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Investigating the impact of the costs for the floor profile on the technological flexibility of six-row buildings for free-box breeding of dairy cows

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Abstract

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28 technical-technological schemes of semi-open six-row buildings common in practice for free-box rearing of milk cows, whose widths vary from 27.70 to 43.40 m, were studied. The options are grouped according to the internal layout of the buildings and a preferred range of widths with maximum technological flexibility is determined. For each variant, the costs of the technological profile of the floor (including stationary equipment) were calculated, and the construction costs of the zero cycle, supporting and enclosing structures of the building were not included. An assessment of the material intensity of the floor profile was carried out according to the construction parameters: consumption of concrete and consumption of steel (reinforcing – for the reinforced concrete floor and profile – for the technological equipment), applied to 1 m^2 of built-up area and to one stock place. According to a methodology developed by us for the qualitative assessment of technological flexibility, taking into account the influence of the mentioned costs in four-row buildings for cows, it was established that with the presence of six rows of boxes, buildings with widths in the ranges of 32.30–34.40 m and 35.20–36.50 m have the greatest technological flexibility. The buildings with widths in the ranges of 31.70–32.30 m and 34.60–35.20 m with equal flexibility also have very good indicators. According to the developed methodology, widths with the same technological flexibility differ when evaluating the influence of costs for the floor profile – to a greater extent in the larger ranges of widths and with less flexibility. According to the costs of concrete and steel for 1 m^2 built-up floor area, the differences are from 0.2 to 3.9%, and according to those for one stock place – from 5.1 to 19.3%.

Keywords: six-row buildings; cows; technological flexibility; floor profile costs; evaluation

Introduction

Over the past 20 years, tied-breeding cow farming has increasingly given way to free-box farming, especially in large-capacity buildings (with 200 and more cows). They are usually arranged as “oversized”, with four or six rows of individual boxes. With the various possibilities for internal distribution and numerous options for combining the sizes of the technological elements, which can vary in certain ranges according to the regulatory requirements, the technologically necessary widths of these buildings vary widely – from 20 to over 40 m (Bickert et al., 2000; Stokes & Gamroth, 2006; Dinev, 2007; Dinev & Dimova, 2007; House, 2015; Prashaw, 2021; Dimova, 2022).

The methods for determining the technologically necessary widths are usually reduced to a search for such a cross-section of a building, in which the maximum number of internal distribution options can be accommodated. A width that meets the stated requirement without resulting in an overspending or a shortage of built-up area can be claimed to have what Dinev (1988) calls "technological flexibility". When moving to future progressive technologies, it should allow accommodation in the building of different production and age categories of animals. At the same time, the aspiration of farmers and designers for better functionality, economic efficiency, and perspective for future development conditions the search for approaches to tie the technology of animal husbandry and architectural-construction parameters of buildings with optimal consumption of construction materials, labor and useful area. Today, closed large-scale buildings are used less and less in the world. Semi-open buildings are preferred, the longitudinal walls of which are replaced by movable curtains (wind blinds). Such buildings have lightweight supporting structures (mostly metal or wooden) and a controlled microclimate, relying mainly on natural ventilation, carried out through the walls and through a lantern formed with open slits along the entire length of the roof (Royer, 2003; Dinev et al., 2017; Prime, 2019; Albers Dairy Equipment, 2021; Wolf System, 2021).

Regarding construction costs for large-scale cattle buildings, some authors (Auernhammer, 1988; Palmer, 2000; Pereira et al., 2003; Holmes et al., 2005) offer information in literature sources, but mostly about general investments required for the supporting and enclosing structures and for the technological equipment, not clarifying what the quantitative costs are for building only the technological profile of the floor. At the same time, the data diverges for different countries. Comparative studies of quantitative costs of concrete and steel, directly related to the technological processes, were made in Bulgaria for the conditions in small cow farms (up to 80 cows) (Dimova et al., 2003; Dinev & Dimova, 2006; Dinev, 2007) and for four and six-row buildings (Dinev, 2007; Dinev & Dimova, 2007). As a result of the dynamics of technological development and the introduction of new, modern techniques for the mechanization and automation of the main technological processes in cow farms, a variety of technological equipment is applicable in modern buildings for cows, the design and dimensions of which vary among the manufacturing companies in different ranges (Limk Ltd, 2021; Trioliet, 2021; Agritop, 2022a, b; Agro-Vista, 2022; Alpha-Mix Ltd., 2022; DeLaval, 2022; GEA, 2022; Patura, 2022). Along with the sizes of the technological elements, this significantly affects the technologically necessary widths of the buildings, which must also comply with the zoohygiene norms in force in the country and the requirements for humane treatment of animals (Technological Norms, 1982; Regulation No. 30, 2000; Regulation No. 16, 2006; Regulation No. 44, 2006; Animal Protection Act, 2008).

In Bulgaria, in recent years, cow farms have been built or are in the process of being built, designed for raising under one roof 200 to 500 and more cows, which are placed in four or six rows of individual boxes. Studies on relationships between technological flexibility and floor profile construction costs in high-capacity buildings are lacking in the literature. In our previous study (Dimova, 2022) the impact of the costs of concrete and steel to form the floor profile on the technological flexibility of four-row buildings for free-box cow farming was evaluated. No similar studies have yet been conducted on six-row buildings.

The purpose of the study was to establish preferred row widths of semi-open six-row buildings for free-box milking cows and investigate the influence of floor profile construction costs on their technological flexibility.

Material and Methods

The object of the study are large-sized buildings for free-box rearing of milk cows with feeding in the building. 28 technical-technological schemes of common in practice six-row buildings with different types of feeding area and rows of individual boxes differently located relative to it were analyzed (Figure 1). The buildings are semi-open (their longitudinal walls are replaced by lifting curtains) and their widths vary from 27.70 to 43.40 m.

The variants are grouped according to the internal distribution of the buildings and are marked with A, B, C, D, E and G as follows:

A_i – variants with a single row of boxes along the longitudinal walls of the building, a double-sided central feeding aisle and a double row of boxes on both sides;

B_i – variants with two single rows of boxes each (along the longitudinal walls of the building and internal), asymmetrically located with respect to the central longitudinal axis feeding aisle and one double row on one side of it between the single rows;

C_i – variants with two single rows of boxes (along one longitudinal wall of the building and an internal one), a double row between them, an asymmetrically located food aisle with respect to the central axis and a double row on the other side;

D_i – variants with three double rows of boxes – two on one side and one on the other side of an asymmetrically located feeding path relative to the central axis;

E_i – variants with one double and one internal single rows of boxes, located on both sides of a central feed aisle;

F_i – variants with two end (to the longitudinal walls) unilaterally used feeding aisles and three double inner rows of boxes;

G_i – variants with two end (to the longitudinal walls) single-sided food aisles, the length of the building is divided into two sectors by a centrally located tubular fence, and in each of the sectors one single (toward the wall) and one double (internal) rows are formed boxes.

Index (i) indicates the type of food area where:

i = 1 is a designation of a food path with bilaterally located food strips (in variants F and G – one strip to the interior of the building) and clamps with occipital restrictive tube;

i = 2 – food path with bilaterally located food strips and grid-type auto-fixers;

i = 3 – feeding path with bilaterally located high mangers and clamps with occipital restrictive tube;

i = 4 – food path with bilaterally located high cribs and lattice-type auto-fixers.

Buildings with entirely concrete floor and skeletal load-bearing structures of steel frames with composite wheelbase – 6.00 m are considered. The subject of the study are only the technological profiles of the floors of the buildings, therefore the construction costs for the load-bearing structures are not taken into account.

During the development of the technical and technological schemes for the variants the minimum and maximum sizes of the technological elements have been adopted, in accordance with the normative requirements in force in our country (Technological Norms, 1982; Regulation No. 44, 2006), good global practices (Tucker et al., 2004; Dinev et al., 2017; DeLaval, 2022; GEA, 2022; Patura, 2022) and the specifics of mechanization for the main technological processes in buildings. It is accepted that each cow has an individual box with a width of 120 cm and a length of 220–270 cm (single row), 220–250 cm (double row). The width of the manure path between the rows of individual boxes is accepted in the range of 200–300 cm, and the width of the manure path to the food path – 300–350 cm or 350–400 cm, depending on the presence of two or three rows of boxes (single or double) on one side. In the absence of a high manger, the feeding paths are of the following width: final – 350–400 cm, inner – 350–500 cm, and their width includes the curbs that separate them from the manure path. In the presence of a manger (width of the manger 70–80 cm) the width of the path is 250–320 cm (final) and 270–340 cm (inner).

A mobile technique has been adopted for the distribution of the fodder – feed trailer – mixer (mixer), moving along

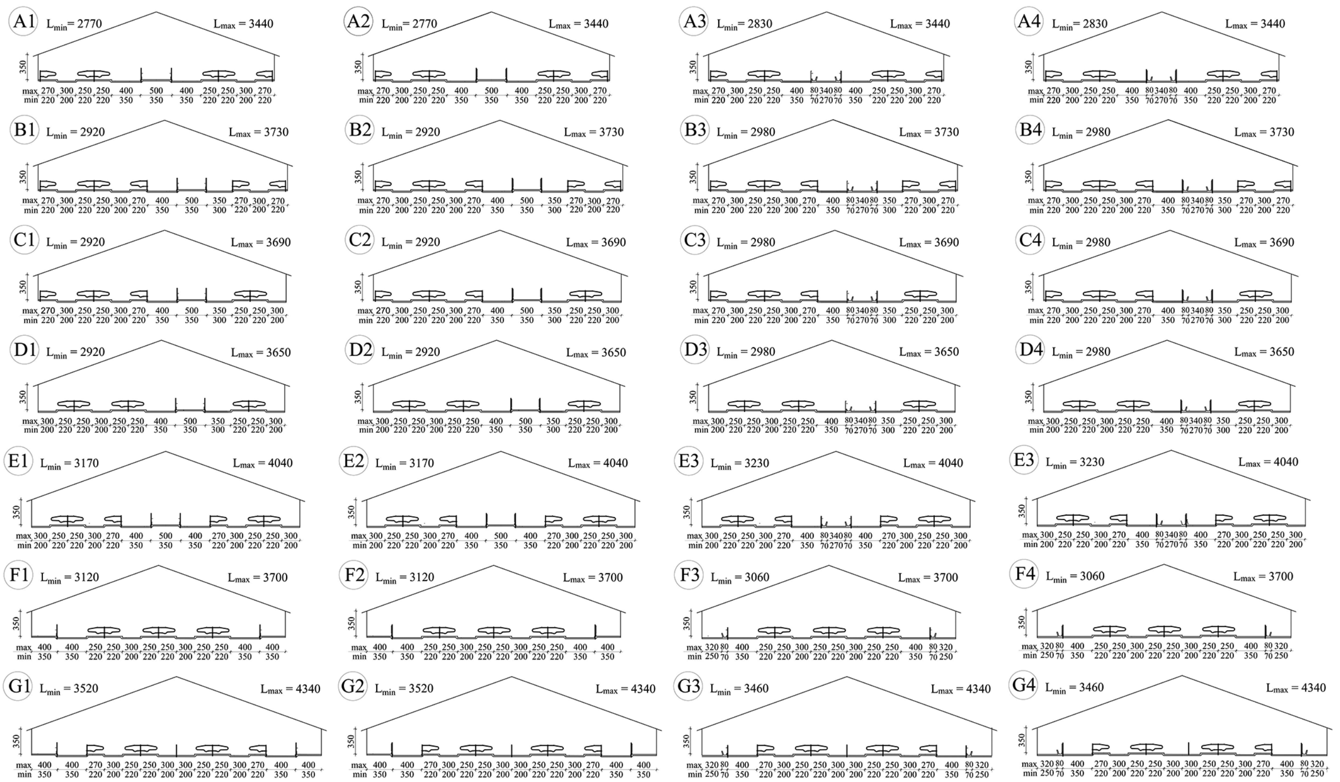

Fig. 1. Technical and technological solutions of semi-open six-row freestall barns for dairy cows

the food path along the building. To determine the width of the path, the dimensions and feed rates of 195 different types and models of self-propelled and attached mixers cited in the literature were studied (Trioliet, 2021; Agritop, 2022a; Agro-Vista, 2022; Alpha-Mix, 2022). Based on this, path widths are accepted in accordance with the indicators of mixers with a minimum capacity of 15 m^3 (width 2.30 m, feed height 0.82 m) and maximum 32 m^3 (width 2.98 m, feed height 1.18 m) suitable for farms with a capacity for over 100 cows. In connection with the feed height of the mixers for the versions with high mangers, the minimum and maximum heights of the mangers from the food path, 0.55 and 0.65 m, respectively, have been adopted.

The widths of the technological and manure paths are determined according to the norms for their cleaning by scraper installations, but it is also possible to use mobile mechanization (tractor with a bulldozer shovel). Delimiters in the rest and dining areas, made of steel pipes, have been adopted. When sizing the elements for technological equipment, constructive decisions have been made according to the norms in force in the country for design of reinforced concrete and steel structures (Norms for Design of Concrete and Reinforced Concrete Structures, 1987; Norms for Design of Steel Structures, 1997), as well as publications of our and foreign authors (Royer, 2003; Tucker et al., 2004; Anderson, 2007; Dinev et al., 2017) and company catalogs (Limk LTD, 2021; DeLaval, 2022; GEA, 2022; Patura, 2022).

By constructing a nomogram according to the method of Dinev (1988), the technological flexibility of the six-row buildings was determined, i.e. the number of variants that fit into the different widths from the range 27.70–43.40 m in 10 cm was specified. After a range between the minimum and maximum technologically necessary widths of the building has been formed for each of the variants, the width ranges are plotted on the abscissa of a coordinate system as steps with a height equal to one unit. In this way, a preferred row of widths was outlined, in which a jump was noted in the nomogram when the width of the building increased. For each preferred width, the costs for the technological profile of the floor (including the stationary equipment) have been calculated for the individual options entered in it, as the construction costs for the construction of the zero cycle, the supporting and enclosing structures of the building are not included. For each of the options, an assessment of the material intensity of the floor profile was made according to the main construction indicators: consumption of concrete and consumption of steel (reinforcing – for the reinforced concrete flooring and profile – for the technological equipment), referred to 1 m^2 of built-up area and to one cattle yard. The calculations were performed for a sector of the building with a length of 6 m (one composition wheelbase). Thus, in the considered sector, with a width of 1.20 m of the boxes, 5 cows can be accommodated along the length of one row. It is assumed that all rows in the allocated sector are filled, i.e. there are no breaks to form passages. To determine the costs of concrete and steel for the individual groups of studied options (A, B, C, D, E, G), the following summarizing formulas introduced by the authors were used:

Consumption of concrete:

- *when feeding cows from a feeding path with feeding strips – variants with feeding zones type i=1 and i=2:*

$$V = (F + uF_V)\, l + nV_f \tag{1}$$

where: V is the cost of concrete for shaping the technological profile of the floor of the building, m^3; F – cross-sectional area of this profile, m^2; l – the length of the surveyed sector of the building (l = 6 m); u – the number of vuts in the floor area; – the area of one vuts in the cross profile of the floor, m^2; n – the number of single foundations of stands of dividers in the rest area and of clamps in the dining area; – the cost of concrete for single foundations of stands of dividers in the rest area and fixers in the dining area, m^3.

- *when feeding from ordinary deep mangers – variants with feeding zones type i = 3 and i = 4:*

$$V = (F + uF_V + wF_m)\, l + nV_f, \tag{2}$$

where: w is the number of deep mangers; F_m – the cross-sectional area per number of mangers, m^2.

Consumption of steel:

- *when feeding from a feeding path with feeding strips – variants with feeding zones type i=1 and i=2:*

$$S = A + 5pS_d + S_{pr} + rS_f \quad , \tag{3}$$

where: S is the consumption of steel for the technological profile of the floor of the building, kg; A – the cost of reinforcing steel for the floor profile, kg; p – the number of rows of boxes; S_d – the consumption of steel for one number of interbox divider, kg; S_{pr} – the cost of profiled steel to strengthen the dividers, kg; r – the number of rows of clamps in the feeding area; S_f – consumption of steel for one limiter in the food zone, kg.

- *when feeding from ordinary deep mangers – variants with feeding zones type i=3 and i=4:*

$$S = A + 5pS_d + S_{pr} + rS_f + w\mathrm{A}_m\,, \tag{4}$$

where: A_m is the cost of reinforcing steel per number of mangers, kg

The values of the costs of concrete and steel calculated according to the indicators studied for the options that fit into all the preferred technologically necessary widths are tabulated. The assessment of the material intensity of the floor profile was carried out by means of a comparative analysis of the average costs for individual widths (Dimova, 2001). In a previous publication (Dimova, 2022) a methodology developed by us for evaluating technological flexibility was presented, taking into account the influence of the mentioned costs in four-row buildings for cows. The methodology was used to evaluate the influence of the construction costs of the floor profile on the technological flexibility of the six-row buildings. The research was carried out in the following sequence:A coefficient K_T is introduced to assess the technological flexibility of the building as the width with the maximum number of entered variants (N_{max}) receives 10 points ($N_{T,max} = 10$)

- An assessment of the technological flexibility of the remaining technologically necessary widths of the preferred order was made according to the formula:

$$K_{T,i} = \frac{N_i K_{T,max}}{N_{max}} = \frac{10N_i}{N_{max}} \quad (5)$$

where: is a coefficient for estimating the technological flexibility of the building at a certain width of the building; – the number of possible variants for internal distribution at the respective width.

- To estimate the material consumption of the floor profile of the building, the following coefficients shall be entered:

– K_1 – coefficient for estimating the consumption of concrete, related to 1 m^2 of built-up area of the floor;

– K_2 – coefficient for estimating the consumption of concrete related to one stock place;

– K_3 – coefficient for estimating the consumption of steel (reinforcement and profile), related to 1 m^2 of built-up area of the floor;

– K_4 – coefficient for estimating the consumption of steel (reinforcement and profile), related to one stock place.

For all studied indicators $K_i = 1$ is assumed for the width with minimum consumption, and the values for the other widths are calculated by the formulas:

$$K_{1,i} = \frac{V_{ba,i}}{V_{ba,min}} \quad (6)$$

$$K_{2,i} = \frac{V_{st.pl.,i}}{V_{st.pl.,min}} \quad (7)$$

$$K_{3,i} = \frac{S_{ba,i}}{S_{ba,min}} \quad (8)$$

$$K_{4,i} = \frac{S_{st.pl.,i}}{S_{st.pl.,min}} \quad (9)$$

where:

$V_{ba,i}$ is the consumption of concrete per 1 m^2 of built-up area of the floor of the building at the i-th preferred width;

$V_{ba,min}$ – the consumption of concrete, related to 1 m^2 of built-up area of the floor of the building with the most economical preferred width;

$V_{st.pl.,i}$ – the consumption of concrete related to one stock place at the i-th preferred width;

$V_{st.pl.,min}$ – the consumption of concrete related to one stock place in the building with the most economical preferred width;

$S_{ba,i}$ – the consumption of steel (reinforcement and profile), related to 1 m^2 of built-up area of the floor of the building at the i-th preferred width;

$S_{ba,min}$ – the cost of steel (reinforcement and profile), related to 1 m^2 of built-up area of the floor of the building with the most economical preferred width;

$S_{st.pl.,i}$ – the consumption of steel (reinforcement and profile), related to one stock place at the i-th preferred width;

$S_{st.pl.,min}$ – the cost of steel (reinforcement and profile), related to one stock place in the building with the most economical preferred width.

- An assessment of the impact of the costs of building the floor profile on the technological flexibility of the four-row buildings for free-box breeding of cows according to the following generalizing formulas:

$$Tf_c^{ba} = \frac{NK_T}{K_1} \quad (10)$$

$$Tf_c^{st.pl} = \frac{NK_T}{K_2} \quad (11)$$

$$Tf_s^{ba} = \frac{NK_T}{K_3} \quad (12)$$

$$Tf_s^{st.pl} = \frac{NK_T}{K_4} \quad (13)$$

$$Tf^{ba} = Tf_c^{ba} + Tf_s^{ba} \quad (14)$$

$$Tf^{st.pl} = Tf_c^{st.pl} + Tf_s^{st.pl} \quad (15)$$

where:

Tf_c^{ba} is the assessment of the impact of the consumption of concrete, related to 1 m^2 of built-up area of the floor, on the technological flexibility of the building;

$Tf_c^{st.pl}$ – the assessment of the influence of the consumption of concrete for the floor profile, related to one stock place, on the technological flexibility of the building;

Tf_s^{ba} – the assessment of the impact of the consumption of steel, related to 1 m^2 of built-up area of the floor, on the technological flexibility of the building;

$Tf_s^{st.pl}$ – the assessment of the influence of the consumption of steel for the floor profile, related to one stock place, on the technological flexibility of the building.

The results of the study are analyzed and presented in tabular and graphical form.

Results and Discussion

The constructed nomogram for determining a preferred row of widths according to the technological flexibility of the studied six-row buildings for free-box breeding of cows is reflected in Figure 2. It can be seen that the buildings with widths in the ranges of 32.30–34.40 m and 35.20–36.50 m have the greatest technological flexibility, where it is possible to realize 24 different variants of technological solutions. Buildings with widths in the ranges of 31.70–32.30 m and 34.60–35.20 m, with 22 possible variants, also have very good data according to studies. 20 variants of technological solutions can be implemented at widths in the ranges: 31.20–31.70 m, 34.40–34.60 m and 36.50–36.90 m – with the same technological flexibility. 18 variants fit in the width range 30.60-31.20 m, and 16 variants are possible for the widths in the ranges: 29.80–30.60 m, 36.90–37.00 m. The least flexibility (2 variants) is noted for the narrowest buildings (widths from 27.70 to 28.30 m), and 4 variants are applicable for widths in the ranges 28.30–29.20 m and 40.40–43.40 m.

Table 1 gives the relative values of the material costs for building the floor profile, calculated for the variants with the different preferred widths of the buildings. The data show a significant variation in the values of the studied indicators depending on the internal distribution of the buildings and the constructive solution of the technological equipment. The

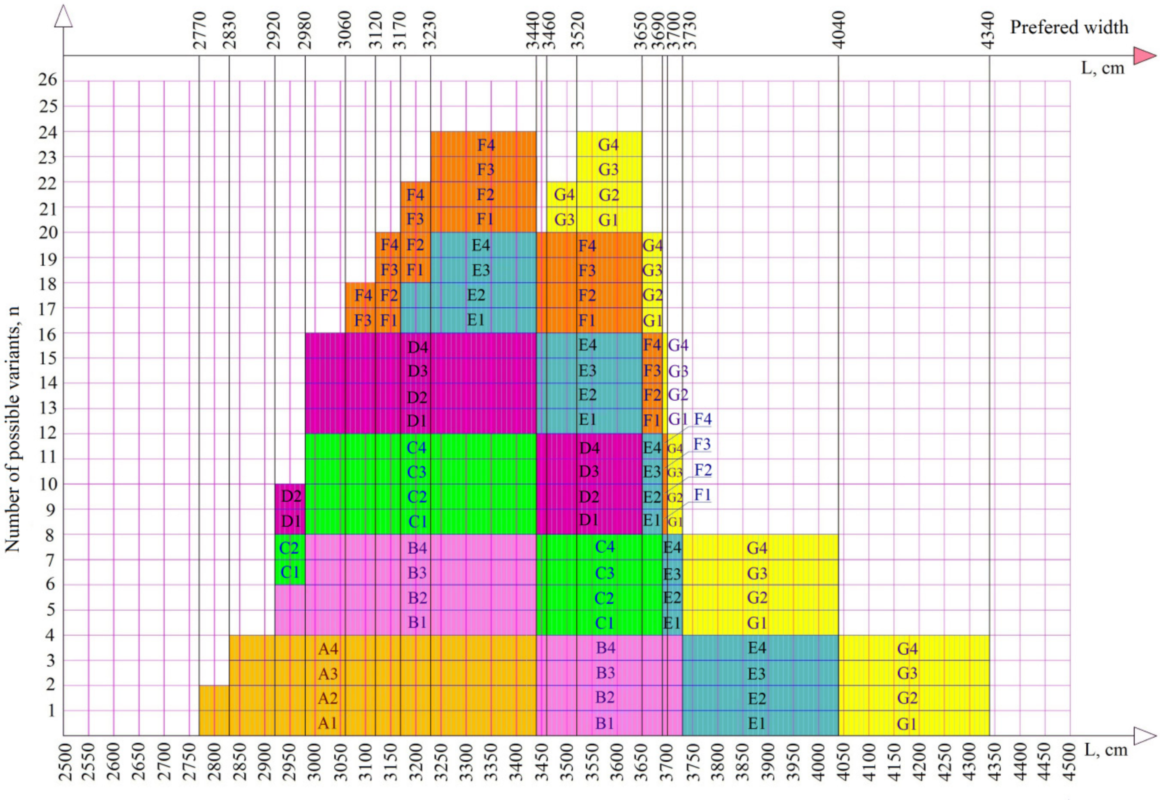

Fig. 2. Nomogram for determining a preferred row of widths with maximum technological flexibility of six-row buildings for free-box breeding of dairy cows

reason for this is the physical nature of the research object – in the range of widths 27.70–43.40 m, from 2 to 24 variants of technological solutions with different internal distribution methods and different types of food zone are applicable.

It can be seen that the nomogram does not give a clear idea of which exact width of a six-row building should be chosen as the most economical if the preferred widths are of equal technological flexibility. For example, according to the nomogram in three widths – 31.20 m, 34.50 m and 36.90 m, 20 variants are applicable. The data in Table 1 reveal that according to all the indicators studied, the costs of the floor profile are minimal for variants D1 and F1 and maximal – for variant B4, while the costs of concrete per 1 m^2 of built-up area for D1 and F1 are the same – respectively 0.1636 m^3/m^2 (at a width of 31.20 m) and 0.1623 m^3/m^2 (at a width of 34.50 m), and at 36.90 m, where D1 is not involved, the consumption for F1 is 0.1615 m^3/m^2. For the other options with the same widths, the values vary up to 0.1774 m^3/m^2, 0.1748 m^3/m^2 and 0.1733 m^3/m^2 (for option B4). Regarding the costs of concrete for one stock place, for D1 and F1 they are 1.0211 m^3/st.pl. (at a width of 31.20 m) and 1.1201 m^3/st.pl. (at 34.50 m), for F1 at 36.90 m – 1.1921 m^3/st.pl., and

Table 1. Consumption of materials for building the floor profile in six-row buildings for cows with different widths and internal distribution

Width of the building (L), cm	Amount of possible options	Option (designation of the TT scheme)	Consumption of concrete		Consumption of steel	
			V_{ba}, m^3/m^2	$V_{st.pl.}$, m^3/st.pl.	S_{ba}, kg/m^2	$S_{st.pl.}$, kg/st.pl.
1	2	3	4	5	6	7
2770	2	A1	0.1656	0.9174	16.96	93.97
		A2	0.1719	0.9523	18.94	104.92
2830	4	A1	0.1653	0.9354	16.82	95.18
		A2	0.1714	0.9703	18.75	106.12
		A3	0.1702	0.9635	17.11	96.85
		A4	0.1764	0.9985	19.05	107.80
2920	10	A1	0.1648	0.9624	16.62	97.05
		A2	0.1708	0.9973	18.49	108.00
		A3	0.1696	0.9907	16.91	98.72
		A4	0.1756	1.0256	18.78	109.67
		B1	0.1685	0.9837	17.14	100.07
		B2	0.1744	1.0187	19.01	111.01
		C1	0.1665	0.9724	16.67	97.33
		C2	0.1725	1.0073	18.54	108.27
		D1	0.1646	0.9611	16.20	94.59
		D2	0.1705	0.9960	18.07	105.53
2980	16	A1	0.1645	0.9804	16.51	98.40
		A2	0.1704	1.0153	18.35	109.35
		A3	0.1693	1.0088	16.77	99.93
		A4	0.1751	1.0437	18.60	110.87
		B1	0.1681	1.0017	16.99	101.27
		B2	0.1739	1.0367	18.83	112.22
		B3	0.1728	1.0299	17.27	102.95
		B4	0.1787	1.0648	19.11	113.89
		C1	0.1662	0.9904	16.53	98.53
		C2	0.1720	1.0253	18.37	109.48
		C3	0.1709	1.0185	16.81	100.21
		C4	0.1768	1.0535	18.65	111.15
		D1	0.1643	0.9791	16.07	95.79
		D2	0.1701	1.0140	17.91	106.74
		D3	0.1690	1.0072	16.35	97.46
		D4	0.1749	1.0421	18.19	108.41

Table 1. Continued

1	2	3	4	5	6	7
3060	18	A1	0.1641	1.0044	16.48	100.83
		A2	0.1698	1.0393	18.26	111.78
		A3	0.1688	1.0329	16.59	101.53
		A4	0.1745	1.0678	18.38	112.48
		B1	0.1676	1.0257	16.81	102.86
		B2	0.1733	1.0607	18.60	113.80
		B3	0.1722	1.0540	17.09	104.59
		B4	0.1779	1.0889	18.88	115.53
		C1	0.1658	1.0144	16.36	100.12
		C2	0.1715	1.0493	18.15	111.06
		C3	0.1704	1.0426	16.64	101.85
		C4	0.1761	1.0776	18.43	112.79
		D1	0.1639	1.0031	15.91	97.38
		D2	0.1696	1.0380	17.70	108.32
		D3	0.1685	1.0313	16.19	99.10
		D4	0.1742	1.0662	17.98	110.05
		F3	0.1685	1.0312	16.19	99.05
		F4	0.1742	1.0661	17.97	110.00
3120	20	A1	0.1638	1.0224	16.35	102.04
		A2	0.1694	1.0573	18.11	112.98
		A3	0.1684	1.0510	16.62	103.71
		A4	0.1740	1.0859	18.37	114.66
		B1	0.1673	1.0437	16.68	104.06
		B2	0.1729	1.0787	18.43	115.00
		B3	0.1718	1.0720	16.95	105.74
		B4	0.1774	1.1070	18.70	116.68
		C1	0.1655	1.0324	16.24	101.32
		C2	0.1710	1.0673	17.99	112.26
		C3	0.1700	1.0607	16.51	103.00
		C4	0.1756	1.0957	18.26	113.94
		D1	0.1636	1.0211	15.80	98.58
		D2	0.1692	1.0560	17.55	109.52
		D3	0.1682	1.0494	16.07	100.25
		D4	0.1738	1.0843	17.82	111.20
		F1	0.1636	1.0211	15.80	98.58
		F2	0.1692	1.0560	17.55	109.52
		F3	0.1682	1.0493	16.07	100.26
		F4	0.1738	1.0842	17.82	111.20

Table 1. Continued

1	2	3	4	5	6	7
3170	22	A1	0.1636	1.0374	16.24	102.96
		A2	0.1691	1.0723	17.97	113.90
		A3	0.1682	1.0661	16.53	104.81
		A4	0.1737	1.1010	18.26	115.76
		B1	0.1670	1.0587	16.58	105.14
		B2	0.1725	1.0937	18.31	116.08
		B3	0.1715	1.0871	16.85	106.81
		B4	0.1770	1.1220	18.57	117.76
		C1	0.1652	1.0474	16.15	102.40
		C2	0.1707	1.0823	17.88	113.34
		C3	0.1697	1.0758	16.42	104.07
		C4	0.1752	1.1107	18.14	115.02
		D1	0.1634	1.0361	15.72	99.66
		D2	0.1689	1.0710	17.45	110.60
		D3	0.1679	1.0645	15.98	101.33
		D4	0.1734	1.0994	17.71	112.28
		E1	0.1668	1.0574	16.22	102.84
		E2	0.1723	1.0923	17.95	113.78
		F1	0.1634	1.0361	15.69	99.49
		F2	0.1689	1.0710	17.42	110.44
		F3	0.1679	1.0644	16.12	102.17
		F4	0.1734	1.0993	17.84	113.12
3230	24	A1	0.1634	1.0554	16.12	104.16
		A2	0.1688	1.0903	17.82	115.10
		A3	0.1678	1.0842	16.38	105.83
		A4	0.1732	1.1191	18.08	116.78
		B1	0.1667	1.0767	16.62	107.34
		B2	0.1721	1.1117	18.31	118.28
		B3	0.1711	1.1052	16.72	108.02
		B4	0.1765	1.1401	18.42	118.96
		C1	0.1649	1.0654	16.19	104.60
		C2	0.1703	1.1003	17.89	115.54
		C3	0.1693	1.0939	16.30	105.28
		C4	0.1747	1.1288	17.99	116.22
		D1	0.1632	1.0541	15.77	101.86
		D2	0.1686	1.0890	17.46	112.80
		D3	0.1676	1.0826	15.87	102.53
		D4	0.1730	1.1175	17.57	113.48
		E1	0.1665	1.0754	16.11	104.04
		E2	0.1719	1.1103	17.80	114.99
		E3	0.1708	1.1035	16.37	105.72
		E4	0.1762	1.1385	18.06	116.66
		F1	0.1632	1.0541	15.74	101.70
		F2	0.1686	1.0890	17.44	112.64
		F3	0.1676	1.0825	15.87	102.53
		F4	0.1730	1.1174	17.57	113.48

Table 1. Continued

1	2	3	4	5	6	7
3440	24	A1	0.1626	1.1184	16.08	110.60
		A2	0.1676	1.1533	17.67	121.55
		A3	0.1668	1.1475	16.46	113.24
		A4	0.1719	1.1824	18.05	124.19
		B1	0.1657	1.1397	16.20	111.45
		B2	0.1707	1.1747	17.79	122.40
		B3	0.1698	1.1685	16.44	113.13
		B4	0.1749	1.2034	18.03	124.08
		C1	0.1640	1.1284	15.80	108.71
		C2	0.1691	1.1633	17.39	119.66
		C3	0.1682	1.1572	16.05	110.39
		C4	0.1733	1.1921	17.64	121.34
		D1	0.1624	1.1171	15.40	105.97
		D2	0.1674	1.1520	17.00	116.92
		D3	0.1666	1.1459	15.65	107.65
		D4	0.1716	1.1808	17.24	118.59
		E1	0.1655	1.1384	15.75	108.34
		E2	0.1706	1.1733	17.34	119.29
		E3	0.1696	1.1668	16.01	110.15
		E4	0.1747	1.2017	17.60	121.09
		F1	0.1624	1.1171	15.40	105.97
		F2	0.1675	1.1520	16.99	116.92
		F3	0.1665	1.1458	15.65	107.68
		F4	0.1716	1.1807	17.24	118.63
3450	20	B1	0.1656	1.1427	16.19	111.73
		B2	0.1707	1.1777	17.78	122.68
		B3	0.1698	1.1715	16.44	113.41
		B4	0.1748	1.2064	18.02	124.36
		C1	0.1640	1.1314	15.80	108.99
		C2	0.1690	1.1663	17.38	119.94
		C3	0.1681	1.1602	16.04	110.67
		C4	0.1732	1.1951	17.63	121.62
		D1	0.1623	1.1201	15.40	106.25
		D2	0.1674	1.1550	16.99	117.20
		D3	0.1665	1.1489	15.64	107.93
		D4	0.1716	1.1838	17.23	118.87
		E1	0.1654	1.1414	15.72	108.44
		E2	0.1705	1.1763	17.30	119.38
		E3	0.1695	1.1698	15.98	110.28
		E4	0.1746	1.2047	17.57	121.22
		F1	0.1623	1.1201	15.40	106.26
		F2	0.1674	1.1550	16.99	117.20
1	2	3	4	5	4	5
		F3	0.1665	1.1488	15.64	107.91
		F4	0.1716	1.1837	17.23	118.86

Table 1. Continued

1	2	3	4	5	6	7
3460	22	B1	0.1656	1.1457	16.16	111.84
		B2	0.1706	1.1807	17.74	122.78
		B3	0.1697	1.1745	16.43	113.70
		B4	0.1748	1.2094	18.01	124.64
		C1	0.1639	1.1344	15.77	109.10
		C2	0.1690	1.1693	17.35	120.04
		C3	0.1681	1.1632	16.03	110.96
		C4	0.1731	1.1981	17.62	121.90
		D1	0.1623	1.1231	15.37	106.36
		D2	0.1673	1.1580	16.95	117.30
		D3	0.1665	1.1519	15.64	108.21
		D4	0.1715	1.1868	17.22	119.16
		E1	0.1654	1.1444	15.71	108.70
		E2	0.1704	1.1793	17.29	119.64
		E3	0.1695	1.1728	15.95	110.40
		E4	0.1745	1.2077	17.54	121.34
		F1	0.1623	1.1231	15.40	106.54
		F2	0.1673	1.1580	16.98	117.48
		F3	0.1665	1.1518	15.61	108.04
		F4	0.1715	1.1867	17.19	118.98
		G3	0.1697	1.1742	16.51	114.27
		G4	0.1747	1.2091	18.10	125.22
3520	24	B1	0.1653	1.1637	16.06	113.04
		B2	0.1703	1.1987	17.61	123.99
		B3	0.1694	1.1926	16.30	114.72
		B4	0.1744	1.2275	17.85	125.66
		C1	0.1637	1.1524	15.67	110.30
		C2	0.1687	1.1873	17.22	121.25
		C3	0.1678	1.1813	15.91	111.98
		C4	0.1728	1.2162	17.46	122.92
		D1	0.1621	1.1411	15.28	107.56
		D2	0.1671	1.1760	16.83	118.51
		D3	0.1662	1.1700	15.52	109.23
		D4	0.1712	1.2049	17.07	120.18
		E1	0.1651	1.1624	15.75	110.90
		E2	0.1701	1.1973	17.31	121.84
		E3	0.1692	1.1909	15.85	111.58
		E4	0.1741	1.2258	17.40	122.52
		F1	0.1621	1.1411	15.28	107.56
		F2	0.1671	1.1760	16.83	118.51
		F3	0.1662	1.1699	15.52	109.24
		F4	0.1711	1.2048	17.07	120.18
		G1	0.1654	1.1641	16.16	113.79
		G2	0.1703	1.1990	17.72	124.74
		G3	0.1694	1.1923	16.40	115.47
		G4	0.1743	1.2272	17.96	126.42

Table 1. Continued

1	2	3	4	5	6	7
3650	24	B1	0.1648	1.2027	16.24	118.55
		B2	0.1695	1.2377	17.74	129.50
		B3	0.1687	1.2317	16.45	120.07
		B4	0.1735	1.2667	17.95	131.02
		C1	0.1632	1.1914	15.82	115.48
		C2	0.1680	1.2263	17.32	126.42
		C3	0.1672	1.2204	16.03	117.00
1	2	3	4	5	4	5
		C4	0.1720	1.2554	17.53	127.94
		D1	0.1617	1.1801	15.37	112.22
		D2	0.1664	1.2150	16.87	123.17
		D3	0.1656	1.2092	15.74	114.86
		D4	0.1704	1.2441	17.24	125.81
		E1	0.1646	1.2014	15.56	113.59
		E2	0.1694	1.2363	17.06	124.53
		E3	0.1685	1.2300	15.79	115.27
		E4	0.1733	1.2650	17.29	126.21
		F1	0.1617	1.1801	15.38	112.24
		F2	0.1664	1.2150	16.88	123.19
		F3	0.1656	1.2091	15.63	114.07
		F4	0.1704	1.2440	17.13	125.01
		G1	0.1648	1.2031	15.96	116.47
		G2	0.1696	1.2380	17.46	127.42
		G3	0.1687	1.2314	16.18	118.13
		G4	0.1735	1.2663	17.68	129.08
3690	20	B1	0.1646	1.2147	16.15	119.18
		B2	0.1693	1.2497	17.63	130.13
		B3	0.1685	1.2438	16.38	120.86
		B4	0.1733	1.2787	17.86	131.81
		C1	0.1631	1.2034	15.73	116.11
		C2	0.1678	1.2383	17.22	127.06
		C3	0.1670	1.2325	16.09	118.75
		C4	0.1717	1.2674	17.57	129.70
		E1	0.1644	1.2134	15.48	114.22
		E2	0.1692	1.2483	16.96	125.17
		E3	0.1683	1.2421	15.71	115.90
		E4	0.1730	1.2770	17.19	126.85
		F1	0.1615	1.1921	15.32	113.04
		F2	0.1663	1.2270	16.80	123.99
		F3	0.1655	1.2212	15.55	114.72
		F4	0.1702	1.2561	17.03	125.67
		G1	0.1646	1.2151	15.89	117.27
		G2	0.1694	1.2500	17.37	128.22
		G3	0.1685	1.2435	16.12	118.95
		G4	0.1732	1.2784	17.60	129.90

Table 1. Continued

1	2	3	4	5	6	7
3700	16	B1	0.1646	1.2177	16.14	119.45
		B2	0.1693	1.2527	17.62	130.40
		B3	0.1685	1.2468	16.35	120.99
		B4	0.1732	1.2817	17.83	131.94
		E1	0.1644	1.2164	15.47	114.50
		E2	0.1691	1.2513	16.95	125.45
		E3	0.1683	1.2451	15.70	116.18
		E4	0.1730	1.2800	17.18	127.13
		F1	0.1615	1.1951	15.29	113.14
		F2	0.1662	1.2300	16.77	124.09
		F3	0.1654	1.2242	15.65	115.78
		F4	0.1702	1.2591	17.13	126.73
		G1	0.1646	1.2181	15.86	117.37
		G2	0.1693	1.2530	17.34	128.32
		G3	0.1685	1.2465	16.11	119.24
		G4	0.1732	1.2814	17.59	130.19
3730	12	B1	0.1644	1.2267	16.08	119.98
		B2	0.1691	1.2617	17.55	130.93
1	2	3	4	5	4	5
		B3	0.1683	1.2558	16.44	122.62
		B4	0.1730	1.2908	17.90	133.57
		E1	0.1643	1.2254	15.42	115.04
		E2	0.1690	1.2603	16.89	125.98
		E3	0.1681	1.2541	15.67	116.86
		E4	0.1728	1.2891	17.13	127.80
		G1	0.1645	1.2271	15.85	118.22
		G2	0.1692	1.2620	17.32	129.17
		G3	0.1683	1.2555	16.05	119.74
		G4	0.1730	1.2904	17.52	130.69
4040	8	E1	0.1632	1.3184	15.28	123.46
		E2	0.1675	1.3533	16.63	134.40
		E3	0.1668	1.3475	15.61	126.10
		E4	0.1711	1.3824	16.96	137.05
		G1	0.1634	1.3201	15.49	125.17
		G2	0.1677	1.3550	16.85	136.12
		G3	0.1669	1.3488	15.72	126.99
		G4	0.1713	1.3838	17.07	137.94
4340	4	G1	0.1625	1.4101	15.38	133.49
		G2	0.1665	1.4450	16.64	144.44
		G3	0.1658	1.4392	15.68	136.13
		G4	0.1698	1.4741	16.95	147.08

for variant B4 at the same widths – 1.1070 m^3/st.pl., 1.2064 m^3/st.pl. and 1.2787 m^3/st.pl. A difference between the minimum and maximum values for the indicated indicators is outlined – respectively 8.4% (at 31.20 m), 7.7% (at 34.50 m) and 7.3% (at 36.90 m).

The data in the table for the considered widths indicate a similar change in the cost indicators of steel (reinforcing and profile). Minimum costs per 1 m^2 of built-up area are noted for options D1 and F1 – 15.80 kg/m^2 (at 31.20 m), 15.40 kg/m^2 (at 34.50 m) and 15.32 kg/m^2 for F1 (at 36.90 m), and the maximum costs with the same widths are for variant B4 – 18.70 kg/m^2, 18.02 kg/m^2 and 17.86 kg/m^2. The cost of steel for one stock place varies from 98.58 kg/st.pl. (at 31.20 m), 106.25 kg/st.pl. (at 34.50 m) for D1 and F1 and 113.04 kg/st.pl. for F1 (at 36.90 m) up to 116.68 kg/st.pl., 124.36 kg/st.pl. and 131.81 kg/st.pl. – for option B4. Thus, the differences between the minimum and maximum values for both indicators are: 18.4% (at 31.20 m), 17.0% (at 34.50 m) and 16.6%.

From the obtained results it is clear that the costs of forming the technological profile of the floor of the six-row buildings are not identical for the widths with the same technological flexibility, but there are significant differences between them. A clearer idea of the material intensity of the floor is provided by the results for the average values of the studied indicators, which are reflected in Table 2. It can be seen that as the width of the building increases, the relative costs vary, and the costs per 1 m^2 of built-up area are the lowest at the wide building (43.40 m) – respectively 0.1662 m^3/m^2 (concrete) and 16.16 kg/m^2 (steel), and those for one stock place – for the narrowest building (27.70 m) – respectively 0.9349 m^3/st.pl. (concrete) and 99.45 kg/st.pl. (steel). Regarding the widths in the above example, in which 20 variants of technological solutions can be realized, the results in the table show a difference in the average values of the indicators.

The data for the considered example show that with the same technological flexibility (20 possible options) the consumption of concrete per 1 m^2 of built-up area is the highest (0.1698 m^3/m^2) at a building width of 31.20 m, at 34.50 m it is 0.1686 m^3/m^2, and is the lowest (0.1680 m^3/m^2) at 36.90 m. Expressed in percentages, the differences compared to the lowest value are insignificant – 1.1% (at 31.20 m) and 0.4% (at 34.50 m). The differences are greater in the other indicators – the consumption of concrete for one stock place is the lowest (1.0598 m^3/st.pl.) at a width of 31.20 m, at 34.50 m it is 1.1630 m^3/st.pl. (with a difference of 9.7%), and at 36.90 m the value is the highest – 1.2397 m^3/st.pl. (with a difference of 17.0%). The lowest consumption of steel per 1 m^2 of built-up area (16.58 kg/m^2) was noted at the width of 36.90 m, followed almost without difference (0.3%) by the consumption at 34.50 m (16.62 kg/m^2) and with a greater difference (3.7%) at 31.20 m (17.19 kg/m^2). For a stock place, the most economical solution is a width of 31.20 m – 107.23 kg/st.pl., followed by a width of 34.50 m (114.66 kg/st.pl. – a

Table 2. Assessment of the technological flexibility and material consumption of the floor profile of six-row buildings for cows

Width of the building (L), cm	Amount of possible options	Consumption of concrete		Consumption of steel		Assessment of the technological flexibility of the building, number of points	Assessment of the material consumption of the floor profile on the building			
		V_{ba}, m^3/m^2	$V_{st.pl.}$, m^3/st.pl.	S_{ba}, kg/m^2	$S_{st.pl.}$, kg/st.pl.	K_T	K_1	K_2	K_3	K_4
2770	2	0.1688	**0.9349**	17.95	**99.45**	0.8	1.016	**1.000**	1.111	**1.000**
2830	4	0.1708	0.9669	17.93	101.49	1.7	1.028	1.034	1.110	1.021
2920	10	0.1698	0.9915	17.64	103.03	4.2	1.022	1.061	1.092	1.036
2980	16	0.1711	1.0195	17.58	104.79	6.7	1.030	1.091	1.088	1.054
3060	18	0.1706	1.0441	17.37	106.29	7.5	1.027	1.117	1.075	1.069
3120	20	0.1698	1.0598	17.19	107.23	8.3	1.022	1.134	1.064	1.078
3170	22	0.1695	1.0748	17.09	108.35	9.2	1.020	1.150	1.058	1.090
3230	24	0.1696	1.0952	17.02	109.94	10.0	1.021	1.172	1.053	1.106
3440	24	0.1684	1.1584	16.70	114.92	10.0	1.013	1.239	1.034	1.156
3450	20	0.1686	1.1630	16.62	114.66	8.3	1.015	1.244	1.029	1.153
3460	22	0.1688	1.1683	16.66	115.30	9.2	1.016	1.250	1.031	1.159
3520	24	0.1685	1.1860	16.59	116.76	10.0	1.014	1.269	1.027	1.174
3650	24	0.1678	1.2250	16.60	121.14	10.0	1.010	1.310	1.027	1.218
3690	20	0.1680	1.2397	16.58	122.38	8.3	1.011	1.326	1.026	1.231
3700	16	0.1681	1.2437	16.56	122.56	6.7	1.012	1.330	1.025	1.232
3730	12	0.1687	1.2583	16.65	124.22	5.0	1.015	1.346	1.030	1.249
4040	8	0.1673	1.3512	16.20	130.91	3.3	1.007	1.445	1.003	1.316
4340	4	**0.1662**	1.4421	**16.16**	140.29	1.7	**1.000**	1.543	**1.000**	1.411

Note: In order to highlight the minimum values of the studied indicators and the coefficients for evaluating the technological flexibility and the material intensity of the profile of the floor of the building, they are bolded in the table.

difference of 6.9%) and a width of 36.90 m (122.38 kg/st.pl. – difference 14.1%).

Table 2 also shows the values for the accepted coefficients for evaluating technological flexibility (Kt) and material costs (K1, K2, K3 and K4), according to the methodology developed by us for four-row buildings (Dimova, 2022). The outlined difference between the values of the coefficients for estimating the relative costs of concrete and steel for the floor profile at the widths with the same technological flexibility can be seen.

The results of the evaluation of the technological flexibility taking into account the influence of the material capacity of the profile of the floor of the studied six-row buildings for cows are reflected in Table 3 and presented graphically in Figures 3 and 4.

From the data in Table 3, shown in Figures 3 and 4, it is clear that the costs of materials per 1 m^2 of built-up area from the floor do not have a significant impact on the technological flexibility of buildings. Width 36.50 m, which received the highest assessment of technological flexibility taking into account the influence of the consumption of concrete (237.63 points) and the consumption of steel (233.69 points) per 1 m^2 of built-up area, differs from the other widths with the maximum number of applicable options only by 0.4% (236.69 points – at 35.20 m) to 1.1% (235.07 points – at 32.30 m) by assessment of the influence of the consumption of concrete and by 0.7% (232.11 points – at 34.40 m) to (227.92 points – at 32.30 m) according to the assessment of the influence of steel consumption.

Regarding the impact on technological flexibility of the floor material capacity per stall, the differences between the preferred widths are more significant. According to the assessment of the impact of concrete consumption, the widths with maximum technological flexibility differ by 5.7% (193.71 points – at 34.40 m) to 11.8% (183.21 points – at 36.50 m) from the 32.30 m width, with the highest rating (204.78 points). Regarding the influence of the consumption of steel for one stock place, the differences with a width of 32.30 m, which again received the highest rating (217 points), are respectively: 4.5% (207.61 points – at 34.40 m), 6.2% (204.43 points – at 35.20 m) and 10.1% (197.04 points – at 36.50 m).

Analogous are the results shown in Table 3 for the overall assessment of the building‘s technological flexibility when

Table 3. Assessment of technological flexibility taking into account the influence of material consumption of the floor profile of six-row buildings for cows

Width of the building (L), cm	Amount of possible options	Technological flexibility according to the consumption of concrete, number of points		Technological flexibility according to the consumption of steel, number of points		Overall assessment of the technological flexibility of the building, number of points	
		Tf_c^{ba}	$Tf_c^{st.pl.}$	Tf_s^{ba}	$Tf_s^{st.pl.}$	Tf^{ba}	$Tf^{st.pl.}$
1	2	3	4	5	6	7=3+5	8=4+6
2770	2	1.58	1.60	1.44	1.60	3.02	3.20
2830	4	6.62	6.58	6.13	6.66	12.75	13.24
2920	10	41.10	39.59	38.46	40.54	79.56	80.13
2980	16	104.08	98.26	98.53	101.71	202.61	199.97
3060	18	131.45	120.86	125.58	126.29	257.03	247.15
3120	20	162.43	146.39	156.01	153.99	318.44	300.38
3170	22	198.43	176.00	191.31	185.69	389.74	361.69
3230	24	235.07	204.78	227.92	**217.00**	462.99	421.78
3440	24	236.92	193.71	232.11	207.61	469.03	401.32
3450	20	163.55	133.44	161.32	143.97	324.87	277.41
3460	22	199.22	161.92	196.31	174.63	395.53	336.55
3520	24	236.69	189.13	**233.69**	204.43	470.38	393.56
3650	24	237.63	183.21	**233.69**	197.04	471.32	380.25
3690	20	164.20	125.19	161.79	134.85	325.99	260.04
3700	16	105.93	80.60	104.59	87.02	210.52	167.62
3730	12	59.11	44.58	58.26	48.04	117.37	92.62
4040	8	26.22	18.27	26.32	20.06	52.54	38.33
4340	4	6.80	4.41	6.80	4.82	13.60	9.23

Note: The widths with the greatest technological flexibility are outlined in pink, and the maximum values from the assessment of technological flexibility taking into account the influence of the material capacity of the floor profile are blackened.

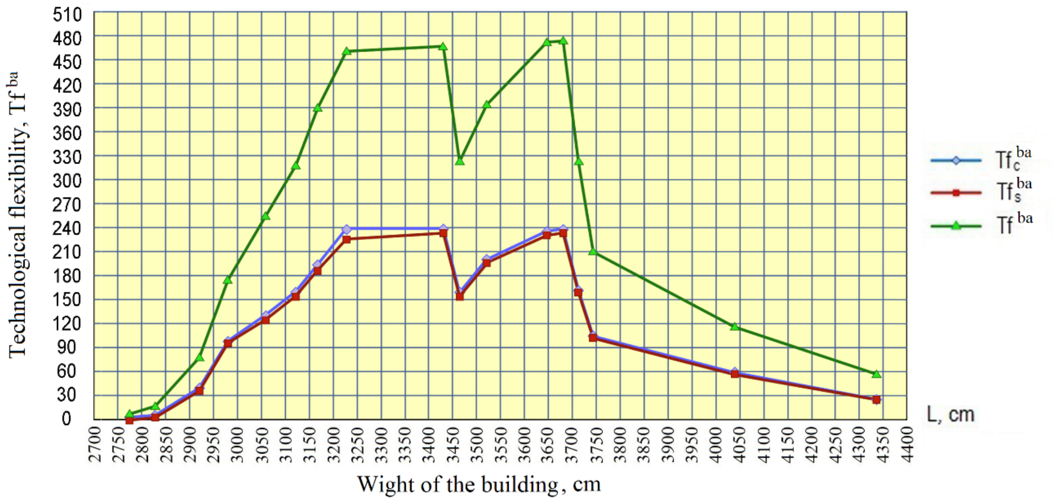

Fig. 3. Assessment of the technological flexibility taking into account the consumption of materials for the floor profile in six-row buildings for cows, referred to 1 m2 of built-up area

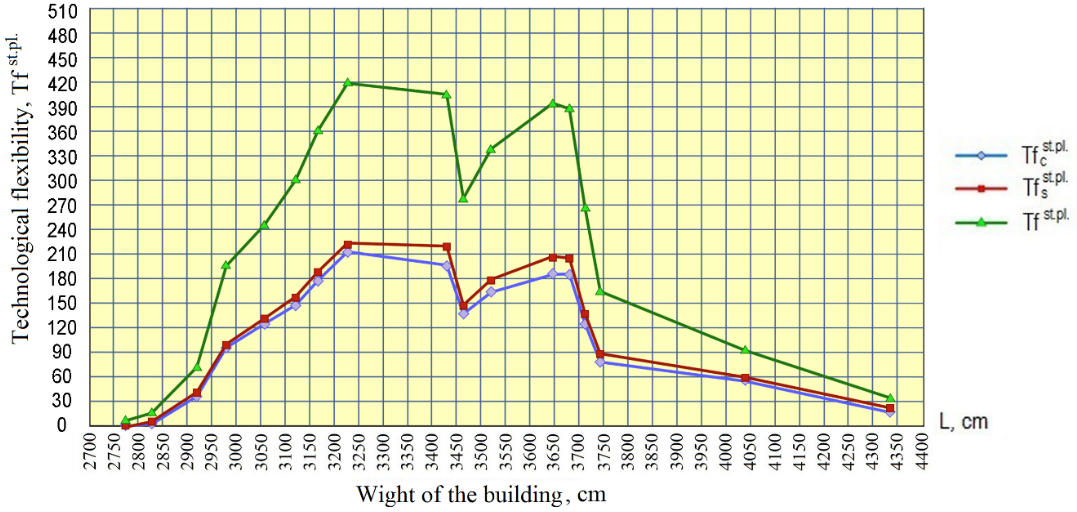

Fig. 4. Assessment of the technological flexibility taking into account the consumption of materials for the floor profile in six-row buildings for cows, referred to one stock place

considering the combined impact of concrete and steel costs. According to the values for 1 m^2 built-up area from the floor of the buildings whose widths have maximum technological flexibility, the assessment is the highest at a width of 36.50 m (471.32 points), followed by insignificant differences of 35.20 m (470.38 points – difference 0.2%), 34.40 m (469.03 points – difference 0.5%) and 32.30 m (462.99 points – difference 1.8%).

According to the influence of the costs for one stock place, the highest estimate is for a width of 32.30 m (421.78 points), followed by 34.40 m (401.32 points – difference 5.1%), 35.20 m (393.56 points – difference 7.2%) and 36.50 m (380.25 points – difference 10.9%).

The differences are more pronounced in the widths of the preferred row with less technological flexibility. For example, widths with the same technological flexibility (22 options) and very good indicators were evaluated taking into account the influence of the total costs per 1 m^2 of built-up area, respectively: 395.53 points (at 34.60 m) and 389.74 points (at 31.70 m), with a difference between them of 1.5%, and in terms of the costs for one stock place – 361.69 points (31.70 m) and 336.55 points (34.60 m), with a difference of 7.5%.

The total estimates for the widths with 20 applicable variants and the differences of the higher estimates with the lowest are as follows: taking into account the impact of costs per 1 m^2 of built-up area – 325.99 points (width 36.90 m), 324.87 points (width 34.50 m) and 318.44 points (width 31.20 m); difference 2.4% and 2.0% respectively; taking into account the influence of the costs for one stock place – 300.38 points (width 31.20 m), 277.41 points (width 34.50 m) and 260.04 points (width 36.90 m); difference 15.5% and 6.7% respectively. Other buildings with the same technological flexibility (16 possible options) received a general assessment according to the costs per 1 m^2 of built-up area: 210.52 points (width 37.00 m) and 202.61 points (width 29.80 m) – a difference of 3.9%, and according to the costs cattle area: 199.97 points (29.80 m) and 167.62 points (37.00 m) – difference 19.3%.

Based on the results obtained during the conducted research, reflected in Tables 2 and 3 and on the graphic images in Figures 3 and 4, as well as the established differences between the different widths of six-row buildings for cows with the same technological flexibility, a contradiction is found in the data on the indicators relating up to costs for 1 m^2 of built-up area and costs for one stock place. At the same time, larger latitudes scored higher on the first indicator and lower on the second. According to Stanev et al. (2001) as a criterion for determining construction costs in the construction of cattle farms, the indicator „cost per cattle place“ should be chosen, which evaluates both the constructive and technological solutions of the building, while the indicator „cost per unit of built-up area“ shows how economical the constructive solution is.

Conclusions

Six-row buildings for free-box breeding of milk cows with widths in the ranges of 32.30-34.40 m and 35.20-36.50 m have the greatest technological flexibility, where 24 variants of technological solutions can be implemented. The buildings with widths in the ranges of 31.70-32.30 m and 34.60-35.20 m with 22 applicable variants also have very good indicators. Widths with the same technological flexibility differ from each other in assessing the influence of the material capacity of the floor profile on it – to a greater extent in the larger ranges and in less flexibility. According to the estimates, taking into account the impact of the total costs of concrete and steel per 1 m^2 of built-up area, the buildings with maximum technological flexibility are practically equal for the different widths – 32.30 m (462.99 points), 34.40 m (469.03 points), 35.20 m (470.38 poitns) and 36.50 m (471.32 poitns), with differences from 0.2 to 1.8%.

According to the influence of the cost per one stock place, the highest overall score is for width 32.30 m (421.78 poitns), followed by 34.40 m (401.32 poitns t), 35.20 m (393.56 poitns) and 36.50 m (380.25 poitns) with differences respectively 5.1%, 7.2% and 10.9%. According to the total costs for 1 m^2 of built-up area, the differences in the widths with the same technological flexibility vary from 0.2 to 3.9%, and according to those for one stock place – from 5.1 to 19.3%. Of the six-row buildings with different internal distribution and different type of feeding area, those with a width of 32.30 m are recommended – with the highest ratings of technological flexibility, taking into account the impact of the costs of concrete and steel for one stock place. The developed methodology for evaluating the technological flexibility of four-row buildings is recommended for the practice of evaluating the impact of costs on the floor profile and for six-row buildings for free-box cow farming, as well as for buildings with a larger capacity.

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