent in local breeds compared to European high yield cattle [2, 5]. Through proper adaptation in the planning and implementation of (stable) buildings, choice of materials, as well as of ventilation systems, the typical regional influences on the animals' well-being can be minimised.

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Keywords

Dairy cow stable, milk yield, semi-arid areas, house ventilation, natural ventilation

The lack of milk and milk products is a large nutritional problem for people in countries with arid and semi arid climates. While milk production in Germany is 342 kg/a per person, in Syria, it is 83 kg/a [5]. In order to reduce milk imports from Europe, deficits in domestic production should be compensated with European breeds.

In arid and semi arid areas such as Syria, average daily peak temperatures reach 33 °C in the summer months (*Fig. 1*). These extremely high temperatures are an enormous stress for the high performance cows, causing their performance to drop by about 30 percent when the temperature passes the 24 °C point (*Fig. 2*). The optimal temperature range for the cows is between 12 and 24 ° C. This is an almost impossible problem for planners in the region to solve. In conventionally built, closed stables, the heat generated from sunshine and from the body temperature of the animals, as well as the polluting gases emerging from excretae, lead to an extremely problematic stable climate. As a rule, control of the climate through the use of air conditioning is not possible due to the high investment and maintenance costs. Milk production is then not viable.

Goals

The study seeks new solutions and alternatives for the construction of dairy cattle stables in arid and semi arid areas and evaluates whether a reduction of interior stable temperatures is possible through cleverly adapted planning, using „natural construction materials" and „free ventilation".

Concept

The air temperature decreases to about 17 °C at night in the summer months, so that the temperature difference between day and night is 15 K [1]. The relatively constant wind from one direction reaches an average speed of 7 m/s. These climatic particularities must be optimally exploited in the stable planning. In the variation presented here - out of a total of three different solution possibilities - a strongly partitioned and massively planned building is considered (*Fig. 3*). The stable is centered around a feeding table and consists of four square units with the functional areas: feeding, lying and movement, each for 45 cows. The two milking parlours with the necessary auxiliary rooms are each assigned to two stable units. The facility is complemented with further buildings sections with a calving area, calf raising area and heifer area as well as lying boxes-loose housing stables for heifers and dry cows. A run area with a roofed lying area is available for all animals. It must be noted that in this proposal (within the framework of a doctoral paper) special emphasis was placed on a demanding and regionally typical architecture.

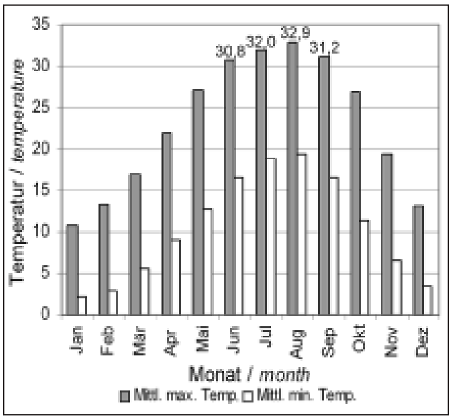

Fig.1: Average maximum and minimum temperatures of Homs city, Syria (acc. to [1])

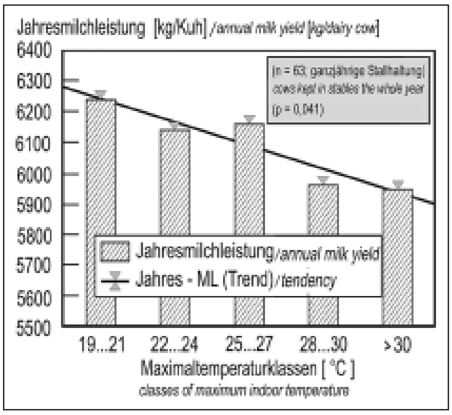

Fig. 2: Average annual milk yield of cows versus maximum stable temperature (acc. to [2])

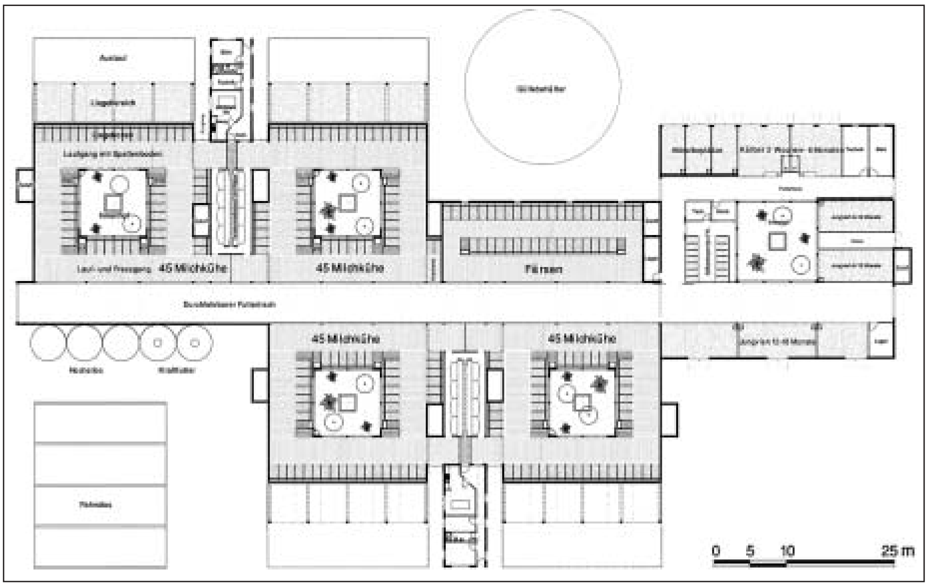

Fig. 3: Ground planof stable building described for 180 cows and followers

Ventilation Concept

In order to save energy and minimise the maintenance costs, the stable is run with „free ventilation“. The relatively thick exterior walls are massive, supporting walls and reduce the heating of the stable interior, or at least delay it. For this reason the roof is in a clamshell format tilted to the interior yard with a smooth, light and reflective surface. Each unit has a green atrium which is covered with a panelled construction during the day. At night the cooler air sinks into the then open area and is drawn into the stable on the following morning (*Fig. 4* - left). Through water containers in the interior yard and beneath the building, adiabatic cooling (evaporation cooling) is used. The air supply is enriched with moisture, which causes additional cooling.

During the day, the air supply via the 18 m wind catchers directed towards the main west/southwest wind direction are captured and carried through channels into the soil area under the building in the stable areas. The almost constant wind from one direction with a relatively high flow speed of 7 m/s favours this approach. Thus in the stable buildings air speeds of from 0.2 to 0.5 m/s and air exchange rates of 600 m^3/GV can be attained. (*Fig. 4* - right).

Summary

The not yet completed study with its three variations should provide constructive solutions with low maintenance costs. It should provide the possibility to produce milk at acceptable cost in arid and semi arid areas. With the help of model studies, flow calculations and temperature measurements for the stable described here in massive from are compared with a half-openî variant and a light weight construction variation.

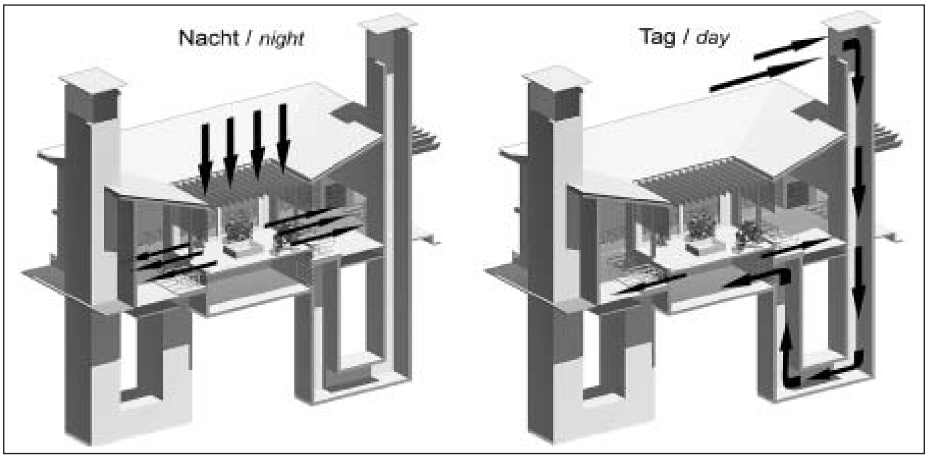

Fig. 4: Perspective presentation of principle for day ventilation and for night ventilation

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