SUSTAINABLE NUTRITION INITIATIVE®
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Release notes for DELTA Model version 2.0

Summary

The principal addition in DELTA Model 2.0 (released online in January 2022), and the reason for a major release, is the first inclusion of environmental impacts of the food system. This version includes a cropland use module, which calculates the land required for primary production of the plant food commodities in a scenario. All cropland results can be found under Cropland Use on the Model tab, and under Crop Yield Model on the Helpful tab. Links to an instructional video for the calculations behind these features are included in the model.

Several other additions and alterations have been made, including changes to the disclaimer and bug fixes.

Many thanks to the group of users who volunteered their time to testing this version prior to release.

In this document:

Cropland use model

Under Model: Cropland Use, the user is now able to view the required land area necessary to produce the primary plant production in a DELTA Model scenario. An explanatory video is linked on this page to provide a visual explanation of the calculations.

Data was obtained from the Food and Agriculture Organisation (FAO) for crop production and area harvested for 160 crops in 213 countries or territories. This included both food and non-food crops. This data was used to calculate national average yields for each crop in each country, and the total land required for each crop and DELTA Model plant food group.

Importantly, rangeland and grazing land used for animal production is not included in the cropland use model. Data for this land is more limited and an animal land use model is a target for future model versions. The current version shows the land used by crops that are directed to animal feed, but this is the limit of inclusion of animal land use in the current version.

The global land requirement for the 2018 Baseline scenario in the DELTA Model is simply the observed 2018 land use. As the user increases or decreases plant primary production, the DELTA Model estimate for land requirement increases or decreases accordingly at the global average yield rate. However, the model also displays the uncertainty in these estimates using range bars on the plots. The lower limit of the range bar shows the land requirement if all increases in production occur at the yield of the best yielding 50% of global production, and all decreases in production occur in the poorest yielding 50% of production first. Conversely, the upper limit of the range bar shows the land requirement if all increases in production occur at the yield of the poorest yielding 50% of global production, and all decreases in production occur in the best yielding 50% of production first. Examples of these dynamics are shown in Figures 1 and 2, and in the instructional video. Dynamics for individual crops can be investigated under Helpful: Crop Yield Model.

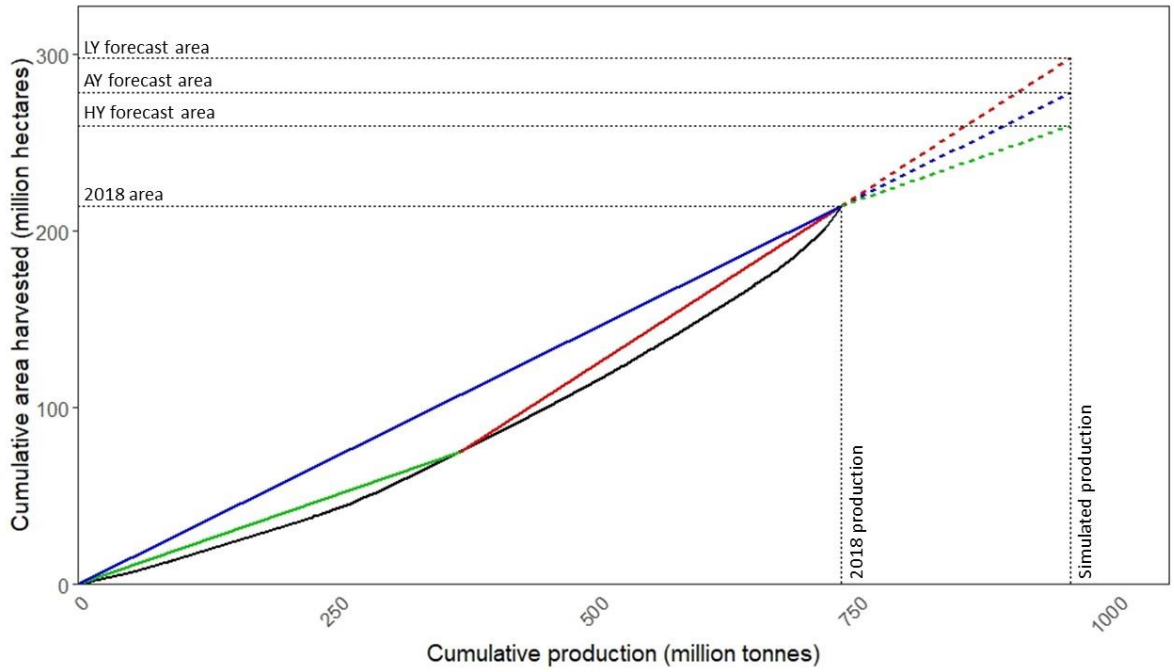

Figure 1. The DELTA Model prediction of required cropland to support a 30% increase in wheat production. The black yield curve shows global production of wheat against land area, with data ordered from best yielding production to poorest yielding. The estimated requirement is calculated using the global average yield (AY, blue line). The upper and lower bounds are calculated using the yields of the poorest (LY, red line) and best (HY, green line) yielding 50% of production, respectively.

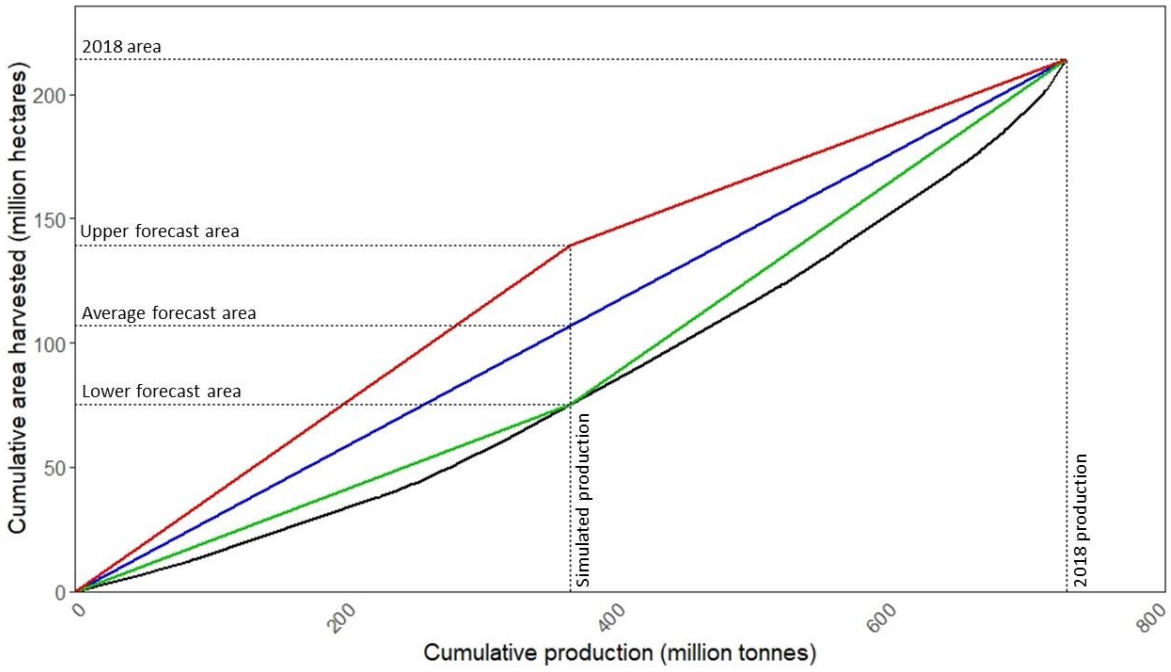

Figure 2. Similarly to Figure 1, here is shown the estimated land requirement, with upper and lower bounds, for decreases in wheat production. For example, halving production (shown as 'Simulated production') would result in a broad range of possible land requirement, depending on the yield of the remaining land producing wheat.

The DELTA Model calculates these variables for all crops and then aggregates the totals for display to the user. The Overview tab shows total cropland divided into either allocation (e.g. Animal Feed, Human Food) or food group (e.g. Cereals, Fruits). The maximum land

available for cropping, shown in the first figure on this page, is calculated as the 2018 cropland area plus all current grazing and rangeland that could be converted to cropland (see Mottet et al. 2017, Global Food Security).

The following tabs show various other views of the same data. One notable point is the use of 'Mixed Allocation' as a category in the outputs. This refers to land used to grow soyabeans, as the production of soyabeans is performed for both human food (largely soyabean oil) and animal feed (largely soyabean cake). Debate exists over which is the primary purpose of soyabean production, with the FAO listing it as food use. To avoid misleading conclusions, 'Mixed Allocation' is displayed for this commodity.

A further feature of the cropland use module is the ability for the user to adjust the performance of crop production, using sliders. Moving the slider increases the proportion of the poorest yielding 50% of production that is improved to the yield of the best yielding 50% of production, thus increasing the performance of production and decreasing the land required to produce the same amount of crop. For example, moving the slider to 100% assumes that all crop production occurs at the average yield of the best 50%, reducing the land requirement in the 2018 Baseline scenario by around a third without changing production mass.

Finally, to ensure that the user is aware of the land use implications of their scenarios, a warning has been added to the Scenario Editor. If the user enters a level of crop production that requires more than the maximum land available for cropping to produce, a warning appears to indicate this.

Changes to dairy and ruminant meat feed ratios

The following method has been used to estimate the proportion of ruminant feed that is consumed by dairy animals as opposed to non-dairy (meat) animals.

There are two key assumptions:

1. Enteric methane emissions from ruminants of the same species are proportional to the dry matter intake of the animal. This is reflected in equations to estimate enteric greenhouse gas emissions from ruminants for national reporting.
2. The proportion of the total feed intake of the animal that comes from "Feed" – as defined within the DELTA Model and the Food Balance Sheets – is the same for both dairy and non-dairy animals of the same species. This is a larger assumption, however without more detailed analysis of global animal feed rations is a sensible default position.

Using these two assumptions and the FAO emissions and production data, we can derive an estimate of the relative feed intake for dairy animals compared with non-dairy animals. Enteric emissions are reported separately for dairy and non-dairy cattle. By comparing the ratio of global enteric emissions to number of production animals of each type we get an estimate of the relative feed intake of a lactating dairy cow compared with other cattle.

$$MEF_{Cattle} = \frac{Enteric_{Dairy}/Stock_{Dairy}}{Enteric_{Non-dairy}/Stock_{Non-dairy}}$$

This gives a ratio of 1.599, which suggests a milking cow eats ~1.6x as much as a non-dairy animal.

This same ratio is then applied to the other dairy species (Buffalo, Sheep, Goats) to give an estimate of the emissions (and thus feed intake) of the milking vs non-milking animals. By summing the estimated enteric emissions of the milking vs non-milking animals across all species we get the following estimates for the relative amount of total feed consumed by dairy animals. In the absence of more detailed information on animal diets, this provides the dairy / non-dairy feed allocation ratio for use in the DELTA Model.

Dairy animal feed ratio

All Ruminant Species: 0.281

Large Ruminants (Cattle and Buffalo): 0.28

Small Ruminants (Sheep and Goats): 0.29

Minor changes and bug fixes

- The overallocated items warning on the main page was not operating correctly. This has been fixed, showing the user commodities that are insufficiently produced to meet the scenario requirements for animal feed and other non-food uses.
- The disclaimer has been amended to better portray the limitations of the model.
- The ‘2030 Vegetarian’ and ‘2030 Vegan’ scenarios have been renamed ‘2030 No meat’ and ‘2030 No animal’, respectively. These scenarios now retain the 2018 Baseline production levels of all plant food groups.
- The thiamine safe upper limit removed, as this was incorrect.
- A warning has been added when the user sets ruminant meat production to less than 1% the amount of dairy production, to convey the fact than dairy production results in at least this amount of ruminant meat co-production.