STANDARDS AND REAL PARAMETERS OF DAIRY FARM TECHNOLOGY IN CZECH REPUBLIC

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Abstract

The aim of this study is to evaluate the current conditions of buildings for dairy farming and show promising methods important for the further development in this area of agricultural production in the Czech Republic. The paper contains an analysis of the current technical state of cowsheds including milking parlours and waiting rooms. Attention is paid to the types of barns and construction materials and to the technical implementation of technological equipment with regard to animal welfare. The required parameters are evaluated according to scientific literature. For the purposes of this study there were examined several new and modernized objects for dairy farming of different design concepts and age. Technological equipment for housing, dimensions and location of feeding and watering troughs, manipulation with manure and other equipment to enhance animal welfare were examined. The types of milking parlour, movement of cows on the farm and methods of heating and ventilation were studied.

Key words: cowshed, milking parlour, waiting room, welfare.

INTRODUCTION

Livestock production in countries with intensive agriculture is currently undergoing big and rapid changes. These changes are also taking place in many dairy farms. If farmers want to be competitive, they must achieve bigger milk yields and higher quality of milk, partly thanks to the better milking system on the farm. Capacity of the farms is expanding and increasing is also the average annual milk production per cow. The number of dairy cows was reduced significantly in the last twenty years in the Czech Republic. Vice versa, average milk yield was significantly improved during this period. There were 1,989,000 cows with average milk yield of 4,117.2 $l.cow^{-1}$ in the Czech Republic in 1995. In 2013, there are 552,000 cows with average milk yield of 7,443.4 $l.cow^{-1}$ in the Czech Republic (ČSÚ, 2014). Development of the dairy farms needs also new constructions of barn and modernization of older buildings. Similar problems on dairy farms are solved not only in the Czech Republic but also abroad (GAWORSKI & LEOLA, 2014; GAWORSKI & PRIEKULIS, 2014).

The cattle were kept on pasturelands or small family farms in previous times (VEGRICHT ET AL., 2008). The period of collectivization and large scale farming began in the fifties of the 20th century. Big cowsheds were mostly masonry or wooden constructions. Tie-stall housing was preferred during that period. However, nowadays almost everywhere is preferred loose housing of dairy cows which is spread to Europe from the US in the second half of the 20th century (SÝKORA, 2014; RIST, 1994). After 1989, began the transition to breeding cows with high milk production in the Czech Republic. This resulted in the formation of new breeding technologies, reconstruction of old barns and building of completely new cowsheds (DOLEŽAL ET AL. 2002).

The aim of this study is to evaluate the current conditions of the buildings for dairy farming and to show promising methods important for further development in this area of agricultural production in the Czech Republic. The paper contains an analysis of the current technical state of the cowsheds including milking parlours and waiting rooms.

MATERIALS AND METHODS

For the purposes of this study there were examined 7 farms (A – G) for dairy farming of different design concepts and age. There were examined 2 different cowsheds at farm B (B1 and B2). We examined also parameters of milking parlours and waiting rooms belonging to the cowsheds. The research is based on the investigation of required parameters personally in the real conditions in the farms, by discussions with designers, managers and farm workers and by evaluation of technical documentation and designs representing the most common types of dairy farms and cowsheds.

In particular, the following parameters were investigated and collected in cowsheds: housing capacity; type of construction and building materials; dimensions; housing technology; internal corridors; dividing barriers and feeding and watering equipment; type of beds; type of slurry and manure removal; ventilation and cooling systems; using of the cow brushes, or other facilities for animal welfare improvement.

Following parameters were investigated in the milking parlours and waiting rooms: the length of the transition into the milking parlour; type of milking equipment; methods of heating and ventilation; number of workers; capacity and dimensions of waiting rooms. To compare different cowsheds, many evaluated parameters were recalculated to specific values per one dairy cow.

RESULTS AND DISCUSSION

The results of our investigation in cowsheds are shown in the Tab. 1 (farm A – C) and Tab. 2 (farm D – G). The results of our investigation in milking parlours and waiting rooms belonging to the cowsheds are presented in the Tab. 3.

The barns are often constructed as a frame construction. The common materials used for supporting structures are: steel, timber, concrete, and masonry (MÁLEK, 2002).

- The most common type of cowshed barn is a steel structure. It is used for construction of cowsheds B1, E and G. The width can be to 36 m without internal support columns (BELADA, 2005).
- Wood is a traditional material suitable for agricultural buildings. There different types of timber constructions (used at farms C and D), however the supporting columns are required in this cowsheds (BELADA, 2005).
- The newest type is a lattice structure in combination with cloth envelope (farm F) (SÝKORA, 2014).
- The bricked constructions are used only in the case of old reconstructed cowsheds (A and B1).

The module of the old renovated cowsheds is 4.5 m (farm A and B1); the newly built cowsheds use mostly the module of 4.8 m or 6 m (farm D).

Indoor air quality is affected by the volume of the barn. Recommended value of specific cowshed volume is 42 $m^3.cow^{-1}$. This value ensures relatively good transfer of excess body heat into the environment. It is also the space which captures excess water vapour, CO_2 and other pollutants (DOLEŽAL ET AL., 2002; BOUŠKA ET AL., 2006). This requirement is not fulfilled just in case of reconstruction cowsheds. The newly built barns have more than sufficient volume per cow. The trend is to build cowshed with higher volume per cow. The requirement on minimum specific area 7.5 $m^2.cow^{-1}$ according to (DOLEŽAL ET AL., 2002; BOUŠKA ET AL., 2006) is fulfilled in all cowsheds.

There is used the roll tarpaulin for inlet of fresh air on the side walls to ensure sufficient ventilation in the barn. The dimensions of the roll tarpaulin should correspond to the requirement of 0.23 $m^2.cow^{-1}$ (DOLEŽAL ET AL., 2002). This requirement is fulfilled in all cowsheds except the cowshed at farm A (there is not used the roll tarpaulin). The trend is to ensure a higher area of roll tarpaulin per cow in the modern cowsheds. Outlet of the warm and humid air ensures the ridge slit whose specific width should be 0.025 m per 1 m of stale width (DOLEŽAL ET AL., 2004). Also this requirement is fulfilled in all cowsheds except the cowshed at farm A. The roof slope is also important for sufficient ventilation. The requirement of minimum roof slope 15° (optimally 20°) according to (DOLEŽAL ET AL., 2002) is fulfilled at all newly built cowshed.

The dimensions of internal corridors are designed with respect to passing of cows. Comfortable width of manure corridor should not be less than 2.5 m, preferably 2.7 m and more. Also applies that the wider the corridor, the lower layer of excrement. The minimum size of the feeding corridor is 3.3 m (DOLEŽAL ET AL., 2002). The width of the feeding table should be at least 3.8 m (DOLEŽAL ET AL., 2004). The results of our research show that the dimensions of these corridors correspond with the recommendation in all cowsheds.

Specific length of feeding trough should be at least 0.52 $m.cow^{-1}$ (cow to trough ratio 1.5 : 1) or 0.72 $m.cow^{-1}$ (cow to trough ratio 1 : 1) (DOLEŽAL ET AL., 2004). However the results of our research show that in many cowsheds (B1, B2, D, E and G) the specific length of trough is shorter. Only in cowsheds at farm A, C and F is this parameter of welfare sufficient.

Watering troughs are usually located in passageways to the feeding area. The optimum length of watering edge is 0.1 $m.cow^{-1}$, but it should not be shorter than 0.05 $m.cow^{-1}$ (DOLEŽAL ET AL., 2002; DOLEŽAL ET AL., 2004). The results of our research show that this optimum length is fulfilled mainly in the newly built cowsheds.

Loose housing can be solved as a cubicle or in group pens (BOUŠKA ET AL., 2006). According to the Czech

standard the minimum width of the cubicle is 1.1 m, the minimum length of single cubicle is 2.3 m and the minimum length of double cubicle is 4.1 m (208/2004 SB). However in practice are recommended these dimensions: single cubicle 1.2 x 2.5 m and double cubicle 1.2 x 4.6 m (DOLEŽAL ET AL., 2002; BOUŠKA ET AL., 2006). This is confirmed also by our research. Another option of loose housing is in group pens, which is used at farm F. For the housing in group pens it is necessary to ensure the specific area of 5 m^2 per cow (208/2004 SB). The specific area of the group pen is 5.4 $m^2.cow^{-1}$ at farm F.

Tab. 1. – Parameters of cowsheds at farm A – C

Parameter	A	B1	B2	C
Type of building	old barn	old barn	new barn	new barn
Year of construction	1996	2001	2001	2003
Type of construction	bricked	bricked	steel	wooden
Structure of side wall	masonry	masonry	wood and roll tarpaulin	wood and roll tarpaulin
Structure of front wall	masonry	masonry	masonry and metal sheet	wood
Number of cows	120	237	360	200
Height of cowshed, m	3	5	7.4	9.6
Width of cowshed, m	19.4	30.7	31.7	31.5
Length of cowshed, m	81.8	68.9	94.2	57.8
Module, m	4.5	4.5	4.8	4.8
Roof slope	0°	11.5°	16°	20°
Area, $m^2.cow^{-1}$	13.22	8.93	8.29	9.10
Volume, $m^3.cow^{-1}$	39.67	35.70	42.31	61.00
Area of roll tarpaulin, $m^2.cow^{-1}$	0.00	0.70	0.63	1.04
Width of ridge ventilation slot per 1 m of barn width, $m.m^{-1}$	0.000	0.036	0.025	0.038
Width of feeding table, m	3.75	4.30	4.50	5.00
Width of feeding corridor, m	3.00	3.40	3.55	3.40
Width of manure corridor, m	3.50	2.50	2.60	2.60
Length of feeding trough, $m.cow^{-1}$	0.67	0.50	0.46	0.52
Number of watering troughs	4	8	12	8
Watering trough, $m.cow^{-1}$	0.05	0.06	0.06	0.09
Housing technology	straw-bedding	bedding-free	bedding-free	straw-bedding
Beds	straw	rubber	rubber	straw
Slurry or manure removal	mobile scrapers	scrapers	scrapers	mobile scrapers
width of cubicles, m	1.125	1.125	1.2	1.2
Length of single cubicles, m	2.4	2.4	2.5	2.5
Length of double cubicles, m	not used	4.6	4.8	4.7
Cow brushes	no	no	no	no
Cooling systems	no	no	no	no
Ventilators	no	no	no	no

Tab. 2. – Parameters of cowsheds at farm D – G

Parameter	D	E	F	G
Type of building	new barn	new barn	new barn	new barn
Year of construction	2007	2008	2012	2014
Type of construction	wooden	steel	lattice steel	steel
Structure of side wall	wood and roll tarpaulin	concrete, roll tarpaulin	concrete and roll tarpaulin	concrete and roll tarpaulin
Structure of front wall	wood	concrete and metal sheet	cloth	concrete and metal sheet
Number of cows	254	352	160	368
Height of cowshed, m	10.4	11.3	14.6	11.4
Width of cowshed, m	32.6	33.6	36	34
Length of cowshed, m	66.5	101.2	62.4	91.2
Module, m	6	4.8	4.8	4.8
Roof slope	22°	23°	30°	22°
Area, $m^2.cow^{-1}$	8.54	9.04	14.04	8.43
Volume, $m^3.cow^{-1}$	60.59	73.89	127.81	66.98
Area of roll tarpaulin, $m^2.cow^{-1}$	0.97	1.24	2.03	1.69
Width of ridge ventilation slot per 1 m of barn width, $m.m^{-1}$	0.037	0.027	0.028	0.032
Width of feeding table, m	4.90	5.00	4.90	5.20
Width of feeding corridor, m	3.20	3.60	3.30	3.80
Width of manure corridor, m	2.70	2.50	0.00	3.00
Length of feeding trough, $m.cow^{-1}$	0.50	0.49	0.72	0.45
Number of watering troughs	8	9	8	9
Watering trough, $m.cow^{-1}$	0.09	0.10	0.15	0.14
Housing technology	bedding-free	bedding-free	straw-bedding	bedding-free
Beds	mattresses	mattresses	straw	water mattresses
Slurry or manure removal	slates	slates	mobile scrapers	slates
Width of cubicles, m	1.2	1.2	pens (9x24 m) for 40 cows	1.2
Length of single cubicles, m	2.5	2.7		2.7
Length of double cubicles, m	5	4.8		4.8
Cow brushes	no	no	yes	yes
Cooling systems	no	no	no	yes
Ventilators	no	no	no	yes

The surface of the beds can be made by various materials depending of housing type (straw-beddings or bedding-free). Most common type of these materials is straw, rubber mattresses (DOLEŽAL ET AL., 2004; BOUŠKA ET AL., 2006). In the case of straw-bedding system the slurry and manure are removed mechanically. In the case of bedding-free system the slurry and manure are removed by scrapers or channels covered by slatted floor (DOLEŽAL ET AL., 2002).

The welfare in the cowshed could be improved by cow brushes, cooling system and ventilators. The cow brushes are located near to the watering troughs (DOLEŽAL ET AL., 2002). The cooling system consists of a metallic arm and the supply hose with nozzles. The period of application with minimal water consumption is about 20 – 30 seconds. Satisfactory is 1 sprinkler for 40 cows (DOLEŽAL ET AL., 2004).

Tab. 3. – Parameters of waiting rooms and milking parlours at farm A – G

Parameter	A	B1	B2	C
Walking distance to milking parlour, m	90	135	65	130
Capacity of waiting room	30	90		60
Area of waiting room, $m^2.cow^{-1}$	1.47	1.50		1.50
Type of milking parlour	auto-tandem	rotary		rotary
Capacity of milking parlour	2 x 4	32		24
Number of workers	2	2		2
Ventilation of milking parlour	natural (windows and chimneys)	natural (windows and skylights)		natural (windows and chimneys)
Heating of milking parlour	ceramic emitters and floor heating	heat recovery from milk cooling room		radiant heating panels
	D	**E**	**F**	**G**
Walking distance to milking parlour, m	80	86	70	75
Capacity of waiting room	70	100	40	70
Area of waiting room, $m^2.cow^{-1}$	1.56	1.62	1.70	1.70
Type of milking parlour	side-by-side	rotary	side-by-side	side-by-side
Capacity of milking parlour	2x12	24	2x8	2x12
Number of workers	2	2	2	2
Ventilation of milking parlour	natural (windows and skylights)	forced (over pressure) and skylights	natural (windows and skylights)	natural (windows and skylights)
Heating of milking parlour	heat recovery from milk cooling room	heater of external air	heat recovery from milk cooling room	heat recovery from milk cooling room

Capacity of the waiting room should correspond with number of cows in the biggest production department of the cowshed. In the waiting room is a necessary to ensure area of 1.4 – 1.5 $m^2.cow^{-1}$ (KAVKA, 2003). The results of our research show that this parameter is fulfilled at all farms. Moreover, the trend is to ensure higher specific area for one cow. The length of the transition into the milking parlour should not be longer than 100 m (DOLEŽAL ET AL., 2002). The results of our research show that this distance is sometimes exceeded (B2 and C).

For ventilation of milking parlours is used mostly natural system: windows in combination with skylights or ventilation chimneys. Utilization of heat recovery from milk cooling room is the most common way of heating of the milking parlours. Other options of heating are radiant heating panels, ceramic emitters, floor heating and the heater of external air.

CONCLUSIONS

1. The only used type of housing in the Czech Republic is loose housing with straw-bedding or bedding-free housing technology.
2. The specific volume of cowsheds $m^3.cow^{-1}$ is constantly increasing in recent years.
3. The specific surface of openings for natural ventilation of cowsheds increases.
4. The specific length of the watering troughs increases.
5. More attention is paid to the capacity and dimensions of waiting rooms.
6. There are used mostly side-by-side or rotary milking parlours with 16 or more milking stalls.
7. The equipment for enhance of animal welfare is more common in new cowsheds.

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