# Damage to Dutch agricultural and horticultural crops as a result of the drought in 2018

*Extent of crop yield losses and mitigating and adaptive measures taken by farmers and growers*

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## 1. Introduction

The period of heat and drought in the summer of 2018 has major consequences for agricultural production. Most crops in the Netherlands have experienced severe yield reductions as a result of unprecedented low levels of rainfall combined with very high temperatures (see Appendix 1). The Ministry of Agriculture, Nature and Food Quality has contracted Wageningen Economic Research to provide a picture of the scale of the loss of yield, of mitigating measures taken on farms to limit the damage and of adaptive measures to compensate for the consequences of the damage suffered. This research follows up the request from the Directorate-General for Agriculture and Rural Development (DG Agri) to all Member States. This memorandum provides an indication of yield losses based on the situation in mid-August for the most important arable crops, open-field horticultural crops and fodder crops, including grassland.

## 2. Method

In the current research two methods were used, which together provide a picture of the drought effects:

- An analysis of yield losses in previous extremely dry years based on data from the Farm Accountancy Data Network (FADN). To this end, the yields obtained in the five most dry years since 1970 have been compared to the average yields in the surrounding years. The years were selected on the basis of the combination of temperature and rainfall (according to Royal Netherlands Meteorological Institute [KNMI] measurements in De Bilt, the Netherlands) in the months of June, July and August. The years selected are: 1976, 1983, 1995, 2003 and 2006. The yields per crop stated in kilogrammes were compared with the averages of the two preceding and the two following years.
- An expert judgement, in which more than 25 sector experts were consulted on the yield losses in 2018 as a result of the drought period and on the mitigating and adaptive measures taken. They were asked to relativise the revenues and measures to the average situation in the past three years (2015, 2016 and 2017).

## 3. Results

### 3.1 Arable crops

The drought has had significant impact on the growth of most arable crops. The analysis of the drought effects includes only the most important arable crops: ware potatoes, seed potatoes, starch potatoes, sugar beet, onions, winter wheat and spring barley (Table 1). Together, these crops account for approximately 90% of the average turnover of arable farms.

The outlook for *ware potatoes* varies. In the past, the harvest in the dry years lagged behind by about 11%. For the extreme year of 2018, the expected yield reduction is approximately 20%. This would mean that an average ware potato harvest of less than 42 tonnes/ha would be expected in 2018 instead of an average of 52 tonnes/ha over the past three years.

About one third of the acreage of ware potatoes was irrigated. It is estimated that this is an average of 100 mm, spread over three to five irrigations. These plots are not expected to yield a maximum harvest either, but the expected loss of yield is much less than on the plots where no irrigation has been carried out. Two thirds of the acreage was not irrigated. The main reason for this is lack of suitable water: in some cases it was prohibited to extract water from surface water and in some cases it is too salty to be used for this purpose. A second possible measure is to postpone the harvest to limit part of the yield loss. This of course depends on the weather conditions in the late season. In addition, there is a risk of a reduction in quality as a result of possible further sprouting.

The outlook for *seed potatoes* is very diverse. In the past there were dry years with relatively low yields (such as 1983), but also fairly good harvests occurred (1976, 2003). The expected fall in yield for 2018, measured in kg/ha, is similar to that for ware potatoes. This is mainly due to the lagging of the tuber growth. The number of tubers differs much less than that of the previous years. In the cultivation of seed potatoes, the number of tubers is particularly important. The larger, oversized tubers are even almost unsaleable as seed potatoes. As a result of the more favourable grading, on balance the fall in yield in terms of the number of marketable tubers is estimated at approximately 5%. Irrigation was also applied in seed potato cultivation, but to a lesser extent than in ware potato cultivation. This is linked to a ban in various regions to prevent contamination with the feared brown rot bacterium through irrigation. On average, 20% of the acreage of seed potatoes has been irrigated. Depending on irrigation, variety and type of soil, the yields will vary enormously, from less than 10 tonnes/ha to more than 45 tonnes/ha.

*Starch potatoes* are grown almost exclusively on sandy soil and reclaimed peatland in the north-east of the Netherlands. In previous dry years, the loss of yield of starch potatoes was comparable to that of ware potatoes. Within starch potato cultivation, too, there are major differences in the sensitivity of the soil to drought and in the options for irrigation. The average harvest in recent years has been around 45 tonnes/ha; this year the harvest is expected to be 25% lower, averaging 30 to 35 tonnes/ha. The starch content strongly depends on the rainfall in the rest of the growing season and is therefore difficult to predict. It is estimated that 15% of the starch potatoes have been irrigated. A reasonable harvest is expected on these plots. However, the loss of yield can be more than 50% on plots which were not irrigated as these are prone to drought.

The harvest of *sugar beet* is also difficult to predict. In the past, the harvest in dry years was on average slightly lower than normal, but there were also years with a relatively high yield. For 2018, the average beet harvest in the clay regions is expected to be 10% lower; for the sandy areas, the estimated loss of yield is about 20%. In addition to the beet yield, sugar production depends on the sugar content. In particular, the development of this content is uncertain. Under good growing conditions, the plant can still absorb a great deal of nitrogen from the soil in August and September. However, there is a risk that the crop will produce a lot of new leaves, which will reduce the sugar content. This has not been taken into account in the harvest estimate. Approximately 20% of the sugar beet acreage has been irrigated. At farm level, irrigation capacity has generally been focused on the more drought-sensitive and capital-intensive crops, such as potatoes and onions. A harvest measure already planned is to postpone the beet campaign. The impact of this measure depends, among others, on the weather and soil conditions in mid-September.

*Onions* are a drought-sensitive crop. This was also reflected in earlier dry years, in which the average yield fell by 15% to almost 60%. The informants estimate that the onion harvest per hectare in 2018 will be only half that of recent years. In some cases, there is even a total crop failure, with the onions now ploughed under. This is particularly the case in the south-west of the Netherlands, where irrigation is impossible. Onions planted in spring have been affected less than onions seeded. This proved to be an advantage in 2018: the loss of onion planted seems to be less than that of seed onions. Approximately 50% of the onion acreage has been irrigated, but the extreme heat and solar radiation has affected the leaves, which means that a loss of yield is also expected on the irrigated plots. Grading is also a matter of concern. Large, coarse onions will be particularly scarce in 2018, while it is precisely these sizes that are most sought after in trade.

Grains, including both *winter wheat* and *spring barley*, have suffered relatively little from drought. This is mainly due to the early harvest, which meant that the crop had already been harvested before the drought

peaked. The grains were ripe early, which sometimes led to some loss of yield. The high hectolitre weight of both wheat and barley was striking.

For livestock farming, the production of straw is especially important. This was lower than in other years, not only in the Netherlands but also in France and England. This, together with increasing demand, has led to a certain scarcity of straw, with correspondingly higher prices.

***Table 1*** *Summary table of the yields in kilogrammes per hectare of the main arable crops in dry and hot years, calculated as change in % compared to the average yield in kilogrammes in the surrounding years*

| | 1976 | 1983 | 1995 | 2003 | 2006 | Average | 2018 (estimation) |
|---|---|---|---|---|---|---|---|
| Ware potatoes | -7 | -14 | -12 | -11 | -11 | -11 | -20 |
| Seed potatoes | 8 | -26 | -2 | 4 | -3 | -4 | -5 |
| Starch potatoes | -13 | -15 | 3 | -17 | -13 | -11 | -25 |
| Sugar beet | 7 | -15 | -2 | -4 | 6 | -1 | -12 |
| Onions | -58 | -16 | -19 | -14 | -21 | -26 | -50 |
| Winter wheat | -2 | -3 | 3 | 1 | -1 | 0 | -2 |
| Spring barley | 1 | -20 | -5 | 9 | 2 | -3 | -2 |

Source: Farm Accountancy Data Network of Wageningen Economic Research

### 3.2 Open-field horticultural crops

In open-field vegetable cultivation for the fresh market the expected loss of yield varies between 5% and 20% (Table 2). More specific, the *asparagus* harvest season traditionally ends on 24 June and the yield in kilogrammes was therefore hardly affected by the drought. The harvest of open-field *strawberries* was almost over at the beginning of August. The heat has led to accelerated ripening and consequently to smaller fruits. It is estimated that, on average, about 15% less product was harvested as a result of the drought. At the beginning of August, most of the *lettuce crops* were still in the field, and this is where the expected loss of yield is greatest. An average loss of yield of approximately 20% is expected. In the case of *cauliflower and broccoli*, 25% had still to be planted at the beginning of August and the loss of yield is expected to be between 10% and 20%. Pending more favourable weather conditions, the planting period may be postponed by one to two weeks, but this will result in a slight postponement of the harvesting period. In the case of *leeks, Brussels sprouts and white cabbage*, most of the harvest takes place in the autumn and, depending on the weather and the subsequent course of the growing season, the crop still has an opportunity to recover to some extent. About 80% of the area of open-field vegetable crops can be irrigated. Thanks to intensive irrigation, the loss of yield was limited to the percentages mentioned above.

In *fruit cultivation*, the Dutch commission involved in yield assessments revised the harvest forecast for apples and pears downwards on 2 August 2018 as a result of the drought, with a yield reduction of 10% now being expected for both products as a result of smaller fruit sizes and loss of quality. In the Netherlands, about 70% of the acreage can be irrigated, so the impact will be less than in Belgium, Germany, Austria and Poland, where irrigation possibilities are limited.

***Table 2*** *Summary table of the yields in kilogrammes per hectare of the main open-field horticultural crops in dry and hot years, calculated as change in % compared to the average yield in kilogrammes in the surrounding years*

| | 1976 | 1983 | 1995 | 2003 | 2006 | Average | 2018 (estimation) |
|---|---|---|---|---|---|---|---|
| Strawberries | -14 | 23 | 12 | -2 | -13 | 1 | -15 |
| Cauliflower | -3 | 3 | 22 | -1 | -11 | 2 | -15 |
| Broccoli | - | - | - | -5 | -16 | -11 | -15 |
| Iceberg lettuce | - | - | - | -9 | -3 | -6 | -20 |
| Leek | 5 | 19 | 15 | 3 | 2 | 9 | -5 |
| Sprouts | -6 | -1 | 5 | 9 | 14 | 4 | -10 |
| White cabbage | 0 | -3 | -7 | -3 | -4 | -3 | -10 |
| Apples | -8 | -5 | 17 | -5 | -6 | -1 | -10 |
| Pears | 21 | 4 | 2 | -2 | 7 | 7 | -10 |

Source: Historical agriculture series and harvest prediction for open-field vegetables of Statistics Netherlands

### 3.3 Fodder crops

65% of the Dutch agricultural acreage consists of grassland and fodder crops. The yields from these crops is almost entirely used to feed grazing livestock, of which dairy farming is the largest sector. Table 3 shows the change in yield of grassland and green maize. Changes in grassland yields in recent years have not been reported because these are not recorded.

***Table 3*** *Summary table of the yields in kilogrammes per hectare of fodder crops in dry and hot years, calculated as change in % compared to the average yield in kilogrammes in the surrounding years*

| | 1976 | 1983 | 1995 | 2003 | 2006 | Average | 2018 (estimation) |
|---|---|---|---|---|---|---|---|
| Grass | | | | | | | -20/-30 |
| Green maize | -17 | -3 | -11 | 1 | -3 | -7 | -35 |

Source: Farm Accountancy Data Network of Wageningen Economic Research

The fall in yield was considerable for *grass*. The informants consulted report that during the drought period in 2018, 1.5 to 2 mowing cuts were lost on non-irrigated plots due to the drought. In general, there was still some grass growth, which for most farms was sufficient to allow grazing to take place. In incidental cases this was not the case and the winter stock had to be used. In contrast to this, 20% of the grassland is intensively irrigated with 100 to 150 mm on average. The loss of yield on these plots was considerably smaller than on non-irrigated plots. Taking this information into account, the average loss of yield until mid-August amounts to 20% to 30% of the average annual yield.

In the previous dry years, *green maize* realised an average yield decrease of 7%. In 2018, however, green maize (i.e., forage for ruminant livestock) proved to be very poorly resistant to extreme drought. Some of the green maize was even harvested early because the leaves were completely withered. This is particularly the case on the drier sandy soils. In these cases, the loss of harvest was in the 70% range, taking into account the low fodder value due to the fact that the development of the cob was lagging far behind. The loss of yield is smaller on plots on clay soils or on sandy soils that are less prone to drought. Experts estimate the loss of yield in these cases to range from 25% to 50% Finally, there are irrigated plots, for which the average loss is estimated to be between 5% and 15%. This concerns approximately 15% of the green maize acreage. An average loss of yield of 35% is taken into account over the entire green maize acreage.

Livestock farmers will take adaptive measures to deal with these losses. At this stage, it is expected that the drought will not lead to a reduction in the number of livestock but that farmers will compensate for the loss

of feed either by drawing on existing stocks or by buying in feed. Many *dairy farms* had a relatively large stock of roughage available due to the good harvests of the past three years. Most dairy *goat farms* did not have much of that stock. Farms with *sheep* will be relatively badly affected, because much more of the sheep's ration than that of dairy cows and dairy goats consists of own roughage.

The loss of yield has led to a scarcity on the roughage market. Whether the supply of roughage will be sufficient to feed the herd until spring 2019 will depend on the growth trend in the coming months. In good conditions, a partial recovery of the losses, in particular on grassland, cannot be ruled out. Grassland is able to recover quickly if sufficient water is available again. Moreover, if the temperature does not drop too low, the organic matter present could still provide a great deal of nitrogen through mineralisation and make up for part of the loss of yield.

In some cases, the drought has damaged the grass to such an extent that it will be necessary to intervene, especially if high weed pressure occurs. An adaptive measure consists of weed control and, if necessary, restoration of the grass turf, but this will hardly lead to any additional yields this year.
For the time being, it is assumed that the loss of yield will lead to major additional feed purchases. Roughage in particular is in danger of becoming scarce and therefore expensive. The provision of concentrated feed will be sufficient and therefore the herd size is not expected to reduce.

## 4. Conclusions

### 4.1 Yield effects

- The long period of drought in 2018 has led to significant yield reductions for almost all crops in the Netherlands. The expected loss of yield due to the drought is generally higher than in previous dry years.
- Large differences in yield loss are expected between farms, depending on the crop, the sensitivity of the soil to drought, the varieties used and the application of irrigation. In practice, the damage ranges from a complete crop failure to almost normal yields.
- In the arable farming sector, yield losses are expected, varying from an average of 2% for grains to an average of 50% for onions. In the case of seed, ware and starch potatoes, the estimated loss of yield is 5%, 20% and 25% respectively. For sugar beet, an average drop in sugar yield of 10% to 15% is taken into account.
- In open-field horticulture, the expected harvest depends on the time of harvest. For strawberries, which were already harvested at the beginning of August, the loss was approximately 15%. The lettuce crops were still on the field at that time and are expected to yield 20% less. Other crops, such as leeks and various types of cabbage, are not harvested until late autumn at the earliest. Yet, due to the drought, the start was not optimal. Therefore, a loss of yield of around 10% is taken into account.
- In fruit cultivation, the fruit remains smaller than normal. It is estimated that apples and pears will suffer a 10% loss in yield.
- The production of grassland and fodder crops is significantly lower. The production of grass is expected to be between 20% and 30% lower than in previous years. For green maize, the expected drop in production is 35%, but this may vary per region/ground type. If the weather conditions in the rest of the season are favourable, the grassland could still produce well. In that case, the loss could be less than what is currently expected.

### 4.2 Mitigating measures[1]

- The most important mitigating measure is irrigation. This was generally applied in open-field horticulture, while in arable farming and forage crops this has strongly depended on the local possibilities in terms of (1) availability of sufficient suitable water, (2) irrigation equipment and (3)

[1] Markets have reacted to the reduced harvests affecting price and farm income. Strategies by farmers that include insurance and sales contracts can offset or worsen some of the income effects of these yield effects. This is not elaborated on here, but information can be found in a policy brief of Wageningen Economic Research that the Minister of Agriculture, Nature and Food Quality has sent to the Dutch parliament (http://edepot.wur.nl/457939).

labour capacity. The consideration of whether the costs of irrigation outweigh the expected yield also plays a role in this.

- Depending on the circumstances and their risk assessment, individual farmers will consider postponing the harvest, particularly of potatoes, sugar beet and green maize, in the hope that some further growth will take place. It may also be wiser to harvest the crop anyway to prevent further loss of quality.

### 4.3 Adaptive measures

- Adaptive measures are particularly important for the loss of grass and fodder crops. As no reduction in livestock numbers is expected, farmers will compensate for the loss of fodder production by making additional fodder purchases. The Europe-wide scarcity of roughage leads to higher purchase prices.
- Products that are used for other purposes in other years will also serve as animal feed in the coming winter period. An example is the feeding of green manure / cover crops. Because on average the main crops are harvested early, the conditions for this are relatively favourable. There is still sufficient nitrogen in the soil and the soil temperature is still high. Sowing grass after grain, onions and potatoes therefore offers real opportunities for additional roughage production. Another example is the feeding of roadside grass, which is normally fermented or burnt for energy use.
- Restoration of grassland is necessary where appropriate, but this will hardly lead to any additional yields this year.

## Appendix 1 The 2018 weather situation in a historical perspective

In the table below, the weather situation in the summer of 2018 is placed below to the average weather situation from 1970 onwards (Norm) and above to the situation in the five driest years. The study included KNMI measurements in De Bilt up to and including 6 August. It turns out that 2018 has been extremely dry and hot.

The heat is derived from several indicators: Over the period considered, the average daily temperature was 19.4 °C, the number of summer days 33, the accumulated temperature 161, the number of above-average dry and sunny days 54 and the number of hours of sunshine 619. All these indicators exceeded the averages in the period since 1970 and were in the top three when looking at individual years.

For the drought, the amount of precipitation was examined. From 1 June to 6 August, 2018 will be the absolute leader with a rainfall of only 17 mm. In a normal year, this is about a factor of 10 higher. Compared to the other five dry years, 2018 was also extremely dry: the year with the second lowest rainfall was 2003 with 64 mm of precipitation. The combination of low rainfall and high temperatures caused an extreme drought for Dutch conditions.

***Table A.1*** *Weather data for 2018 compared to average year (Norm) and selection of the most dry and hot summers since 1970 in De Bilt (ordered by number of ADS days)*

| Year | Average temperature (°c) | | Summer days[1] | | Accumulated temperature[2] | | Number of ADS days[3] | | Sun (hours) | | Precipitation (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 June - 31 August | | | | 1 May - 31 October | | 1 May - 30 September | | 1 June - 31 August | | | |
| | *Total period* | *Up until 6 August* | *Total period* | *Up until 6 August* | *Total period* | *Up until 6 August* | *Total period* | *Up until 6 August* | *Total period* | *Up until 6 August* | *Total period* | *Up until 6 August* |
| *Norm* | *17.0* | *16.9* | *21* | *16* | *87* | *65* | *32* | *23* | *588* | *444* | *220* | *150* |
| 2018 | | 19.4 | | 33 | | 161 | | 54 | | 619 | | 17 |
| 1976 | 18.4 | 18.4 | 41 | 25 | 164 | 140 | 58 | 40 | 814 | 571 | 113 | 101 |
| 2006 | 18.5 | 19.4 | 37 | 36 | 201 | 174 | 52 | 39 | 676 | 585 | 214 | 79 |
| 2003 | 18.7 | 18.7 | 40 | 33 | 133 | 93 | 52 | 34 | 706 | 542 | 74 | 64 |
| 1995 | 18.2 | 17.9 | 38 | 26 | 170 | 119 | 51 | 33 | 725 | 516 | 134 | 114 |
| 1983 | 18.2 | 18.0 | 39 | 27 | 134 | 101 | 39 | 24 | 708 | 505 | 88 | 74 |

[1] Summer days = number of days above 25 degrees.
[2] Accumulated temperature = sum of daily averages above 18 degrees.
[3] ADS days = number of above normal dry and sunny days.

Source: KNMI, processed by Michael Schaap (www.mscha.nl/knmi)

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2018-092