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Investment needs of machinery barns and grain storehouses

With the trend towards increasing farm sizes the demand of space for agricultural machines and equipment as well as for storage capacities is rising. In addition to building costs for stables that have been determined within the KTBL working programme „calculation standards“, data of the investment needs for machinery barns and grain storehouses are now being made available.

Keywords

Machinery barn, grain storage, investment needs

Abstract

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■ The investment requirements for machinery barns and grain stores were determined at the request of the Association for Technology and Structures in Agriculture (KTBL) by the Johann Heinrich von Thünen-Institut (vTI) on the basis of already realised housing and of calculated examples [1]. Cost calculations are according to classifications used by the cost groups under DIN 276 „Costs in building construction“ [2] and comprise the pure building costs from the cost groups 300 „Building constructions“ and 400 „Technical installations“. Costs for the exterior fittings are not considered, nor those for, e.g., additional building costs such as planning fees and building permission charges. All prices are given as net without any applicable value added taxes.

Special points regarding method

Differently from the livestock housing models evaluated so far in the KTBL working programme, the building costs for machinery and grain storage involve a relatively limited proportion of technical equipment. This factor represents only around 5–10 % of building costs compared with up to 40 % in livestock housing, depending on the management system involved. The following text aims to look into the influence on respective total costs of the methods used in construction of enclosing components of different types of buildings.

Six building models of 400–1 500 m² floor space were defined, representing a spectrum of currently applicable barn sizes that are also suitable for other applications (table 1).

The barns could be classified basically in three categories according to requirements:

Table 1

Characteristics of the building structures

Typ/ Type	Beschreibung/ Description	Abmessung/ Dimension	Ausstattung/ Facilities
1	Remise/ Remise	30 x 13 m	Verbundpflaster, einseitig offen pavement, one side open
2a	Geschlossene Halle/ Hall	30 x 15 m	Verbundpflaster, Schiebetore pavement, sliding doors
2b	Geschlossene Halle/ Hall	42 x 22 m	Verbundpflaster, Sektionaltore pavement, sectional doors
2c	Geschlossene Halle/ Hall	60 x 25 m	oberflächenvergütete Stahlbe- tonbodenplatte, Sektionaltore power trowelled concrete floor, sectional doors
3a	Getreidelager/ Grain storehouse	42 x 22 m	oberflächenvergütete Stahlbe- tonbodenplatte, Sektionaltore, separate Schüttgutwände power trowelled concrete floor, sectional doors, separate wall system
3b	Getreidelager/ Grain storehouse	60 x 25 m	oberflächenvergütete Stahlbe- tonbodenplatte, Sektionaltore, separate Schüttgutwände power trowelled concrete floor, sectional doors, separate wall system

■ Barn type 1: Purely a shelter against the weather, what could be called a simple shed, open on one side and offering cost-effective shelter for agricultural machinery and equipment. With the researched building a row of supports set back from the entrance is planned, allowing rapid entrance and exit and minimising danger of damage when driving in.

■ Barn types 2a, 2b und 2c: completely enclosed machinery barns with closable entrances. These three types mainly differ through respective size. In the model calculations different floor types (paved or steel-reinforced plates) and door systems (sliding or sectional) as well as door positioning have been taken into account. To allow the possibility

of multi-use interior construction free of supports was selected. In addition, the variants 2b and 2c are so dimensioned with regard to floor areas that they could be reused as riding halls for equestrian events.

■ Barn types 3a und 3b: Solid enclosing walls – grain stores. Hygiene regulations for food material storage mean requirements here are higher regarding types of surfaces in contact with the stored material and standards of sealing between building component joints.

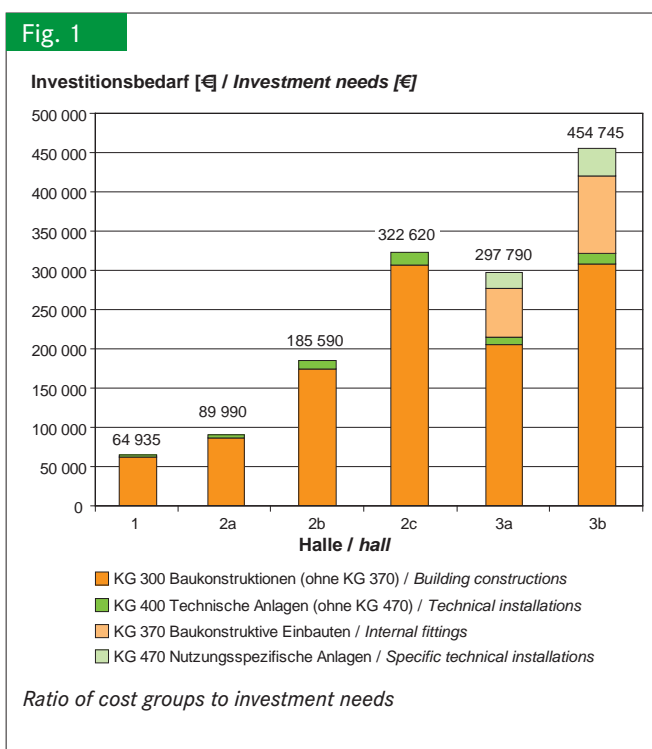
Regarding bulk material retaining wall construction, two alternatives were investigated. Looked at in the first case were separate load-bearing wall elements on the barn floor; in the second the static-construction of the outer walls was such that they were able to bear the weight of the bulk material. Both types of grain stores had the same building measurements as machinery barns 2b and 2c.

Factors influencing investment requirement

To permit comparability between individual building models, important constructional elements have been kept identical in this investigation: the supporting structure as freestanding steel beam construction, the outer wall cladding of trapezium profile sheets and the roof cladding of corrugated fibre-cement sheets. The ratio of the cost groups to investment requirements is presented in **figure 1**.

Different types are evaluated in the following text according to floor construction (paving elements or planed-surface reinforced concrete plates), door type (sliding or sectional) and bulk material retaining wall in the grain stores.

Fig. 1



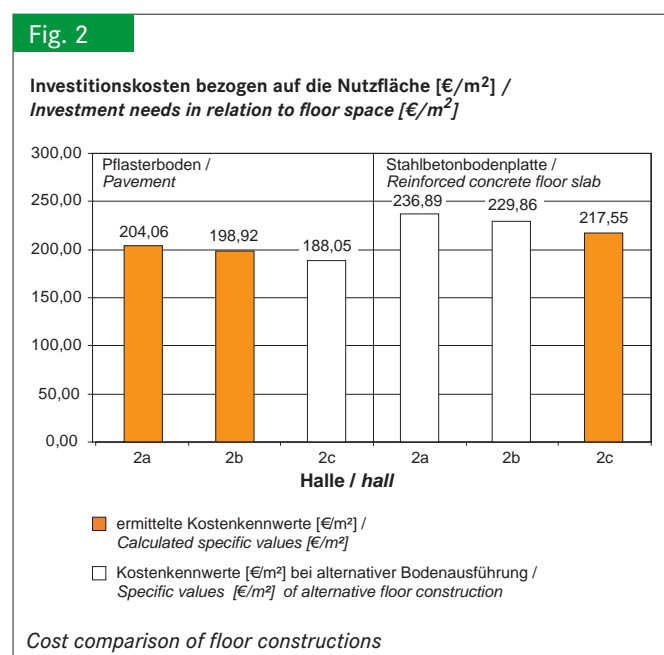
Floor construction

Paved flooring is assumed for barns 1, 2a and 2b. Basically, however, a higher quality concrete floor is also practical for a machinery barn with better cleaning characteristics when dirtied through oil, grease, fuel, etc. The proportion that flooring represents in total costs in the investigated building models runs from 17–22 % and thus represents an important part of costs. With barn types 2a, 2b and 2c cost degression is to be expected through the same design being applied to increasing sizes of barn. The high quality construction of the barn flooring as planed-surface reinforced concrete plates compared with concrete paving cost significantly more with type 2c. **Figure 2** shows construction costs in relation to usable floor area of the barns in €/m². For the respective sizes of barn in this report a cost degression of around 8 % is offered through the alternative flooring.

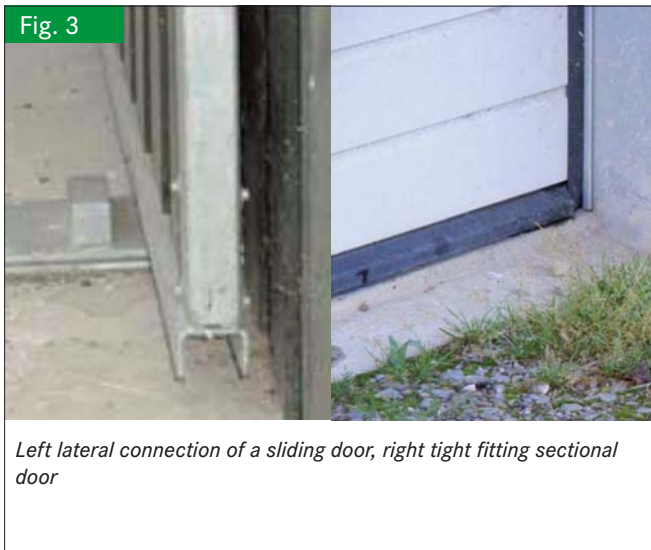
Door systems

A further cost relevant factor is the type and number of barn doors. With the models for machinery barns and grain stores both sliding and sectional doors were considered. Alongside the function of barn entrance the doors are also there for security purposes. An effective protection for illicit entry is important, especially for barns outside built-up areas, in that the machinery and equipment parked there, as well as stored products, represent a significant cash value for the farm which must be protected from break-ins. Additionally, because of the hygiene regulations with grain storage, high standards are required regarding the tightness of constructional component joints. Because of their almost complete sealing effect when closed through the sliding rail system, sectional doors offer comprehensive protection from intrusion by rodents, birds and other small creatures. But on the cost side the higher functionality of the sectional doors (unit price of approx. 5 500 €) has to be

Fig. 2



weighed against the fact that they cost twice as much as simple sliding doors (figure 3).



Bulk material retaining walls

For barns with grain stores two modifications in store wall design are compared. In the first variant these comprise mounted steel reinforced concrete plates fitted approx. 1 m away from the outer walls. The space thus created can be used for technical installations, for instance the air ducting. Where more flexibility for barn use is required there are a large number of demountable wall systems available on the market, e.g. of steel component construction.

In the second variant the outer walls serve for bulk material retention. In this way the entire floor area is available as storage space. The effects on total investment are shown in figure 4.

Costs of cost group 300 increase through the higher price for the outer walls. With regard to total costs this, however, is compensated for through non-requirement of separate walls in the cost group 370 „Internal fittings“. This brings investment requirement for this variant down by approx. 13 %. Just as in the construction of the storage walls, the selection of drying technology also influences price. Pushing air through the stored grain can be building component integrated with underfloor ducts or via perforated flooring as well as through mobile systems, e.g. telescopic air ducting. The latter are included in this research within the cost group 470 „Specific technical installations“.

Research tool

A comprehensive presentation of the building cost investigations into barn building can be found in the online facility „Baukosten“ which can be called-up with a password (fee required) under www.ktbl.de. In the large databank for agricultural buildings, costs of numerous barns and livestock housing can be researched. Alongside the cost elements up to the third le-

vel of detail under DIN 276 there are key planning figures and construction descriptions as well as construction drawings as ground elevations and sectional presentations demonstrated for the individual models.

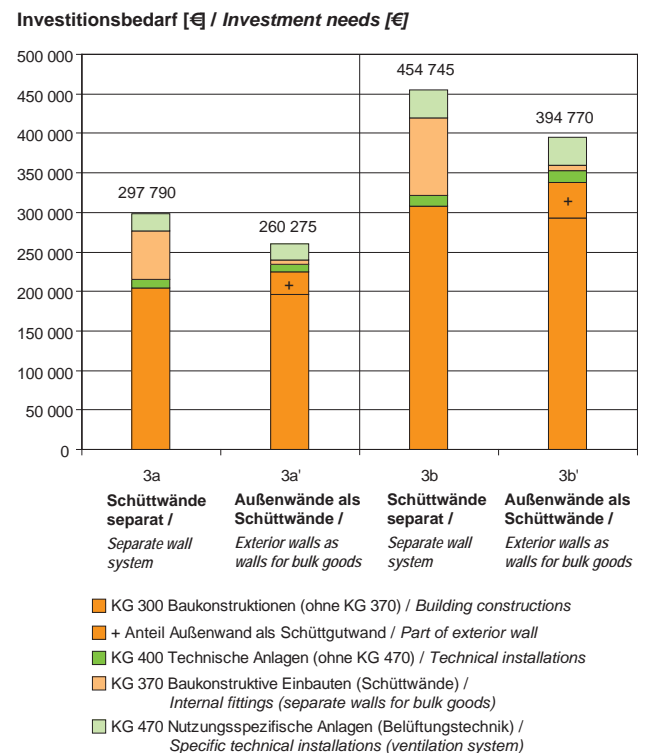
Within similar types of model with differing dimensions own values may be interpolated. Additionally, there is the possibility of completely changing the respective building model prices as well as adjusting individual cost elements regarding number and unit price.

Conclusions

Cost efficient building under the pressures of business economics should not simply mean building cheaply. Instead, it should be understood as appropriate response to the technical and functional requirements according to the building's role. Before starting a new building, or rebuilding an existing one, possible variants to the design and degree of technical equipment should therefore be carefully weighed-up one against the other in order to identify and to utilise all possible optimising potential.

The definitive influential factors acting on storage barn investment costs are, above all, the enclosing constructional components and the type of construction selected. The respective parameters must be optimised in relation to costs for the building's proposed role as well as some flexibility for future use.

Fig. 4



Wall constructions for bulk goods

Literature

- [1] Gartung, J.; Uminski, K.; Baumann, R. (2008): Forschungsbericht zum Investitionsbedarf für Maschinen- und Lagerhallen. Interner Abschlussbericht an das Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL) im Rahmen des KTBL-Arbeitsprogrammes „Kalkulationsunterlagen (KU)“
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