FishPrint_workbook

Jessica Gephart

6/15/2020

To do

1. Fill in feed ingredient FP and protein content values

- Alon will use the terrestrial feed data to extract the N and P content directly. Will need to do sensitivity checks around the weighting of the feed ingredients into the feed component categories

2. Factors to multiply protein content by to get N and P

- Patrik can get factors with reference

3. Whole fish N and P content by species

- Alon will talk to Zach about this; also talk to Christina about the modelled values

4. Replace placeholder diesel, petrol and natural gas CO2 eq/L values with data in function

- Rob

5. How to handle Energy_demand column in non-feed ghg function?

- Rob - can you take a look at this column? It is mostly blank, but there are some weird entries

6. The biggest gap is harvest and yield, which is needed to get a per unit land FP, as well as a surface area for evaporative losses. Need to talk through land FP since the time dimension doesn't seem clear to me. - Patrik look into after holiday

7. What units do we want the FP estimates in?

- Input from anyone (we just need to pick something at some point to make sure everything is consistent)

8. Need help/suggestions for evap rate by country - looks like it is available through this, but it is not straightforward to extract: http://www.fao.org/aquastat/en/climate-info-tool/. We will also need to determine how best to average over time and space.

- There are a lot of options here, but we might consider biasing values within some buffer zone for brackish production. Inland is harder because we probably don't expect too much production in arid areas/times or maybe cold areas/times. We don't want to go too far down the road of modelling where aquaculture occurs though, as this becomes very complicated very fast. One approach here is to model it with no geographical or temporal preference in the evaporative loss factor, but with a parameter that would allow us to shift the factor toward higher or lower evaporative losses.

10. Need factor for increasing evaporation losses for aerated ponds

- Any suggestions for refs for this?

Code improvements

1. Update feed associated FP function to handle fed and non-fed species (or just make all feed ingredient proportions zero for non-fed)
2. Incorporate differences based on system type in each function
3. Check that feed proportions sum to 1
4. Standardize units throughout
5. Add categories we need to add/standardize are: system type, fed/unfed, aerated/non-aearated, intensity level

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.0 --

## v ggplot2 3.3.0      v purrr   0.3.3
## v tibble  2.1.3      v dplyr   0.8.3
## v tidyr   1.0.2      v stringr 1.4.0
## v readr   1.3.1      v forcats 0.4.0

## -- Conflicts ------------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

Calculate Feed Footprint

The feed footprint estimate inputs are:

- FCR
- Percent soy, other crops, FMFO and animal
- The GHG, water, N, P, and land footprint per unit of feed ingredient

We then calculate the feed-associated footprint (FP_{feed}) as:

$$FP_{feed} = FCR_{dry} \sum_{i=1}^{4} FP_i p_i$$

where FCR_{dry} is the dry weight feed conversion ratio, i indexes the feed ingredient, FP_i represents the footprint of the feed ingredient, and p_i represents the proportion of the feed comprised of component i.

For species without LCA data, we will need to estimate FCR and the percent soy, other crops, FMFO and animal products in feeds.

Calculate on farm footprints

The inputs are:

- N and P content of protein [treated as constants]
- Protein content of each feed ingredient [treated as constants]
- Protein content of fish [treated as constants]
- Country-specific GHGs with electricity use [treated as constants]
- Diesel, petrol, and natural gas GHG values [treated as constants]
- Yield
- Total harvest
- Production system type
- Aerated or not
- Electricity, diesel, petrol, and natural gas use
- Grow-out period

Nitrogen and Phosphorus

The non-feed (which here we mean as the virtual footprint associated with the feed) nitrogen and phosphorus are calculated as by estimating the difference between the N and P in the feeds and the N and P in the final fish, following:

$$FP_{nonfeedN} = FCR_{dry}N_{Pr}\sum_{i=1}^{4}(Pr_ip_i) - N_{Pr}Pr_{fish}$$

where N_{Pr} represents the average nitrogen content of protein, Pr_i represents the protein content of each feed component, and Pr_{fish} represents the protein content of a unit of fish or shellfish. Similarly,

$$FP_{nonfeedP} = FCR_{dry}P_{Pr}\sum_{i=1}^{4}(P_ip_i) - P_{Pr}Pr_{fish}$$

where P_{Pr} represents the average phosphorus content of protein.

Greenhouse gases

The non-feed associated greenhouse gas emissions are calculated as the electricity use times the country-specific GHG footprint, plus the diesel, petrol, and natural gas use times each of their GHG footprint factors.

Land

The non-feed associated land use refers to the pond area allocated to the growth of a unit of output. This is calculated as:
$$FP_{nonfeedland} = Yeild/Harvest$$

Water

To calculate the on farm water use, we estimate the evaporative losses over the surface area allocated to the unit of production as:

$$FP_{nonfeedwater} = C_{aeratoin}Evap_{rate}FP_{nonfeedland}GrowOut$$

where $C_{aeration}$ is the constant factor for aerated ponds.

[Sorry I got lazy with equation notation – will eventually improve!]

Plots

This is largely fake data, so probably shouldn't think about it too much.