

Representative dmo for HYPUD

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Overview

This demo compares regular and high-frequency slurry removal from pig barns, plus storage emission.

Prep

```
devtools::load_all()

## i Loading ABM
library(data.table)
library(ggplot2)
```

Inputs

Say, 450 pigs, constant slurry production at 5 kg/pig-d, over 11 week batch.

```
mng_pars1 <- list(slurry_prod_rate = 2200,
                  slurry_mass = 20000,
                  storage_depth = 2,
                  resid_depth = 0.1,
                  area = 200,
                  empty_int = 73,
                  temp_C = 18,
                  wash_water = 0,
                  wash_int = NA,
                  rest_d = 0,
                  resid_enrich = 0.5)

sub_pars <- list(subs = c('VSd'),
                 T_opt_hyd = c(VSd = 40),
                 T_min_hyd = c(VSd = 0),
                 T_max_hyd = c(VSd = 90),
                 hydrol_opt = c(VSd = 0.008),
                 sub_fresh = c(VSd = 50),
                 sub_init = c(VSd = 50))

grp_pars <- list(grps = c('m0', 'm1', 'm2', 'sr1'),
                 yield = c(default = 0.05, sr1 = 0.065),
                 xa_fresh = c(all = 0.05),
                 xa_init = c(all = 0.05),
                 dd_rate = c(all = 0.02),
```

```

ks = c(default = 1, sr1 = 0.5),
qhat_opt = c(m0 = 0.8, m1 = 0.9, m2 = 1.5, sr1 = 9),
T_opt = c(m0 = 12, m1 = 18, m2 = 28, sr1 = 44),
T_min = c(m0 = 0, m1 = 6.41, m2 = 6.41, sr1 = 0),
T_max = c(m0 = 25, m1 = 25, m2 = 38, sr1 = 51))

mic_pars <- list(dd_rate_xa = 0.02)

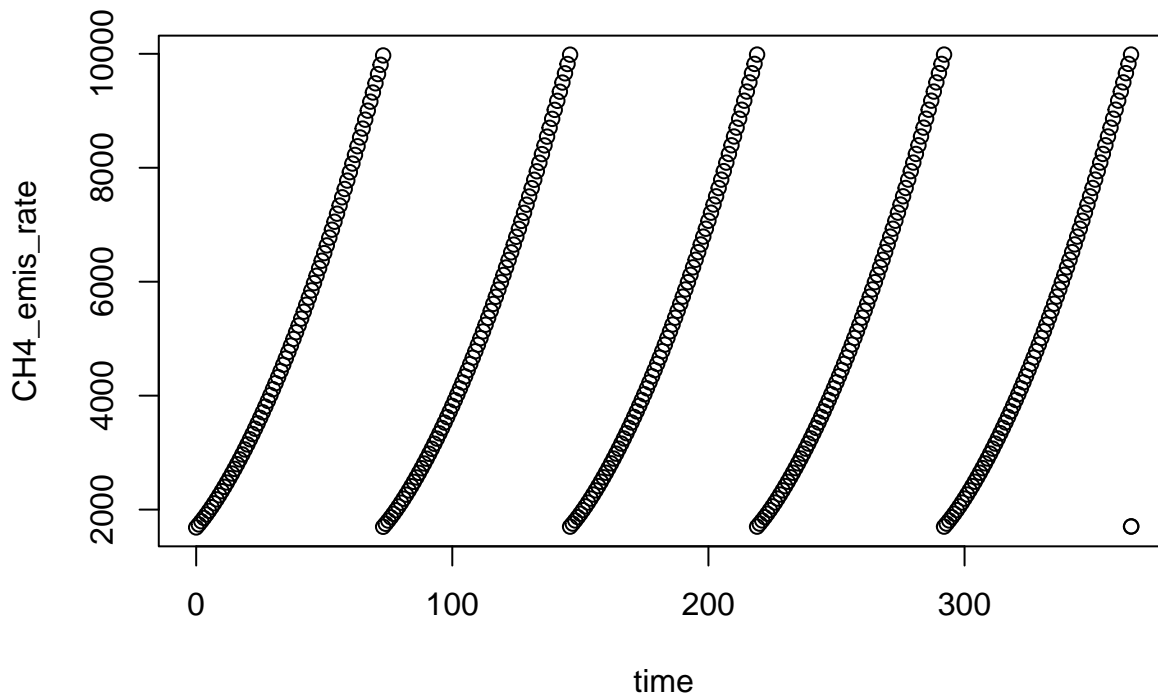
man_pars <- list(VFA_fresh = c(VFA = 2), pH = 7, dens = 1000)

chem_pars <- list(COD_conv = c(CH4 = 1/0.2507, xa = 1/0.7069561,
                              VFA = 1/0.9383125, S = 1/0.5015, VS = 1/0.69,
                              CO2_aer = 1/0.436, CO2_sr = 1/1.2,
                              C_xa = 1/0.3753125))

out1b <- abm(365.1,
            mng_pars = mng_pars1,
            man_pars = man_pars,
            grp_pars = grp_pars,
            mic_pars = mic_pars,
            sub_pars = sub_pars,
            chem_pars = chem_pars,
            startup = 1)

##
## Startup run 1x -> and final run
## Using starting conditions from `starting` argument
setDT(out1b)
plot(CH4_emis_rate ~ time, data = out1b)

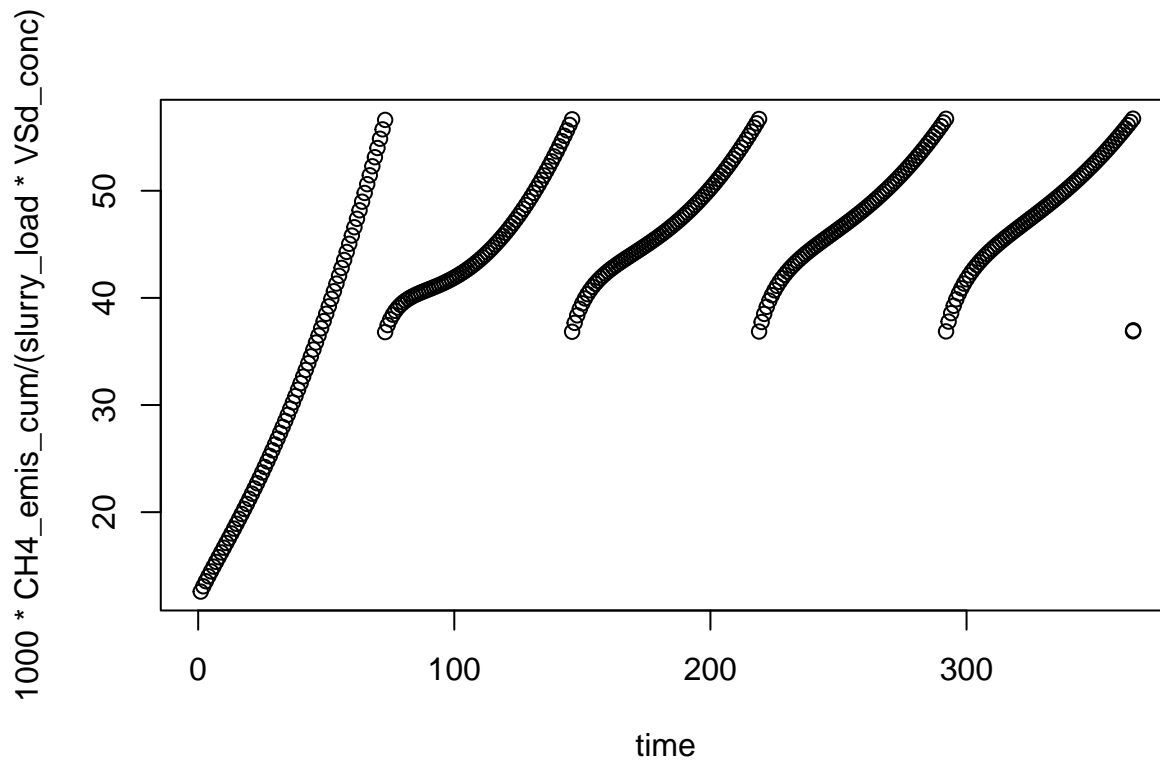
```



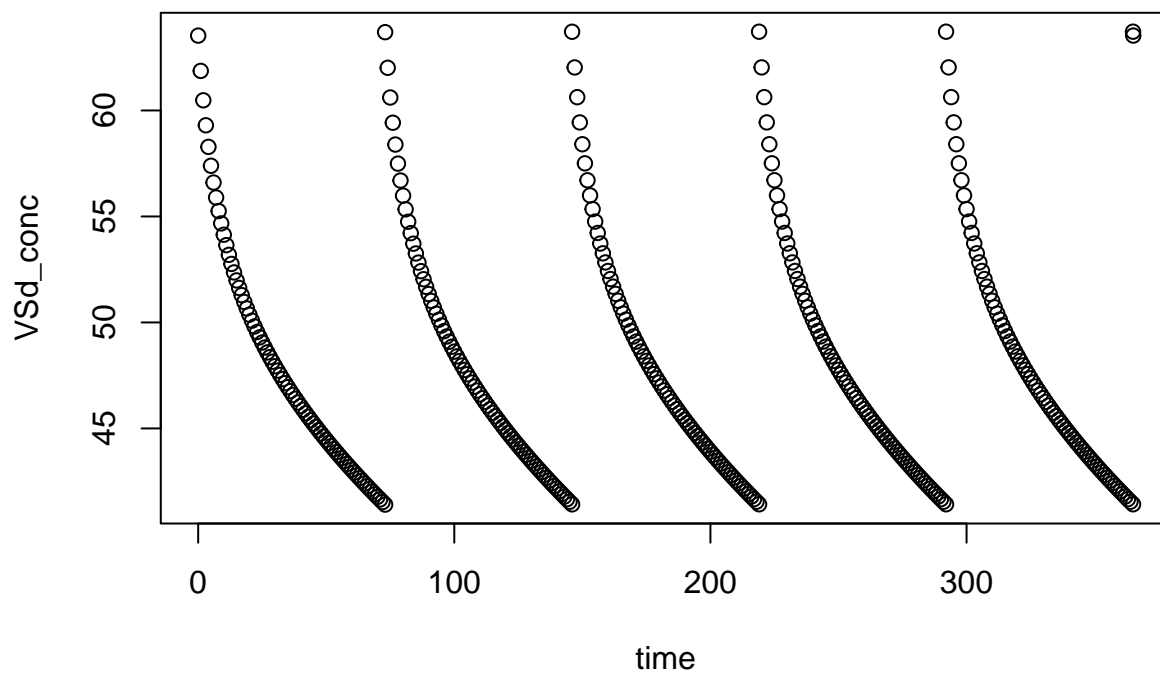
```

plot(1000 * CH4_emis_cum / (slurry_load * VSd_conc) ~ time, data = out1b)

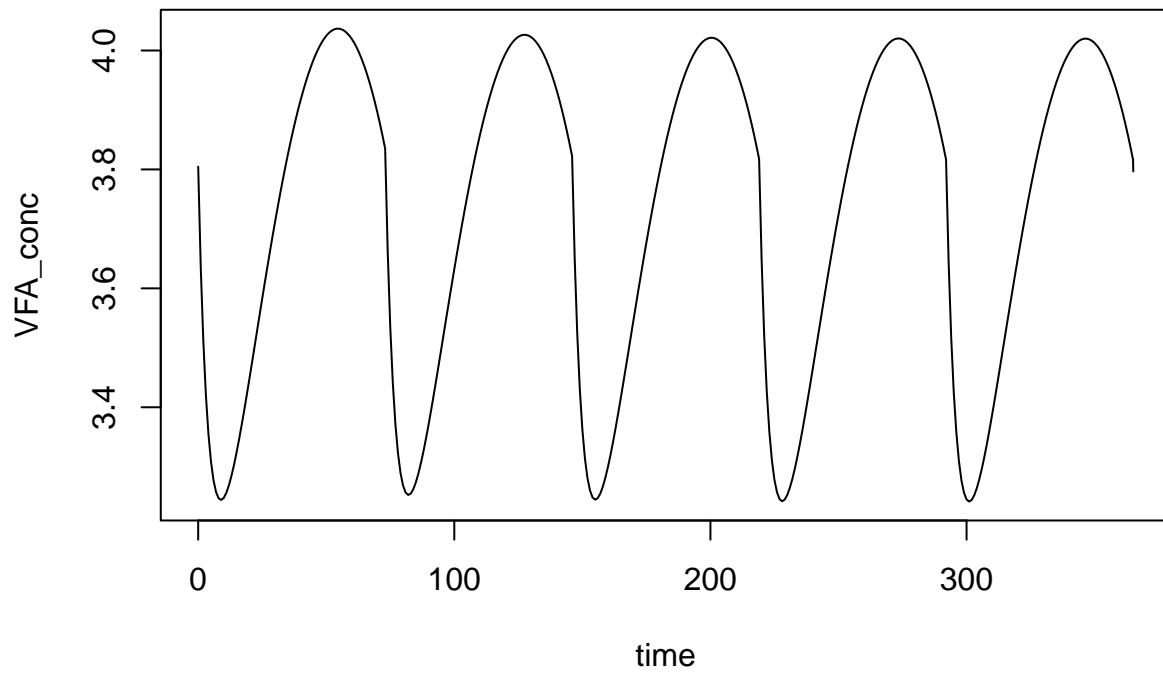
```



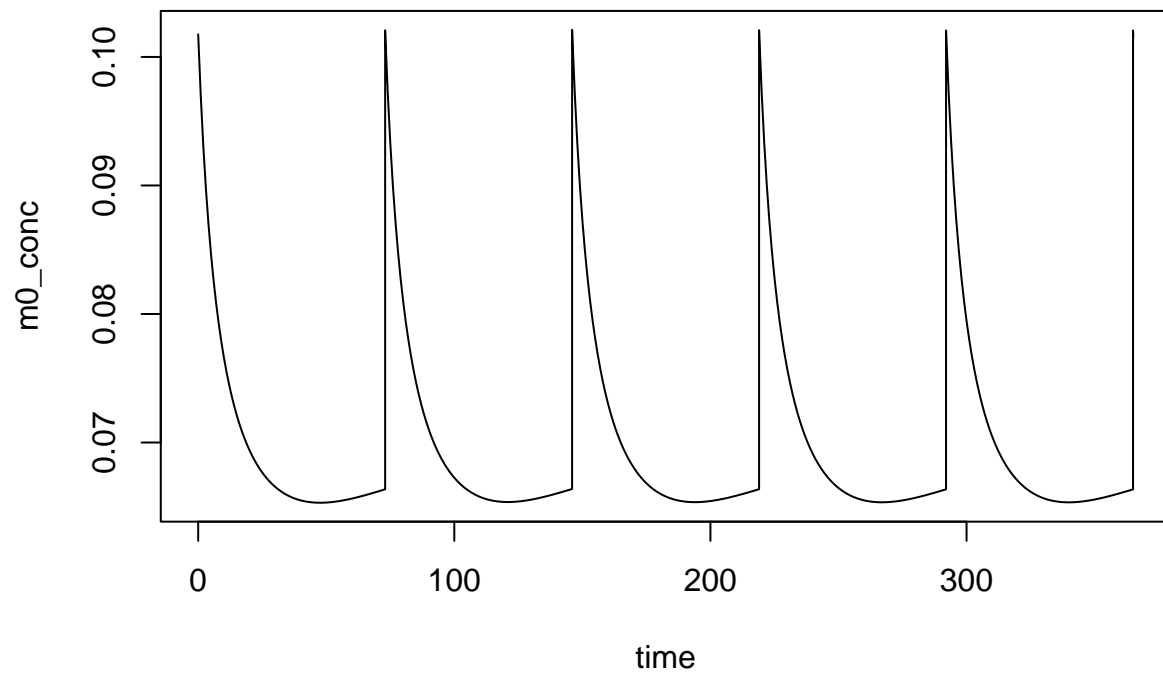
```
plot(VSd_conc ~ time, data = out1b)
```



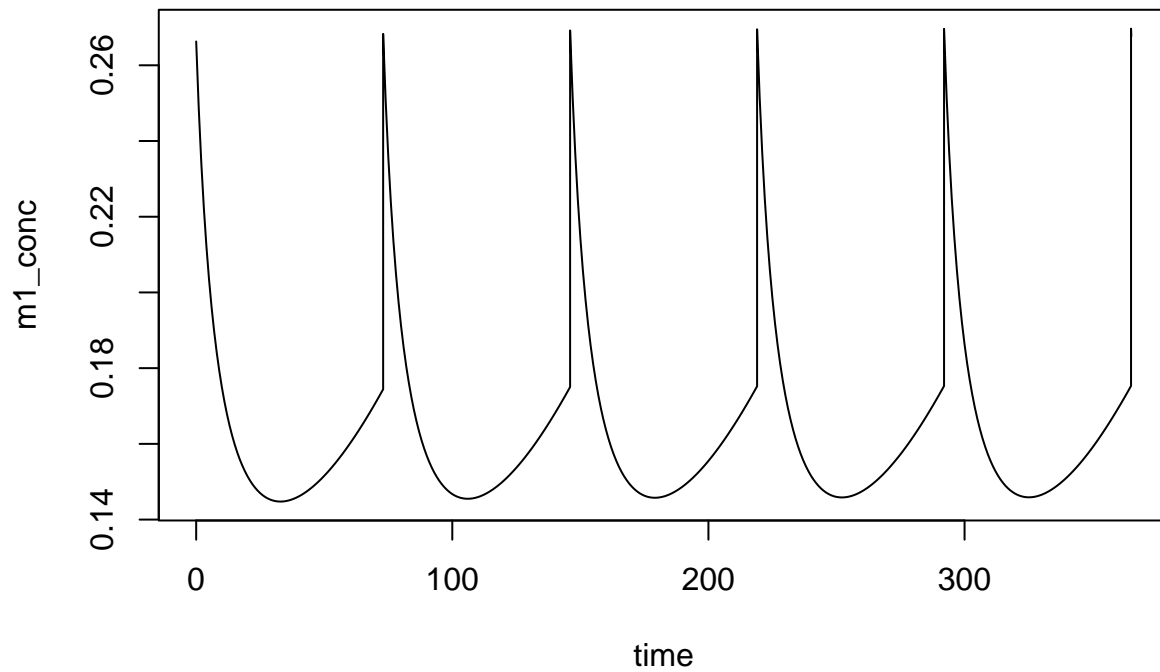
```
plot(VFA_conc ~ time, data = out1b, type = 'l')
```



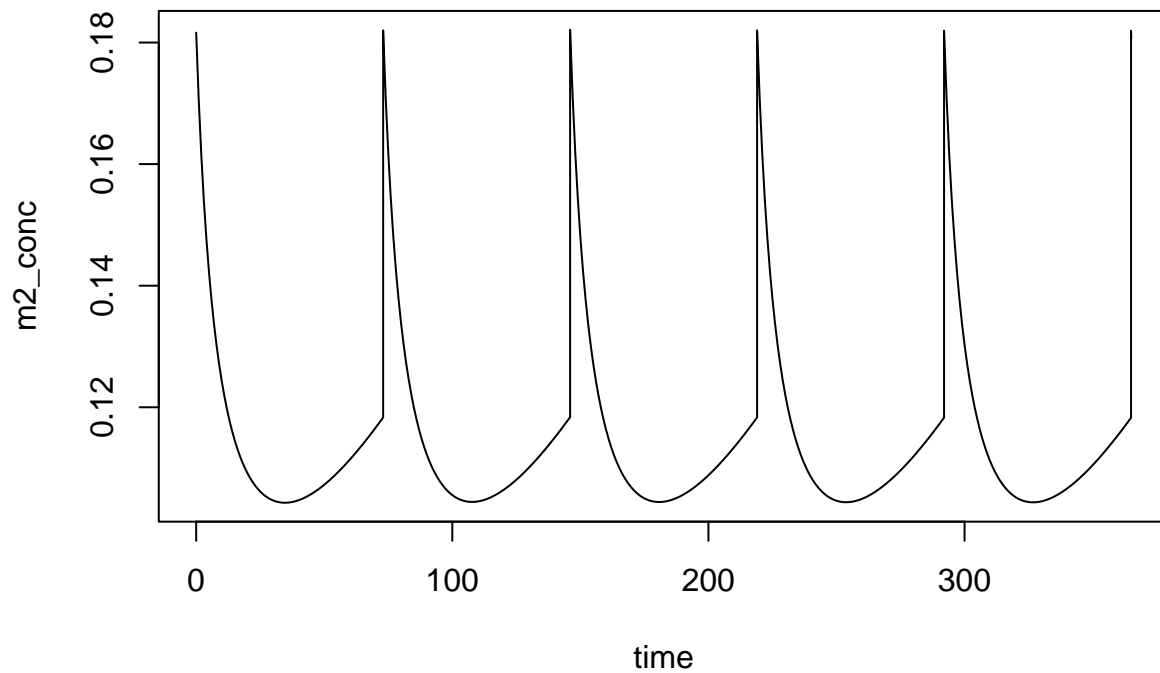
```
plot(m0_conc ~ time, data = out1b, type = 'l')
```



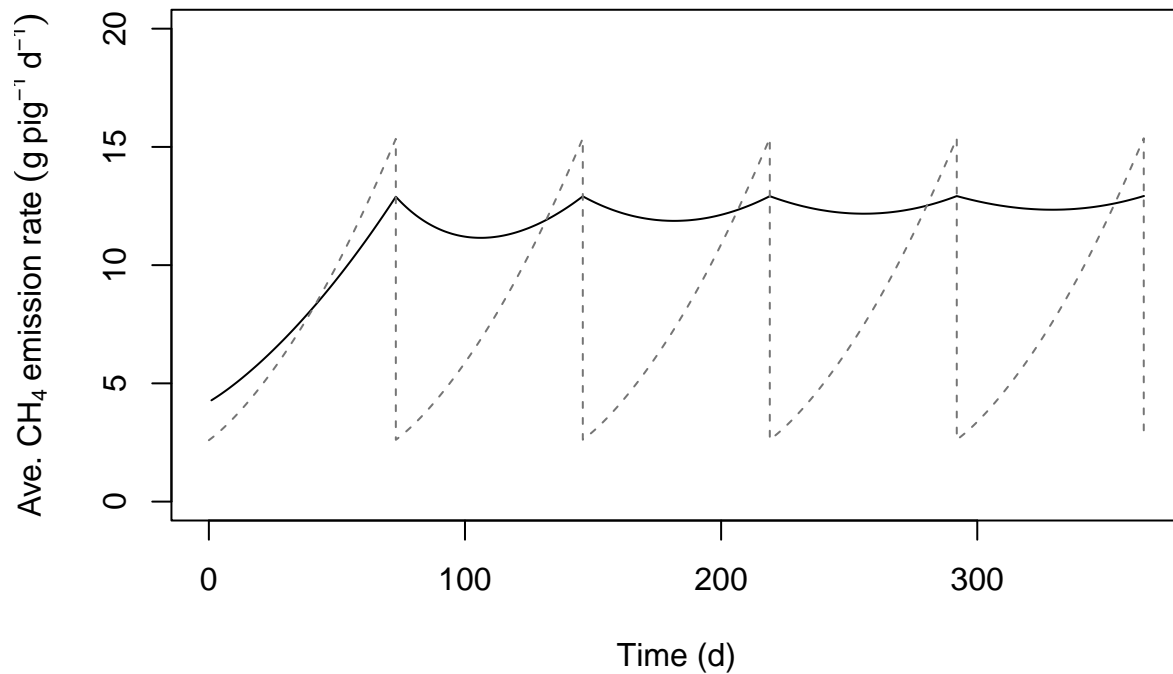
```
plot(m1_conc ~ time, data = out1b, type = 'l')
```



```
plot(m2_conc ~ time, data = out1b, type = 'l')
```



```
plot(CH4_emis_cum / 400 / time ~ time, data = out1b,
     type = 'l', ylim = c(0, 20),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission rate'~(g~'pig'^-1~d^-1)))
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out1b, type = 'l', lty = 2, col = 'gray46',
     ylim = c(0, 13000), axes = F, xlab = '', ylab = '')
```



Now storage of removed slurry.

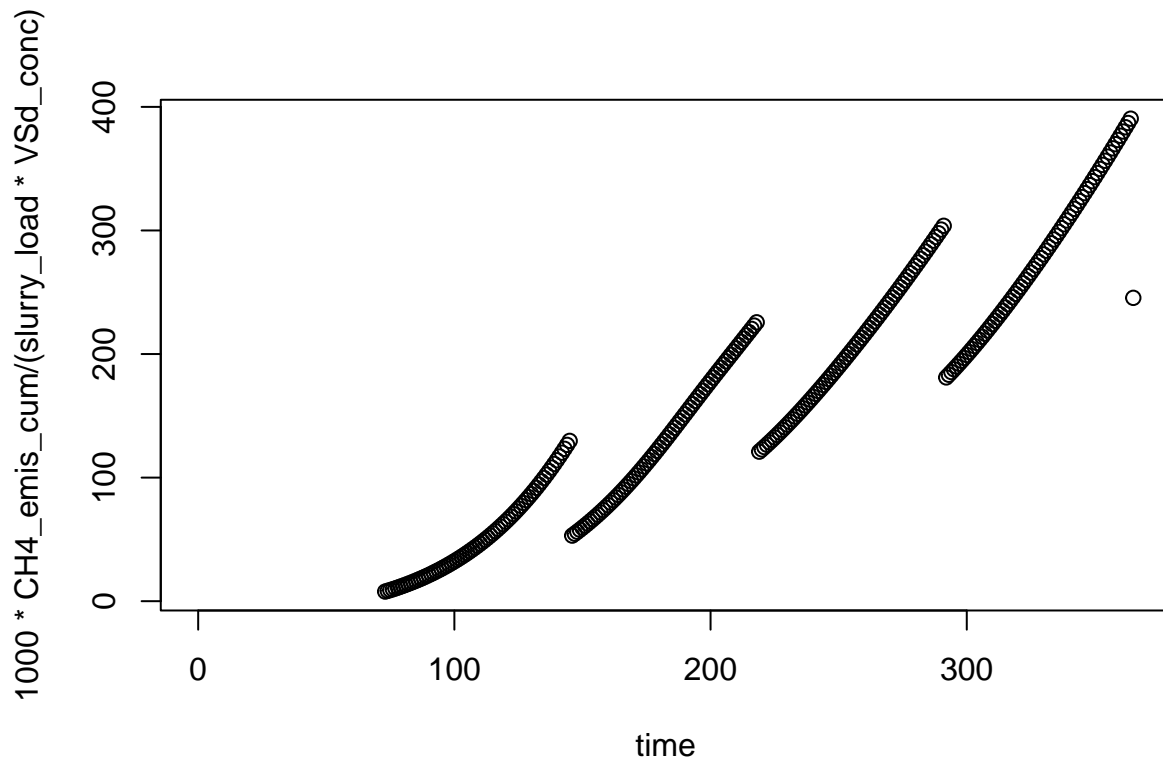
```
out1b <- out1b[c(!duplicated(time[-1]), TRUE), ]
slurry_mass_dat <- data.table(time = out1b$time, slurry_mass = out1b$slurry_mass_eff)
sub_dat <- data.table(time = out1b$time, VSd = out1b$VSd_conc)
VFA_dat <- data.table(time = out1b$time, VFA = out1b$VFA_conc)
```

```
devtools::load_all()
```

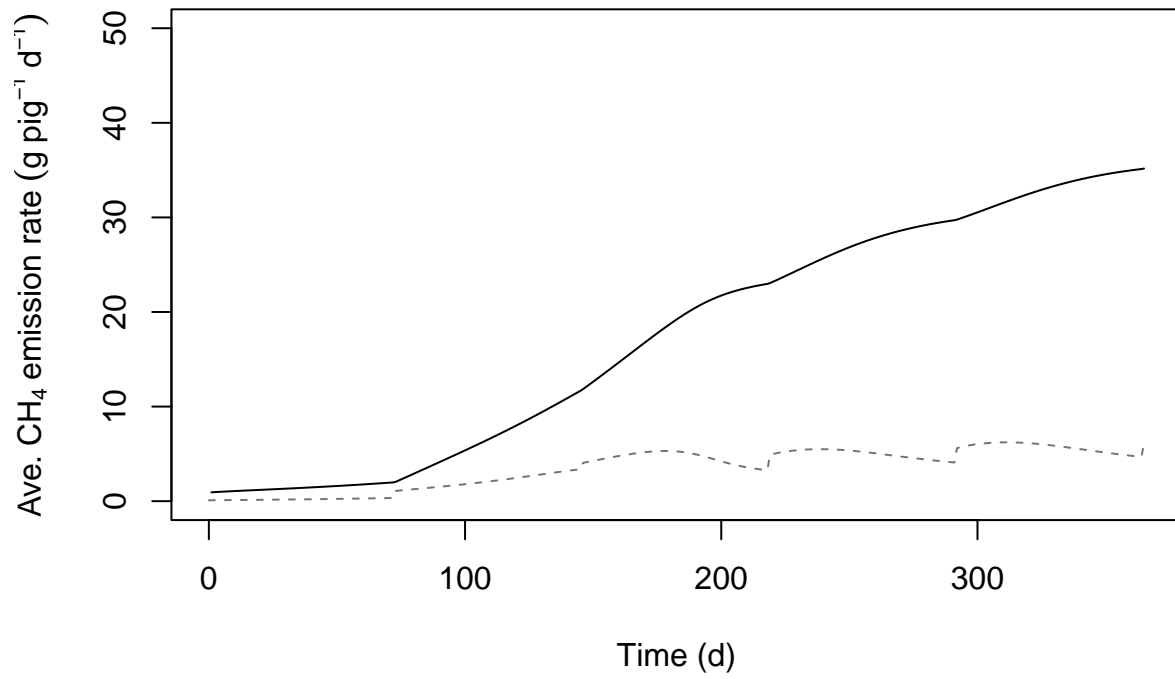
```
## i Loading ABM
```

```
out1e <- abm(365,
  mng_pars = mng_pars1,
  man_pars = man_pars,
  grp_pars = grp_pars,
  mic_pars = mic_pars,
  sub_pars = sub_pars,
  chem_pars = chem_pars,
  var_pars = list(var = slurry_mass_dat, sub_fresh = sub_dat, VFA_fresh = VFA_dat))
```

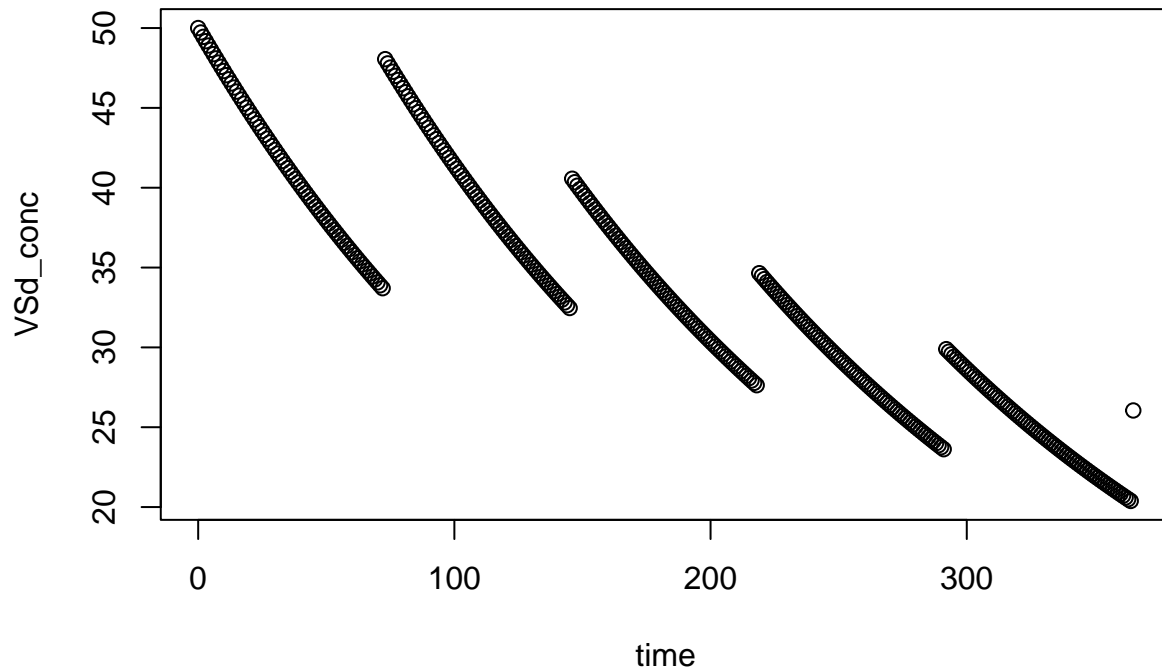
```
setDT(out1e)
plot(1000 * CH4_emis_cum / (slurry_load * VSd_conc) ~ time, data = out1e)
```



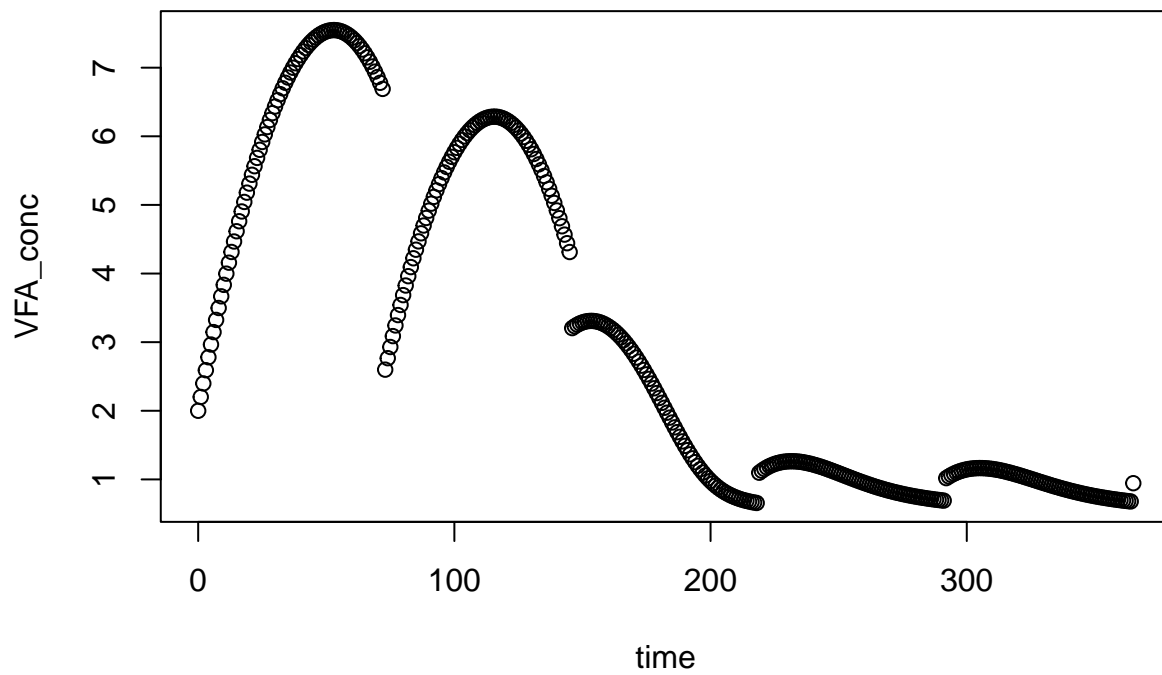
```
plot(CH4_emis_cum / 400 / time ~ time, data = out1e,
     type = 'l', ylim = c(0, 50),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission rate'~(g~'pig'^-1~d^-1)))
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out1e, type = 'l', lty = 2, col = 'gray46',
     ylim = c(0, 200000), axes = F, xlab = '', ylab = '')
```



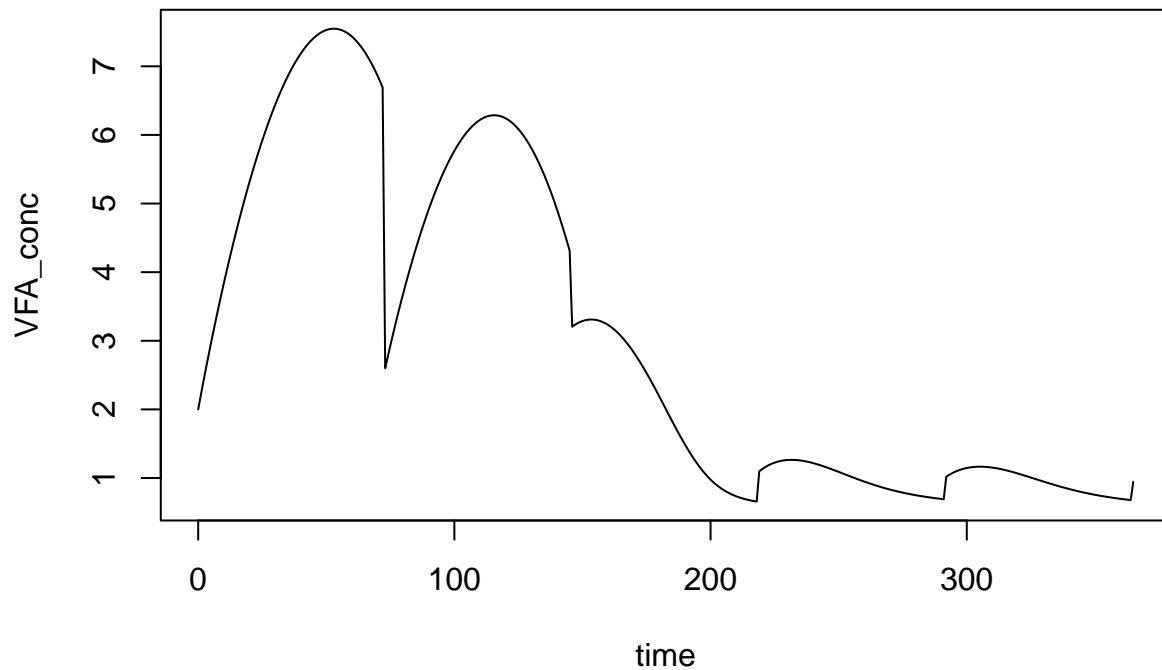
```
plot(VSd_conc ~ time, data = out1e)
```



```
plot(VFA_conc ~ time, data = out1e)
```



```
plot(VFA_conc ~ time, data = out1e, type = 'l')
```

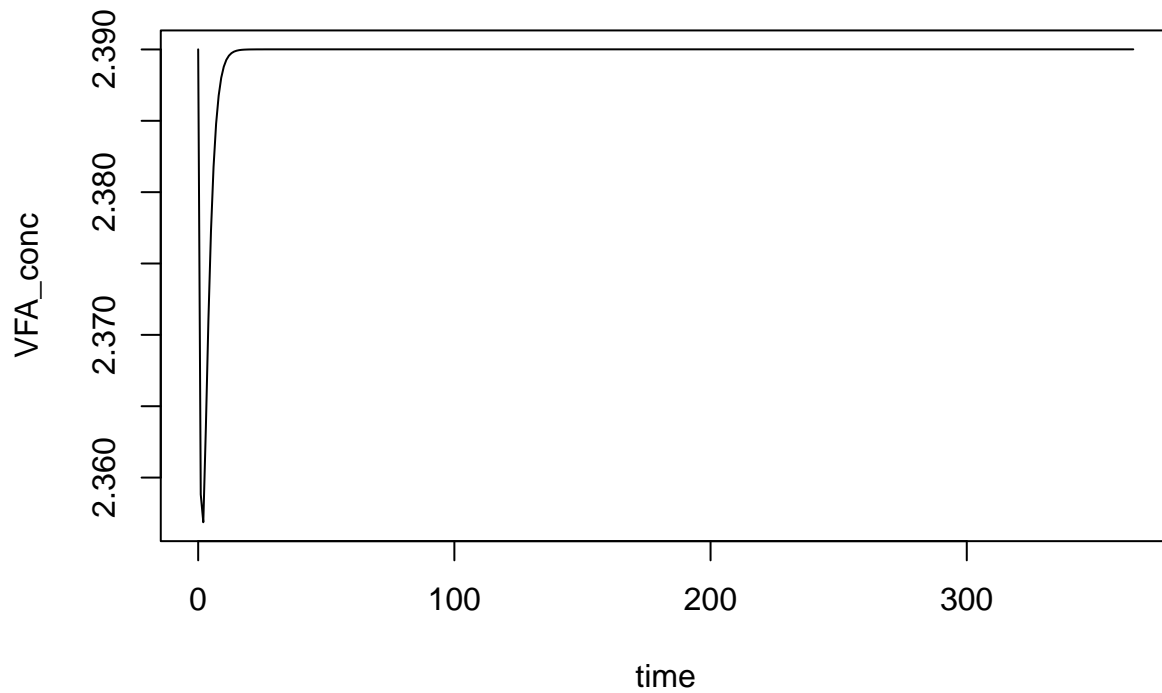



Scenario 2 is with frequent emptying.

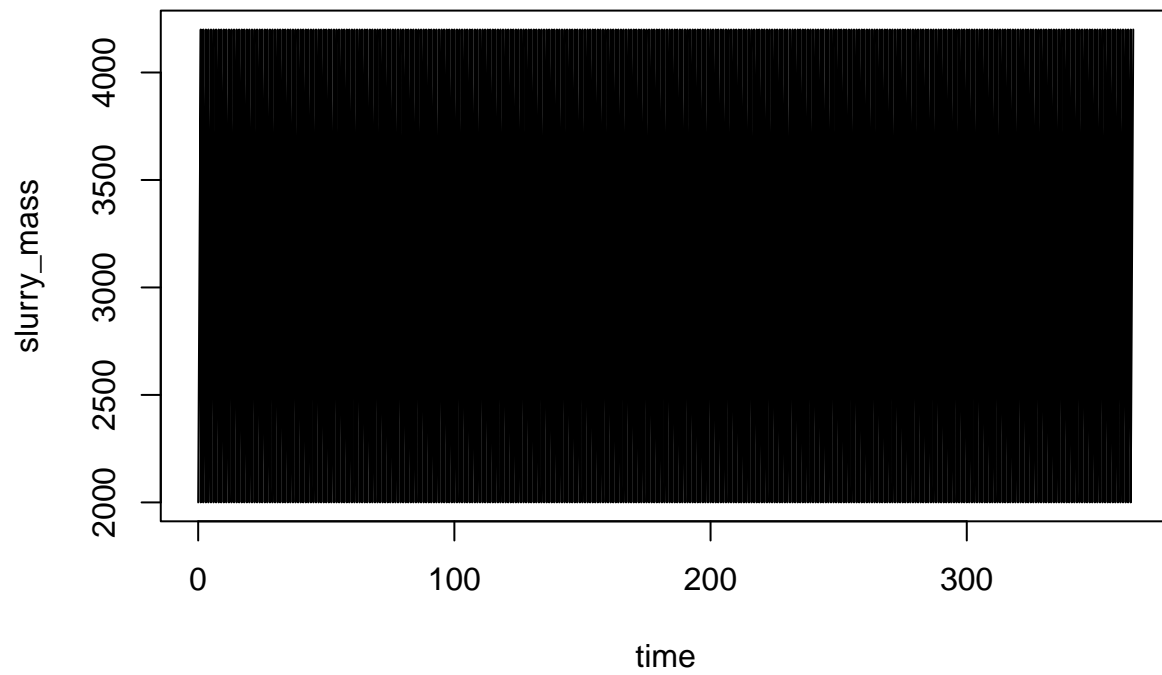
```
mng_pars2 <- list(slurry_prod_rate = 2200,
                  slurry_mass = 2000,
                  storage_depth = 2,
                  resid_depth = 0.01,
                  area = 200,
                  empty_int = 1,
                  temp_C = 18,
                  wash_water = 0,
                  wash_int = NA,
                  rest_d = 0,
                  resid_enrich = 0.5)
```

```
out2b <- abm(365,
             mng_pars = mng_pars2,
             man_pars = man_pars,
             grp_pars = grp_pars,
             mic_pars = mic_pars,
             sub_pars = sub_pars,
             chem_pars = chem_pars,
             startup = 1)
```

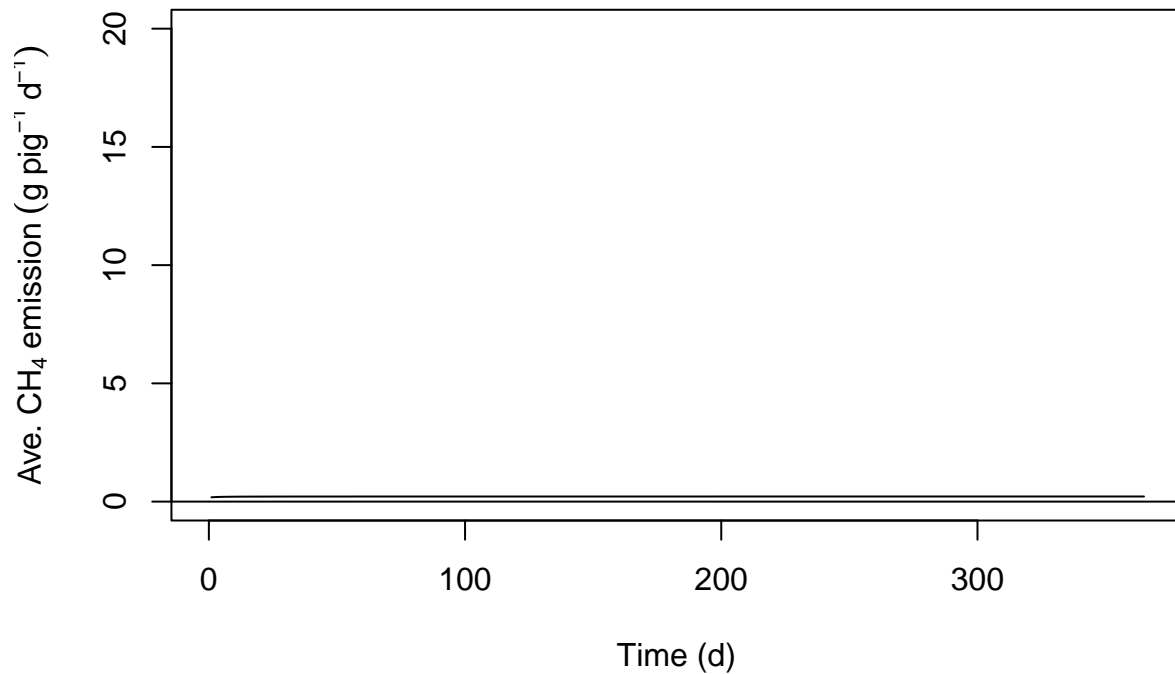
```
##
## Startup run 1x -> and final run
## Using starting conditions from `starting` argument
setDT(out2b)
plot(VFA_conc ~ time, data = out2b, type = 'l')
```



```
plot(slurry_mass ~ time, data = out2b, type = 'l')
```



```
plot(CH4_emis_cum / 400 / time ~ time, data = out2b,
     type = 'l', ylim = c(0, 20),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'~'-1'~d~'-1'))))
abline(h = 0, lty = 1)
```

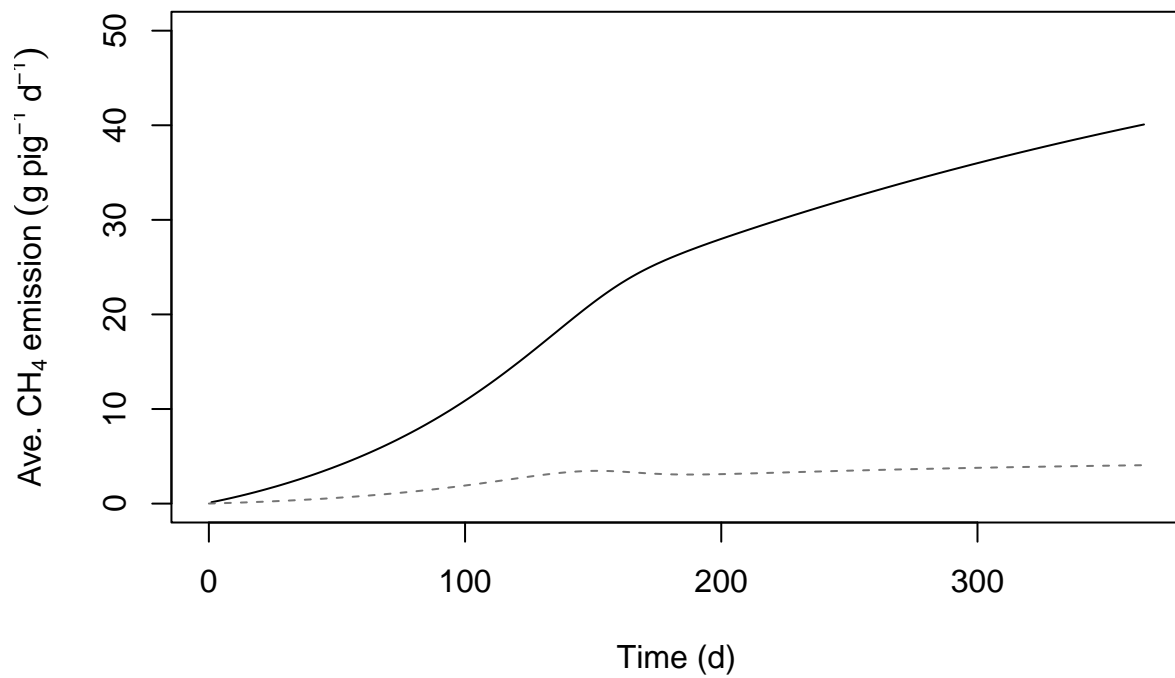


Now storage of slurry removed from the barn.

```
out2b <- out2b[c(!duplicated(time[-1])), TRUE], ]
slurry_mass_dat <- data.table(time = out2b$time, slurry_mass = out2b$slurry_mass_eff)
sub_dat <- data.table(time = out2b$time, VSd = out2b$VSd_eff_conc)
VFA_dat <- data.table(time = out2b$time, VFA = out2b$VFA_eff_conc)

out2e <- abm(365,
  mng_pars = mng_pars2,
  man_pars = man_pars,
  grp_pars = grp_pars,
  mic_pars = mic_pars,
  sub_pars = sub_pars,
  chem_pars = chem_pars,
  var_pars = list(var = slurry_mass_dat, sub_fresh = sub_dat, VFA_fresh = VFA_dat))

setDT(out2e)
plot(CH4_emis_cum / 400 / time ~ time, data = out2e,
  type = 'l', ylim = c(0, 50),
  xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'~'^-1'~d~'^-1'))))
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out2e, type = 'l', lty = 2, col = 'gray46',
  ylim = c(0, 300000), axes = F, xlab = '', ylab = '')
```



```
plot(CH4_emis_rate / (slurry_mass / 1000) ~ time, data = out2e)
```

