**Flock Dynamics Model: Shiny App Summary**

***Flock dynamics model:***

The model simulates flock turnover in a small ruminant flock based on variable demographic input parameters and is used to assess the effectiveness of vaccination programmes by tracking the level of immunity (proportion of immune animals) in the flock following vaccination. End-users can input demographic data and select vaccination programmes to explore the most suitable strategy for their local context.

***The input parameters + default values***

Input parameters processed from 4 datafiles, 3 containing input defined by users (see end of document):

* user\_demographic-pars.csv
  + population demographic parameters (births, deaths, offtake, intake, popsize)
* user\_model-pars.csv
  + vaccination programme specification (number of years, coverage, intervals)
* user\_vaccination-pars.csv
  + model specs (timeframe, seasonality, output)

One file defines the decay of maternal antibodies, this is fixed for all simulations:

* imm\_decay\_bodjo\_v2.csv
  + Fixed, simulates loss of maternal antibodies in offspring.

***Function Overview:***

*Two main functions, a wrapper function and the model function:*

* dynmod\_wrapper()
  + A wrapper function for the model
  + Includes pre-processing of demographic data & formatting of output
* dynmod\_sim()
  + Main model function
  + Takes input of system state, model specification, demographic parameters, vaccination programme and birth pattern.
  + Gives output of population state (demographic, health-state) over time, including:
    - Proportions in each age-sex group
    - Proportions in each health state: imm, immune, susceptible
  + See detail at end of document.

Also two additional functions for formatting output:

* Output\_func(), Summarydf()

***Expected Outputs***

*Graphical output similar to plot (i) but formatted as plot (ii).*

* flock immunity level following vaccination. Dashed line indicates target 70% threshold immunity.

A graph of a graph

Description automatically generated

A graph of a number of blue lines

Description automatically generated with medium confidence

Text output:

* Summary of the number of weeks in total, and % of the programme, with immunity <70% in 1 year, 4 years etc
  + (i) Weeks with immunity >70% in 1 year or 4 year programme
  + (ii) % of the programme (1 or 4 years) with immunity >70%

***R Requirements:***

*Packages required for model:*

* See setup.R script:
  + library(tidyverse)
  + library(readr)

**MODEL FUNCTION:**

dynmod\_sim <- function(

f\_list, # vector initial state of female population

m\_list, # vector initial state of male population

TimeStop\_dynamics, # Duration of simulation

output, # model output: always “dynamics” for shiny app

demographic\_pars, # dataframe of demographic pars by age-sex group

summary\_df, # df for storing flock dynamics and health states

Imm\_b, # vector of maternal immunity in offspring

Kid, # age groups for Kids

Sub, # age groups for Young

Adu\_F, # age groups for Adults

Vstart, # vacciantion start date

Vprog, # df of vacciantion programme

birthpeak\_w, # weeks of birth peak (NA if non-seasonal)

seasonal, # defines seasonality of birth pattern

nBirths # mean births per year

){…}

**DATA INPUTS**

**Demographic Data:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Default** | **Description** | **Notes** |
| N\_tot | 1000 | Flock Size | *User-defined* |
| kid\_m\_prop | 0.12 | Proportion males <6m | *User-defined* |
| kid\_f\_prop | 0.12 | Proportion females <6m | *User-defined* |
| sub\_m\_prop | 0.1 | Proportion males 6-12m | *User-defined* |
| sub\_f\_prop | 0.1 | Proportion females 6-12m | *User-defined* |
| adu\_m\_prop | 0.1 | Proportion adult male | *User-defined* |
| adu\_f\_prop | 0.46 | Proportion adult female | *User-defined* |
| kid\_max | 6 | Max age kids | *FIXED* |
| sub\_max | 12 | Max age sub-adults | *FIXED* |
| pR | 0 | Proportion initially immune | *User-defined* |
| nBirths\_yr | 300 | Mean number of births per year | *User defined: Seasonal or non-seasonal* |
| pBirths | 0.7 | Proportion births during birth peak | *User-defined, with conditions: Only applicable to seasonal reproduction (if non-seasonal NA)* |
| peak\_wks | 8 | Duration of birth peak in weeks | *User-defined, with conditions:Only applicable to seasonal reproduction (if non-seasonal NA)* |
| peakmnth | 1 | Month of birth peak (1-12) | *User-defined, with conditions:Only applicable to seasonal reproduction (if non-seasonal NA)* |
| NET\_offtake\_y | 0 | Offtake of kids | *FIXED* |
| NET\_offtake\_m | 0.3 | Offtake in adult males | *User-defined* |
| NET\_offtake\_m2 | 0.9 | Offtake in young-adult males (<2years) | *User-defined* |
| NET\_offtake\_f | 0.3 | Offtake in adult females | *User-defined* |
| mortality\_y | 0.15 | Mortality of offspring <6m | *User-defined* |
| mortality\_a | 0.05 | Mortality of adults >6m | *User-defined* |
| adu\_f\_max\_yrs | 10 | Max age of females in flock | *User-defined* |
| adu\_m\_max\_yrs | 3 | Max age of males in flock | *User-defined* |
| min\_age\_offtake | 10 | Minimum age animals can be exchanged | *User-defined* |
| min\_age\_repro | 10 | Minimum age of reproduction (females) | *User-defined* |

**Vaccination Programme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Default** | **Description** | **Notes** |
| prop\_vaccinated | 1 | Proportion flock vaccinated per round | *User-defined:*  *0-1* |
| years\_vaccination | 4 | Number of years of vaccination programme | *User-defined: 1-4 years* |
| interval | 12 | Interval between vaccination campaigns | *User-defined with conditions:  - 6 months or 12 months.*  *If seasonal reproduction 12 months* ***only*** |

**Model Paremeters:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Default** | **Description** | **Notes** |
| timestop | 20 | Duration of simulation | *FIXED, Vaccination at mid-point.* |
| seasonal | Y | Seasonal or non-seasonal reproduction | *User-defined* |
| output | dynamics | Format of output (dynamics = full flock dynamics) | *FIXED* |