DEPARTMENT OF
PRIMARY INDUSTRIES

Agriculture Notes

Note Number: AG0104

Published: January 1998

Updated: October 2008

Estimating Crop Yields and Crop Losses

A method of estimating crop yields and crop losses is presented for grain growers, along with associated tables of constants and conversion factors for use in the calculations.

Introduction

Accurate, early estimations of grain yield and crop loss are important skills in grain production.

- Farmers require accurate estimates for a number of reasons:
- Crop insurance purposes
- Delivery estimates
- 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

For many years a simple but accurate formula (formula 1) has been used by DPI staff, and others, for estimating cereal grain yield. It 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 1

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

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.

The value of the "known constant" varies according to the grain weight, which in turn 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.

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*

Accuracy of estimates calculated by this method, or any other 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. An example of such a form is given on the last page of this Agriclture Note.

Compensation for row spacing

All the calculations discussed so far have assumed a row spacing of 175 mm. However, there is a range of row spacings in the different forms of modern sowing equipment. Allowance for row spacing is therefore necessary when estimating yield by the head and grain count method.

The most convenient procedure is to carry out a yield estimation according to formula 1 (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 in the next section on 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. The calculations would then 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 2 can be used to estimate yield loss by this approach.

Formula 2

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

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

As is the case in Formula 1 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.

As was the case with yield estimation, there is a need to take a number of random counts that are representative of the loss problem and to use an average figure in the final calculation. Again, a pre-ruled page for recording counts and calculation is a valuable aid.

An example will clarify the procedure.

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

Formula 2 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 therefore 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.

An 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:

Gathering loss = 162 - 147
= 15 grains/0.1 sq m

Gathering yield loss = $\frac{15}{294}$
= 0.051 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 minus 162 divided by width factor
= 72 divided by $\frac{7.2\text{ m}}{1.5\text{ m}}$
= 72 divided by 4.8
= 15 grains/0.1 sq m

Therefore walker yield loss = $\frac{15}{294}$
= 0.05 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

Summing up

Grain counts and the formulae described in this Agriclture Note can give estimates of grain yield and grain losses with a surprising degree of accuracy. It should be recognised, however, that the answer is still only a guide and any assumption made from the estimates contains a degree of uncertainty.

The accuracy of estimates depends on an adequate number of counts being taken to give a representative average. Knowledge of the appropriate 100 grain weight for selection of "known constants" is also important.

If these points are recognised the above methods can be successfully used in many situations on a grain growing property.

Continues next page……….

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

Acknowledgements

Original publication was developed by Geoff Stratford in the 1980's .

It was reviewed by:

Brendan Williams in 1998.

Greg Bowey, Farm Services Victoria – Grains. October 2008.

ISSN 1329-8062

Published and Authorised by: Department of Primary Industries
1 Spring Street
Melbourne, Victoria

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