Many farmers often need to know how much silage is stored in their finished stack, pit or bunker for feed budgeting, for selling or calculating contractor costs.

Calculating the weight of silage in the storage requires measurement or an estimation of:

a) **storage volume (capacity)** in cubic metres (m$^3$); and
b) **silage density** in kg/cubic metre (kg/m$^3$)

The weight of silage in storage is then calculated on a wet basis using

**Equation 1:**
Silage wet weight = Volume of stack or pit (m$^3$) x silage density (kg wet weight/m$^3$)

OR on a dry matter (DM) basis using

**Equation 2:**
Silage DM weight = Volume of stack or pit (m$^3$) x silage density (kg DM/m$^3$)

**Estimating stack volume**
The first step is to estimate the volume of the storage by multiplying the dimensions of the storage - width by the length by the approximate height of silage. Calculations would be simple if the silage was stored as a rectangle or square block. However, given that most silage storages are irregular shapes the dimensions have to be estimated, taking into account the taper on the top of the storage and slope of the sides and ends.

The estimates will then be approximates of the length, width and height as shown in Figure 1. In this example the dimensions have been estimated at a length of 30 m, width of 5 m and height of 3 m.

The volume of the ‘stack’ in Figure 1 is $30 \times 5 \times 3 = 450$ m$^3$.

**Figure 1:** Estimates of the height, width and length of the storage must take into account the tapering of the top and slope of the sides and ends of the silage as indicated in the diagrams below.

Frank,
I need a diagram (b) showing a side view of the bunker – showing the ends tapering to nothing and the estimated length at 30 m along the same lines as in Figure 1(a), please. While your at it … I’m happy with the right side of the bunker above (ie the position of the vertical line so it cuts through the slope at half way, but I can’t get the left vertical to move – it needs to come in half a space)….. could you please have a go at moving it please?
Estimating Silage Density

It is difficult to accurately estimate silage density without sampling and measuring the actual density of silage in the storage. Density of the ‘settled’ stack is affected by the dry matter (DM) content of the silage, chop length and degree of compaction.

If it is not practical to sample and measure density the following default values can be used. A rough rule of thumb allows for about 600 kg of wet silage in one cubic metre of settled stack, which is, at an average of 33% DM, about 200 kg DM/m$^3$.

It is important to remember that long chopped, poorly compacted or very wet silage will have a lower density, probably closer to 500 kg/m$^3$ wet silage while fine chopped or a well-compacted stack may be over 700 kg/m$^3$ wet silage.

The variation in silage densities that can occur was highlighted in a survey conducted in Wisconsin, USA, which measured the densities of 81 maize stacks and 87 stacks of mainly lucerne silage (see Table 1). The average density of wet silage was 590 (mainly lucerne) to 690 (maize) and both averaged about 235 kg DM/m$^3$. However, the range within each silage type was huge, obviously affected by different DM contents, chop lengths and/or compaction. Similar surveys have not been conducted in Australia, but ranges are likely to be similar.

Table 1. Dry matter contents and densities of lucerne and maize silages

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mainly Lucerne silages(87)</th>
<th>Maize silages(81)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>DM content (%)</td>
<td>42</td>
<td>24 – 67</td>
</tr>
<tr>
<td>Wet density(kg/m$^3$)</td>
<td>590</td>
<td>210 – 980</td>
</tr>
<tr>
<td>DM density(kg/m$^3$)</td>
<td>237</td>
<td>106 – 434</td>
</tr>
<tr>
<td>Av. particle size(mm)</td>
<td>11.7</td>
<td>6.9 – 31.2</td>
</tr>
</tbody>
</table>

Source: Muck and Holmes (1999)
A more accurate method to determine the density in a stack is to measure it, remembering to do so at several locations and depths in the stack. Cut a square or rectangle of known dimensions out of the stack and weigh it. The density of the silage on a wet or DM basis (measured by feed testing or using a microwave oven) is then calculated using the following:

**Equation 3:**
Silage density = weight of silage sample ÷ volume of sample

**Example:**
A square block of silage has dimensions of 0.2m (length) x 0.2m (width) x 0.2m (height).
This silage sample weighs 5.0 kg (wet weight) and has a DM content of 40%. This is an equivalent DM weight of 2.0 kg.

The volume of silage = 0.2 x 0.2 x 0.2 = 0.008 m$^3$
Wet density of silage = 5.0 ÷ 0.008 = 625 kg/m$^3$
DM density of silage = 2.0 ÷ 0.008 = 250 kg DM/m$^3$

**Calculating the Weight of Silage in Storage**
The estimates of stack volume and the density of the silage are used in Equation 1 to calculate the wet weight of silage, or in Equation 2 to calculate the weight of silage DM in storage.

From the previous examples:
Volume of stack = 450 m$^3$
Silage density = 625 kg/m$^3$ (wet weight)
OR = 250 kg DM/m$^3$

Using Equation 1:
Weight of silage (wet basis) = 450 m$^3$ x 625 kg/m$^3$
= 281,250 kg
= 281 tonnes (approx.)

Using Equation 2:
Weight of silage (DM basis) = 450 m$^3$ x 250 kg DM/m$^3$
= 112,500 kg
= 112 tonnes (approx.)