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Grain storage—grain sheds

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Orange

Of the many types of structure used for long-term grain storage one of the more popular is the rectangular shed with an entrance at one end—either open or with doors. When not required for grain storage it can be used for housing machinery. A typical example is shown below.

New South Wales is well serviced by companies that construct all types of farm buildings. Some will supply and erect the steel frame and leave you to attach wall and roof cladding; others do the whole job.

Experienced companies are the ones to contact if you want a well designed and serviceable shed. However, before you do anything about building a new grain shed consider the points raised in this Agfact. They can serve as a check list to ensure the shed chosen best suits your needs.

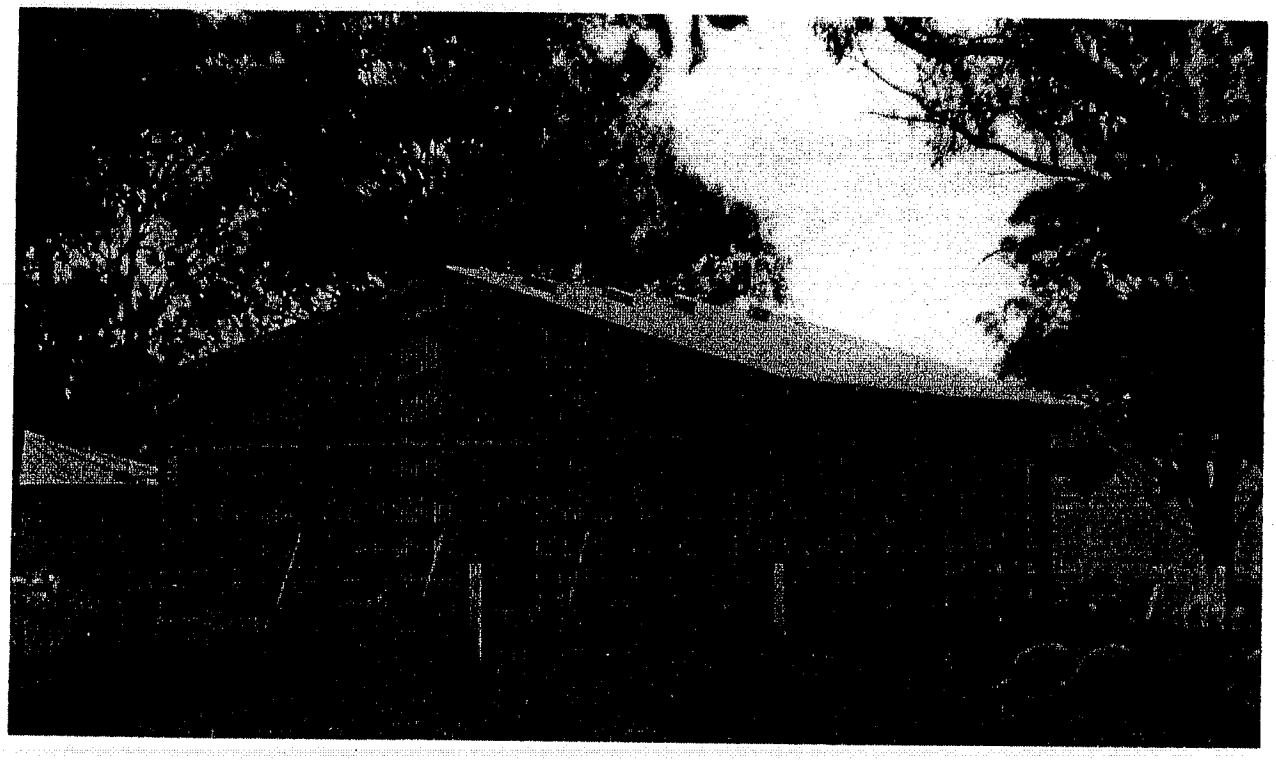
Structural details are not given because it is impossible to cater for all designs and load conditions. If you cannot buy the shed of your choice easily and you want to design your own, get a qualified structural engineer to check the plans. He or she will be aware of the relevant building codes and regulations that apply.

At present (1986) there is no Australian Standard for farm building construction.

SHED CONVERSIONS

Some landholders have considered converting existing buildings into grain storage sheds. To do this it is essential that additional support columns are erected and sufficient wall girts are

A typical grain shed.



fitted to withstand the greatly increased forces acting on the walls. Wall cladding is fixed to the inside of the girts so that the grain pushes the cladding against the girts.

Considerable load is imposed on shed walls and foundations by grain, and inadequate design has resulted in many failures. It is essential to seek the advice of a qualified engineer to assist in any shed conversions.

SITE SELECTION

When selecting the site for a grain shed you must consider the surrounding topography and soil type. The site must be well drained to allow access to the shed at all times.

The entrance should be on the side sheltered from prevailing weather.

On some soils with high clay content it may be necessary to lay road base to ensure trafficability in wet weather.

If the shed is to be used for machinery storage or other uses these must also be considered as regards accessibility and proximity to farm services.

SHED SIZE

Grain storage capacity should be sufficient to cater for crops in most years. For exceptionally good years, temporary facilities such as mesh bins or plastic covered dumps can be used to store excess grain.

If the shed is for both machinery and grain storage, think carefully about the dimensions of the building and its openings. An extra metre in shed width may allow implements to be housed side by side, and the width and height of openings must be chosen to suit the machines to be stored. Remember to allow for any space needed to manoeuvre equipment inside the shed.

Methods and charts to help you work out the grain capacity of various shed types and sizes are given in the box on page 6.

STEEL OR TIMBER CONSTRUCTION?

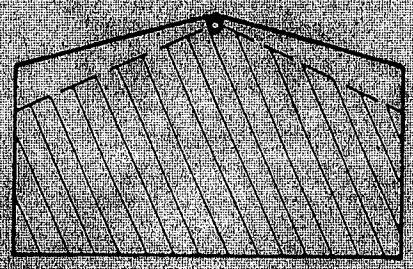
While galvanised steel sheeting is the commonest and most economical cladding product, the shed frame may be made from steel, timber or a combination of these two materials.

Some manufacturers specialise in one or other material, but satisfactory performance can be obtained with each form of construction. Timber may need to be protected from termite attack, whereas poor construction or inadequate maintenance may lead to corrosion problems with steel.

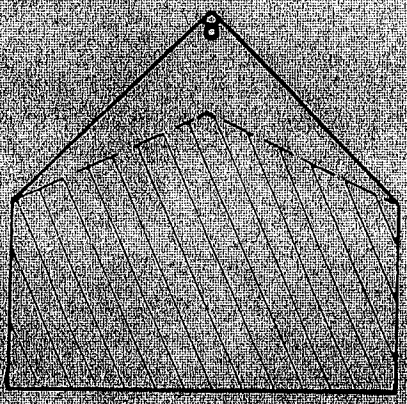
Relative cost will vary depending on geographic location, source of supply, span and bay length of the building and the way in which the project is undertaken.

It is the task of the design engineer to select appropriate member sizes and joint details, knowing the materials to be used and the loads to which the structure will be subjected.

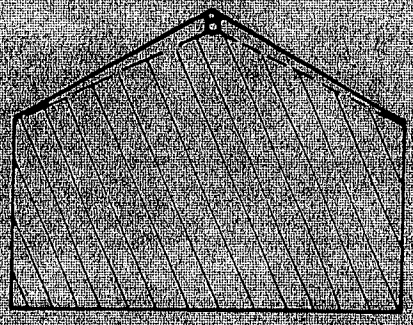
ROOF ANGLES



Shed roof angle 15 degrees—too shallow. Grain has to be shovelled to utilise full wall height.



Shed roof angle 45 degrees—too steep. Roof space cannot be used. Additional grain will put a load on the roof cladding.



Shed roof angle 30 degrees—close to ideal. For most types of grain this allows efficient use of available space.

SHED FILLING AND EMPTYING

Most discussions about grain sheds highlight the difficulty and expense of filling and emptying. Therefore, when designing your shed, a great deal of thought should be given to the methods to be used for these operations.

Some systems require special consideration when the shed is being designed. An auger along the shed roof, for example, will need a frame and sufficient roof strength to support it. An underground trough auger or belt conveyor requires special floor treatment.

Methods of filling include:

- tip direct in shed
- auger into shed with mobile auger
- auger or elevator into end gable of shed then along the ridge with an internal auger
- auger through hole in roof.

Methods of emptying include:

- auger out with mobile auger
- auger through holes in shed side wall
- tractor and front-end loader
- underground trough auger or belt conveyor.

The important point is that filling and emptying is considered as part of the initial shed planning.

ROOF ANGLE

The roof angle of grain storage sheds is important if wasted space is to be avoided. When heaped, most grains form an angle of between 25 and 35 degrees with the floor, known as the angle of repose. More efficient use of the internal space can be made if the roof slope is in this range. If the roof slope is appreciably less, then the shed cannot be filled to the full height of the walls. If the slope is much greater, excessive space is left unused at the ridge. These cases are illustrated. However, roof slope is also influenced by the type of frame to be used for the shed. Portal frames have lower roof angles for economic use of material than column and truss frames, and some compromise may be needed.

If a horizontal roof auger is used, then roof angle should be slightly steeper than grain heap angle. This is to provide space for the auger, while still allowing the shed to be filled to the top of the walls.

CONCRETE FLOOR

Concrete shed floors are usually laid before the shed frame is put up. A hard, smooth concrete floor makes cleaning easy and prevents grain contamination during removal. Before concreting, a firm base of sand or fine gravel should be laid and any allowances made for the installation of augers or conveyers if necessary.

To prevent dampness rising through the concrete a layer of plastic film should be placed on top of the sand base. The plastic should be at least 200 microns thick (0.2 mm) and have an overlap of 150 mm at any joints.

Grain shed floors must withstand the weight of grain, loaded grain trucks (if shed tipping is planned) and tractors and headers. Therefore minimum thickness is 100 mm, and if loaded trucks will drive over it it must be at least 150 mm thick.

The concrete should be reinforced with wire of 6 mm diameter by 200 mm square mesh. Place this about one quarter of the concrete thickness from the base. In this position the wire will act most efficiently due to the 'bowing' effect when a loaded truck passes over it and puts the mesh in tension. The wire should not be placed in the centre or upper position of the concrete as it will be virtually ineffective.

The final level of the concrete floor should be above normal ground level to stop water entering. The ground around the shed should be graded to channel water away.

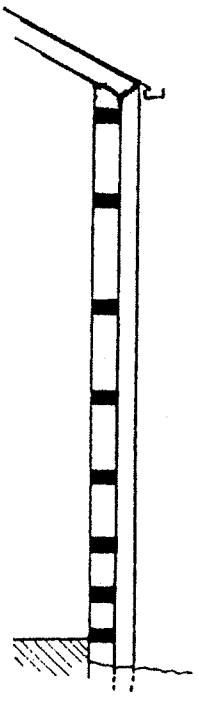
Because slight movements will occur between the floor and the wall use a flexible sealant at the joints. Similarly seal the floor expansion joints. This is important as any crevices not filled will become choked with grain and be susceptible to infestation by insects.

WALL GIRTS

Wall girts are the horizontal wall supports between the main uprights. When grain is loaded against shed walls the lower part of the wall has to withstand a much greater load than the upper part. Therefore, *do not* space girts evenly up the shed wall. Position about two-thirds of them in the lower half. Have them close together at floor level and gradually spaced further apart up the wall.

Put the bottom girt at floor level to prevent the wall cladding being pushed out by the grain.

Place girts closer together at the bottom of the walls. Ideally, two-thirds should be in the lower half of the wall.



Girts are typically 100 × 75 mm, 125 × 50 mm or 150 × 50 mm hardwood laid flat (that is, with the longer side horizontal), or made of C-section steel. The size and number of girts will depend on the spacing between the main shed uprights and shed height. The designer's or manufacturer's recommendations must not be altered.

WALL CLADDING

Grain pressure is outwards against the walls and therefore the wall cladding must be fixed on the inner side of the girts and main support columns. Besides being strong, this construction makes removal of grain easy. If the cladding were on the outside, residues of grain could collect on the ledges of the girts and lead to insect infestation.

If possible, use wall cladding with a length equal to the height of the wall. Pop rivet the adjacent sheets together with at least a two corrugation side overlap. Full lengths reduce the problem of crevices between the end laps of sheets; these cannot be avoided if short sheets are used. Such crevices hold grain and once again could lead to insect infestation.

CROSS TYING OF MAIN SUPPORT COLUMNS

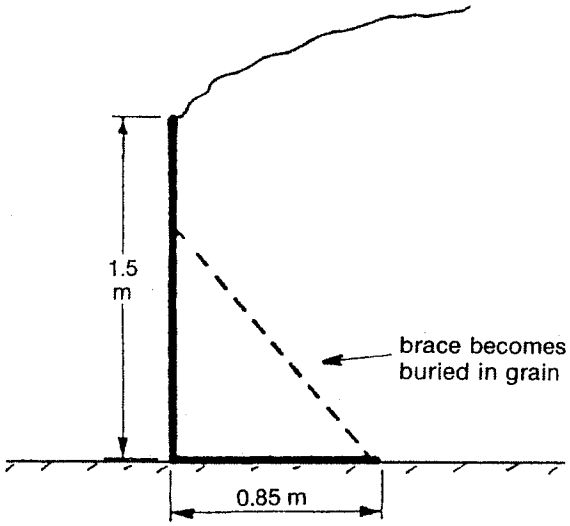
Because of the high grain loads against the side walls, the main support columns must have substantial foundations and be cross tied from one side of the shed to the other. The bottom tie could be a 25 mm diameter steel bar laid within the floor and bolted to the base of opposite columns.

With certain types of shed construction a top cross brace is also desirable. Unfortunately this reduces headroom for machinery storage. To avoid this problem a bar hinged at each end and centrally connected and tensioned by a turnbuckle could be used. When the shed is not used for grain the top tie is released and dropped down. When grain storage is required the bars are reconnected and tensioned with the turnbuckle. This system has one major fault—you *must* remember to reconnect before using the shed for grain.
required extra headroom for machinery storage, is to fit a tie across the roof truss. This tie must be no more than a third of the way up the truss, and shed columns must be securely bolted and braced to the truss.

Do not underestimate the outward force exerted by a large volume of grain. Main support columns have been pushed outwards in sheds not cross tied, resulting in serious shed damage and crop loss.

GUTTERS AND DRAINAGE

The ground around grain sheds must be graded to allow water from all storms to flow away. Construct concrete floors at least 100 mm above outside ground level so that water cannot flow in. If gutters and downpipes are fitted to a shed, the downpipes should discharge well away from the sides or corners of the shed.



Temporary wall panels of this type are useful in sheds with one end open to increase storage or configure the grain.

TEMPORARY WALL PANELS

To allow more grain to be stored within a shed that has one end open, or within part of a shed, temporary wall panels can be used. These panels are 1.2 metres wide, and a row of them forms a solid wall 1.5 metres high. The panels are L-shaped and manufactured from standard sized 2.4 × 1.2 metre steel sheet, gusseted as shown by the dotted line in the diagram.

The panels must have a large base area so that grain weight holds them firmly in position. For additional support, special sockets can be made in the concrete floor to allow posts, against which the panels can rest, to be fitted.

HOW TO CALCULATE GRAIN SHED CAPACITIES

Different grains have different densities and settle to different angles in a bulk pile. As well, the angle changes with moisture content and grain settles during storage. Therefore all figures given are approximate. To obtain storage capacity in tonnes, multiply cubic metres by the appropriate conversion factor from the table.

To convert tonnes of wheat to tonnes of another crop divide by 0.75 and multiply by the appropriate figure for the other crop.

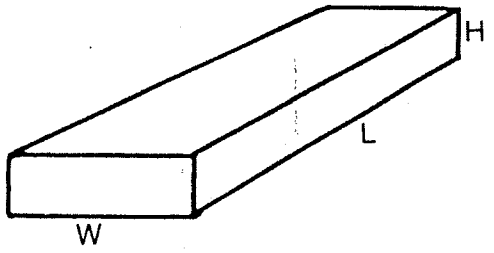
Diagrams and formulas for three different grain storage arrangements are given on the next page. Simply use your calculator or the charts to work out the volume for each type.

Note: All measurements are in metres—L, W and H refer to shed length, width and side wall height respectively.

Table. Factors for converting capacity in cubic metres to tonnes for selected grain products.

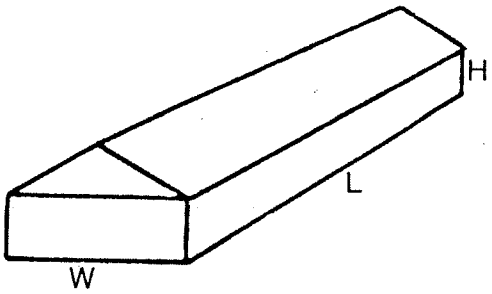
Grain product	Conversion factor
Wheat	0.75
Maize	0.72
Oats	0.50
Sunflower	0.40
Linseed	0.73
Rye	0.71
Sorghum	0.72
Barley	0.62
Rape	0.67
Soybean	0.75
Safflower	0.53
Rice (paddy)	0.62

Closed end shed, equal grain depth throughout



L × W × H = Volume (cubic metres)

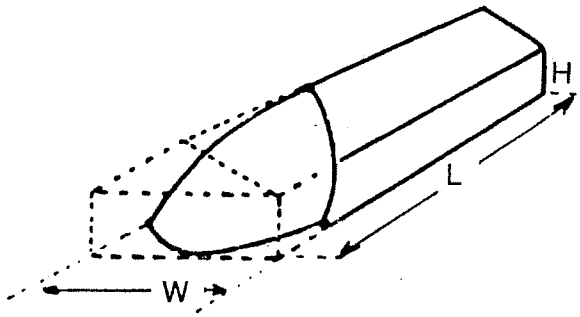
Closed end shed with grain peaked along the centre



$$(L \times W \times H) + \frac{(L \times W \times W)}{8} = \text{Volume*}$$ (cubic metres)

* based on 26½° grain angle

Shed with one end open



With this type of shed, which is common in Australia, a large space is wasted at the open end. The calculation for grain content in the sloping and curved end portion is complex. To make it easier, refer to the three charts based on storage of *wheat* in the box on page 6. An example illustrates how the charts can be used.

For any one grain shed you only need to use one chart. Each chart is for grain loaded to a certain sidewall height. To use the charts, first decide which of the 3, 4 or 5 metre grain wall heights best suits your needs; then either read off a shed length and a shed width to obtain wheat capacity of the shed in tonnes, or, if you know how many tonnes of wheat you wish to store, find the line for your tonnage and see what shed lengths and widths coincide with the line. You can do this on each chart to decide on the best wall height.

Note: Remember if you use these charts for *other* grains you must divide by 0.75 to find out the volume in cubic metres, then work out the approximate tonnage for your crop. The results for other crops will be less accurate because their grain angle of repose will differ from that of wheat.

CONCLUSION

The correct structural design of a grain storage shed is beyond the capacity of most producers, and it is necessary to follow the guidance of reputable manufacturers or use the service of a structural engineer.

On no account should dimensions, member sizes, or construction details be changed without the approval of appropriate authorities. To try to save a few dollars by using fewer or smaller components and ultimately find the building becomes unserviceable because of some kind of failure is false economy.

Acknowledgment

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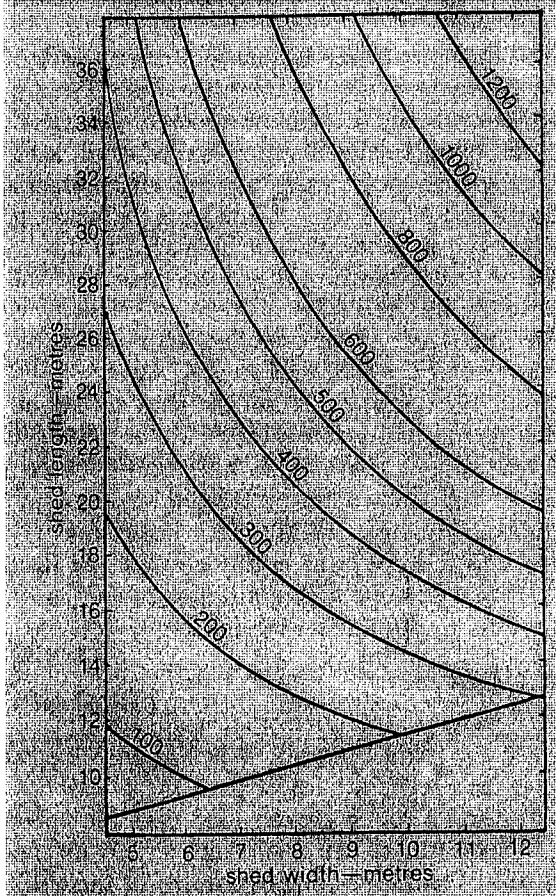
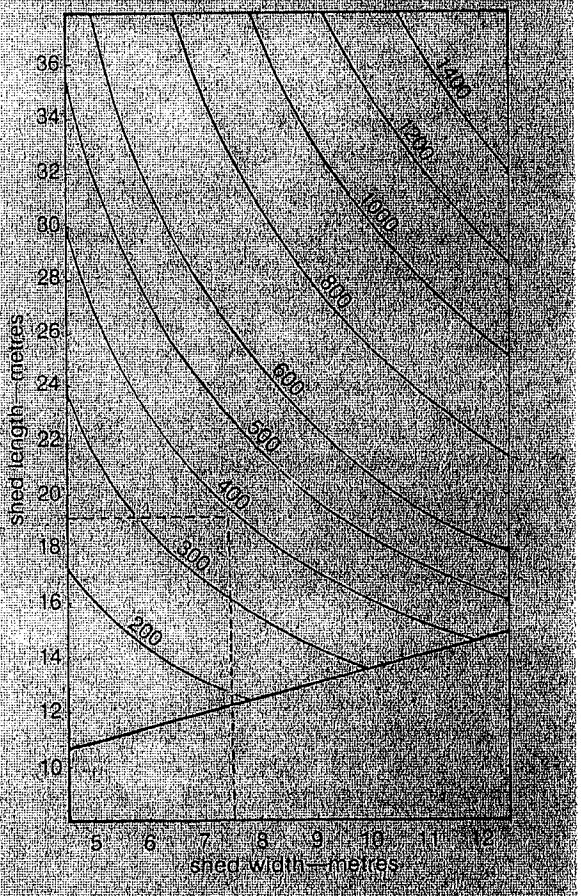
WHEAT CAPACITY CHARTS FOR SHEDS WITH ONE END OPEN (TONNES)

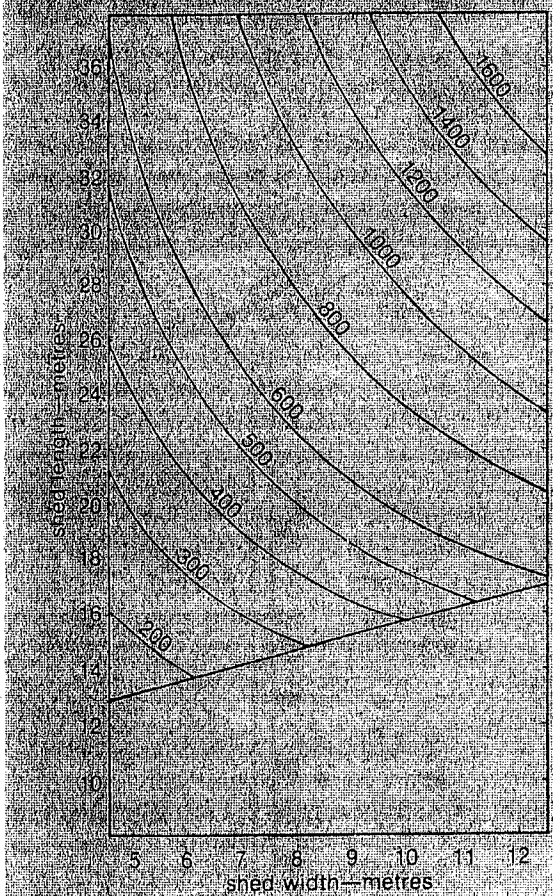
3 metre wall height.



4 metre wall height.



5 metre wall height.



Examples on use of wheat capacity charts

Question 1: I'm going to build a shed 19 metres long, 7.5 metres wide with a side wall height of 4 metres. If one end is open, and I peak the grain along the centre, how many tonnes of wheat will the shed hold?

Procedure:
(i) Select the chart for a 4 metre wall height.
(ii) Read across from the 19 metre position on the vertical scale and note where it meets the 7.5 metre line from the horizontal scale (this is marked on the chart). The shed capacity is read from the heavy curved lines and the answer is just under 400 tonnes.

Question 2: I require a wheat storage capacity of 600 tonnes. What size shed do I need?

Procedure: If a shed with side walls 4 metres high is used, then in the chart above it is seen that shed sizes can be read from any point along the 600 tonne line, namely from 38 metres long × 5 metres wide to 18 metres long × 12.5 metres wide. A suitable pair of dimensions can be selected from the range. For other side wall heights note the 600 tonne line of the appropriate chart.

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