

Agriculture

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Estimating Crop Yields and Crop Losses

Note Number: AG0104

Published: January 1998

Updated: May 2012

Accurate, early estimations of grain yield and crop loss are important skills in grain production. Farmers require accurate estimates for:

- crop insurance purposes
- forward marketing and delivery planning
- planning harvest and storage requirements
- cash-flow budgeting.

Extensive personal experience is essential for estimating yields at early stages of growth. As crops near maturity, it becomes easier to estimate yields with greater accuracy.

Estimation methods

A simple but accurate formula for estimating cereal grain yield is based on the number of heads per 500 mm of drill row, the number of grains per head and the size of the grain.

Formula for estimating grain yield

$$\frac{\text{Average number of heads per 500 mm of row} \times \text{Average number of grains per head}}{\text{Known constant (K)}} = \text{tonnes/hectare}$$

The "known constant" is that number of grains in the half metre of row at 175 mm row spacing that is equivalent to 1 tonne per hectare.

It is more difficult to count the number of grains per 500 mm of row for trailing crops such as field peas and lentils, but if managed, the average number of grains per 500 mm of row divided by the appropriate known constant will provide a yield estimate. Alternatively, you can use the formula for estimating losses, by counting the number of grains of these crops per 0.1 sq m and divide by the known constant "X" from table 3. This will also give a yield estimate.

The value of the "known constant" varies according to the grain weight, which differs for each type of crop. Even within the same crop it may be necessary to adjust the "known constant" to compensate for a heavier or lighter grain weight. For example, in seasons of heavy rust infection the "known constant" for wheat is generally decreased to compensate for lighter grain weights.

A range of "known constants" for different grain weights is shown in Table 1.

Estimation accuracy, regardless of method, depends on the accuracy of observations taken in the field. Counts of grains per head and heads per length of row must be accurate and taken randomly at enough locations (at least 10) to provide an average count representative of the whole field. A length of steel rod or light timber, cut or clearly marked in half-metre segments, is a useful measuring aid. Another useful aid is a pre-ruled form for recording of counts. This is used for calculation and a permanent record of the yield estimate.

Table 1. "Known constants" for various grain weights

Weight of 100 grains (grams)	Known constant (K) (grains/500 mm of row)
2.6	336
2.8	312
3.0	292
3.2	273
3.4	257
3.6 (typical of wheat)	243
3.8	230
4.0 (typical of oats)	219
4.2	208
4.4 (typical of barley)	199
4.6	190
4.8	182

16 (typical of lupin -narrow leaf type)	55
18 (typical of chickpea - desi)	47
20 (typical of field pea)	44
30 (typical of lupin - broad leaf type)	29
40 (typical of chickpea - kabuli type, broadbeans)	22
50 (faba bean*)	17.5
70 (faba bean – large)	12.5

Note: The "known constant" (K) is the number of grains per 500 mm of row that is equivalent to a yield of 1 tonne per hectare at 175 mm row spacing.

Compensation for row spacing

The calculations used in these formulas assume there is row spacing of 175 mm. As there is a range of row spacings in the different forms of modern sowing equipment, it is necessary to allow for row spacing when estimating yield by the head and grain count method.

The most convenient procedure is to carry out a yield estimation according to the Formula for estimating grain yield (175-mm row spacing) and then multiply the result by one of the conversion factors in table 2 which adjusts yield estimates for different row spacings.

Table 2. Conversion factors that adjust yield estimates for different row spacings

Row spacing (mm)	Conversion factor
150	1.17
175	1.00
200	0.88
225	0.78
250	0.70
275	0.64

300	0.58
325	0.54
350	0.50

Row counts are not practical for broad leaf crops which branch or sprawl. Yield estimates for such crops are more easily taken on a seed per unit area basis (usually 0.1 square metre).

The information on the assessment of crop loss and table 3 is equally applicable to yield estimates of broad leaf crops. Instead of counting seeds on the ground, the seed is rubbed out of the standing heads and pods within an area of 0.1 square metres.

Assessment of crop loss

Having estimated potential yield for a given area of crop it is often necessary to assess grain losses. These could be the result of environmental factors (hail or wind) or mechanical factors at harvest.

In the case of hail damage it is often appropriate to substitute an estimate of the average grains per head missing for grains per head in the calculation outlined above. This would produce an estimate of the loss due to hail.

Losses that are the result of other factors are more appropriately estimated by the number of grains per unit area spilt on the ground.

Formula for estimating yield loss

Grain count/unit area

Yield loss (t/ha) = Known constant (X)

Where "X" is the number of grains per unit area equivalent to 1.0 tonne/ha (see table 3)

As is the case in the formula for estimating grain yield, the known constant will be different as the grain weight varies.

Table 3 provides values for known constant "X" for a range of 100-grain weights. These values are recorded for a unit area of 0.1 square metre; it is usually impracticable to count larger areas unless grain loss is very slight.

A simple measure of 0.1 square metre can be formed from a square of light steel rod or square tubing with inside measurements of 316 by 316 mm. A fully formed quadrat may prove difficult to place in the crop: an "L"-shaped device may be easier to use, with the missing sides represented by imaginary lines.

Similarly to yield estimation, you should take a number of random counts that are representative of the loss problem and use an average figure in the final calculation. Again, a pre-ruled page for recording counts and calculation is a valuable aid.

Example 1

After a number of counts the average number of wheat grains on the ground in a standing crop was recorded as 147 per 0.1 square metre.

We already know that wheat usually has a 100-grain weight of 3.4 grams. The known constant "X" for this particular calculation is therefore 294 (from table 3).

$$\text{Yield loss (t/ha)} = \frac{\text{Grain count/unit area}}{\text{Known constant "X"}} = \frac{147}{294} = 0.5 \text{ t/ha}$$

Estimates of header losses

The formula for estimating crop loss can also be used to estimate losses at harvest as an aid to correct header adjustments.

Losses due to environmental factors will have occurred before the header passes and should be subtracted from machine losses. Machine losses can occur at the front of the machine (gathering losses) and behind the machine (walker losses).

Gathering losses can be assessed by stopping the header and backing it up to expose the cut stubble before the walkers have passed over. Gathering losses are the grains under the header minus the environmental losses. "Walker" losses are the total losses behind the straw walkers minus environmental and gathering losses divided by a factor to account for the walkers being narrower than the full width of the machine.

This factor is equal to the cutter bar width divided by the walker outlet width. The straw spreader (where fitted) should be disconnected during this assessment.

The following example will clarify this procedure:

Example 2

A count of grain loss due to environmental causes of 147 grains per 0.1 square metre was established in example 1. A count of 162 grains per 0.1 square metre was recorded "under" the header.

The gathering losses are:

$$\text{Gathering loss} = 162 - 147 = 15 \text{ grains/0.1 sq m}$$

$$\text{Gathering yield loss} = \frac{15}{294} = 0.051 \text{ t/ha}$$

The header had a comb width of 7.2 m. After it had passed, the average number of grains on the ground behind the 1.5 m straw walkers was 234.

Therefore walker losses

$$= 234 \text{ minus } 162 \text{ divided by width factor} = 72 \text{ divided by } \underline{7.2} \text{ m} = 72 \text{ divided by } 4.8$$

$$1.5 \text{ m}$$

$$= 15 \text{ grains}/0.1 \text{ sq m}$$

$$\text{Therefore walker yield loss} = \frac{15}{294} = 0.05 \text{ t/ha}$$

Total yield loss is therefore: Environment losses 0.5 t/ha + Gathering losses 0.05 t/ha + Walker losses 0.05 t/ha = 0.60 t/ha

Table 3. Values of known constant "X" for various 100-grain weights

Weight of 100 grains (grams)	Known constant (X) (grains/0.1 sq m)
0.4 (typical of canola)	2500
0.6	1666
0.8 (typical of linseed/canola)	1250
3.2	312
3.4 (typical of wheat)	294
3.6	278
3.8 (typical of safflower)	263
4.0 (typical of oats)	250
4.2 (typical of barley)	238
4.4	227
4.6	217
16 (typical of lupin -narrow leaf type)	62
18 (typical of chickpea - desi)	56
20 (typical of field pea)	50

30 (typical of lupin - broad leaf type)	33
40 (typical of chickpea - kabuli type, broadbeans)	25
50 (faba bean*)	20
70 (faba bean – large)	14

Note: The "known constant" (X) is the number of grains per 0.1 square metre that is equivalent to a yield of 1 tonne per hectare.

*Faba bean weight can vary from 35g per 100 grains to 70g per 100 grains

Record of grain yield (example form)

Name.....
 Date.....
 Crop type.....
 Variety.....
 Location.....
 Anticipated 100-grain weight.....grams
 Therefore K =

Count No.	Heads/500 mm	Grains/head	Count No.	Heads/500 mm	Grains/head
1			21		
2			22		
3			23		
4			24		
5			25		
6			26		
7			27		
8			28		
9			29		

10

30

11

31

12

32

13

33

14

34

15

35

16

36

17

37

18

38

19

39

20

40

Total A

Total B

Total B

Total A + B

Average (H)

(GH)

Calculation

Yield (t/ha) = (H) X(GH).....
"K"

Correction for row spacing

Yield (t/ha) = Above estimate X conversion factor (Table 2)

= X = t/ha

Published and Authorised by:

Department of Environment and Primary Industries

1 Spring Street

Melbourne, Victoria

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Page last updated: 31 July 2015

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