

APPENDIX 5. Source code for the within-farm model

withinfarmmodel.mbp

```
[LINK]
  Application=d:\withinfarmmodel\withinfarmmodel.mbx
  Module=withinfarmmodel_main.mbo
  Module= withinfarmmodel_spread.mbo
  Module= withinfarmmodel_dialogs.mbo
  Module= withinfarmmodel_functions.mb
```

Withinfarmmodel.def

```
declare sub main
declare sub load_data
declare sub promotestatus
declare sub diseasespread
declare sub updatecounters
declare sub results
declare sub sentvacc
declare sub opentable
declare sub savepop
declare sub seedinf
declare sub backgrounddeath
declare sub records
declare sub progresswin
declare sub factorial

Declare sub seedrandom lib "d:\AIModel\Pseudo Random Number Generators\randomad.dll" alias "TRandomInit" (byval seed
as integer)
Declare function random lib "d:\AIModel\Pseudo Random Number Generators\randomad.dll" alias "TRandom" () as float

Declare function triangle (ByVal l as integer,ByVal m as integer,ByVal h as integer) as integer
Declare function poisson (ByVal la as float) as integer
Declare function tsp (ByVal l,m,h as integer, n as float) as integer
Declare function normal (ByVal mean,sd as float) as integer
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Declare function lognormal (ByVal mean,sd as float) as integer
Declare function weibull (ByVal alpha,beta,shift as float) as integer
Declare function beta_pert(ByVal l as integer,ByVal m as integer,ByVal h as integer) as integer
Declare function gamma (ByVal alpha as float, ByVal scale as float) as float
Declare function uniform (ByVal l as integer, ByVal h as integer) as integer

global itctr,day,nsus(),ninf0(),ninf1(),ninf2(),nlat(),nimm(),ndead(),nsero(),newdead(),startexp,nbirds,
    nsheds,x,sentregular,lastday,reportday,nsentinels,iterations,
    incbgd,nvacc,seed1,initcount,nsurvsero(),nsurvinf(), nsusceptible, ntoseroconvert, nseroconv, exposed,
ndeadttotal, ninf0total, ninf2total as integer

global vacc_efficacy,cPdienv,cPdieV,clplnv,clphnv,clplv,clpmv,clphv,ciplnv,cipmnv,ciphnv,ciplv,cipmv,ciphv,
    dPdienv,dPdieV,dlplnv,dlphnv,dlplv,dlpmv,dlphv,diplnv,dipmnv,diphnv,diplv,dipmv,diphv,
    Pvv,Pvvnv,Pnvv,Pvnv,suscvt,time,
    timer1,timer2,timer3,timer4,la,l,m,h as float

global n0,f as float

global poppath, savepath, howend as string

global includevacc, duck as logical

type sheddata
    id as integer
    shed_id as integer
    vacc as integer
    sentinel as integer
    status as integer
    todie as integer
    clinsx as integer
    daystilclinsx as integer
    daysleftlat as integer
    daysleftinf as integer
    dayexposed as integer
    daystatus2 as integer
    daystatus4 as integer
    typeofspread as string
end type

```

```
global dataset1() as sheddata
global dataset2() as sheddata
global dataset3() as sheddata
global dataset4() as sheddata
```

withinfarmmodel_main.mbo

```
include "mapbasic.def"
include "withinfarmmodel.def"
```

```
sub main
dim ctrl, totsusc as integer
close all
set format date "local"
set coordsys nonearth units "m" bounds (0,0) (300,10)
```

```
itctr=1
day=0
nsheds=4
vacc_efficacy=0
nsentinels=0
startexp=1
cPdienv=1
cPdiev=0
clplnv=0
clphnv=1
ciplnv=1
cipmnv=1.5
ciphnv=2
clplv=1'
clphv=2'
ciplv=1'
cipmv=1'
ciphv=4'
dPdienv=0.1
dPdiev=0
dlplnv=1
```

```
dlphnv=1
diplnv=4
diphnv=5
dlplv=1
dlphv=1
diplv=1.402259
dipmv=3.22
diphv=5.518995
pvv=00
pvnv=1
pnvv=0.5
pnvvnv=1
suscv=1
sentregular=0
includevacc=false
howend=" "
lastday=200
iterations=100
seed1=1
nbirds=40000
exposed=20
duck=0

time=timer()

do

call seedrandom(seed1+ITCTR)

nvacc=0
x=0
reportday=0

'setup iterations here

redim nsus(nsheds)
redim nlat(nsheds)
redim ninf0(nsheds)
```

```

redim ninf1(nsheds)
redim ninf2(nsheds)
redim nimm(nsheds)
redim ndead(nsheds)
redim nsero(nsheds)
redim nsurvsero(nsheds)
redim nsurvinf(nsheds)
redim newdead(nsheds)
ninf0total=0
ninf2total=0

call load_data

if includevacc=true then
    call sentvacc
end if

call seedinf

call updatecounters

if itctr=1 then
    create table Records (iter integer,dayno integer,id integer,
        shed_id integer, vacc integer,sentinel integer,status integer,clinsx integer,
        daysleftlat integer,daysleftinf integer,daystatus2 integer,daystatus4 integer,typeofspread char(20))

        create table endofoutbk (iter integer,N_birds integer,VE float, NV integer,mortality float,daysinfv0 integer,
        daysinfv2 integer, report integer,dayend integer,Nattack integer,
        how char(20))

end if

do
    day=day+1
    call promotestatus
    call diseasespread
    call updatecounters
    if iterations=1 then
        call results
    end if
end do

```

```

    end if

if day=lastday or day=reportday then
    insert into endofoutbk
        values (itctr, nbirds, vacc_efficacy, nvacc, ndeadtotal/nbirds, ninf0total, ninf2total, reportday, day,
nbirds-nsusceptible, howend)
end if

call progresswin

loop until day=reportday or day=lastday

itctr=itctr+1
day=0
lastday=200
howend=" "

loop until itctr>iterations

close table blank

note random()

browse * from endofoutbk
end sub

sub load_data

dim shedctr, ctr2, ctr1 as integer

for shedctr=1 to nsheds
    if shedctr=1 then
        redim dataset1(nbirds/nsheds)
        for ctr2=1 to nbirds/nsheds
            dataset1(ctr2).id=ctr2
            dataset1(ctr2).shed_id=1
            dataset1(ctr2).vacc=0
        
```

```
dataset1(ctr2).sentinel=0
dataset1(ctr2).status=0
dataset1(ctr2).todie=0
dataset1(ctr2).clinsx=0
dataset1(ctr2).daystilclinsx=0
dataset1(ctr2).daysleftlat=0
dataset1(ctr2).daysleftinf=0
dataset1(ctr2).dayexposed=0
dataset1(ctr2).daystatus2=0
dataset1(ctr2).daystatus4=0
dataset1(ctr2).typeofspread=0
next
elseif shedctr=2 then
redim dataset2(nbirds/nsheds)
for ctr2=1 to nbirds/nsheds
dataset2(ctr2).id=ctr2
dataset2(ctr2).shed_id=1
dataset2(ctr2).vacc=0
dataset2(ctr2).sentinel=0
dataset2(ctr2).status=0
dataset2(ctr2).todie=0
dataset2(ctr2).clinsx=0
dataset2(ctr2).daystilclinsx=0
dataset2(ctr2).daysleftlat=0
dataset2(ctr2).daysleftinf=0
dataset2(ctr2).dayexposed=0
dataset2(ctr2).daystatus2=0
dataset2(ctr2).daystatus4=0
dataset2(ctr2).typeofspread=0
next
elseif shedctr=3 then
redim dataset3(nbirds/nsheds)
for ctr2=1 to nbirds/nsheds
dataset3(ctr2).id=ctr2

dataset3(ctr2).shed_id=1
dataset3(ctr2).vacc=0
dataset3(ctr2).sentinel=0
dataset3(ctr2).status=0
```

```

        dataset3(ctr2).todie=0
        dataset3(ctr2).clinsx=0
        dataset3(ctr2).daystilclinsx=0
        dataset3(ctr2).daysleftlat=0
        dataset3(ctr2).daysleftinf=0
        dataset3(ctr2).dayexposed=0
        dataset3(ctr2).daystatus2=0
        dataset3(ctr2).daystatus4=0
        dataset3(ctr2).typeofspread=0
    next
elseif shedctr=4 then
    redim dataset4(nbirds/nsheds)
    for ctr2=1 to nbirds/nsheds
        dataset4(ctr2).id=ctr2
        dataset4(ctr2).shed_id=1
        dataset4(ctr2).vacc=0
        dataset4(ctr2).sentinel=0
        dataset4(ctr2).status=0
        dataset4(ctr2).todie=0
        dataset4(ctr2).clinsx=0
        dataset4(ctr2).daystilclinsx=0
        dataset4(ctr2).daysleftlat=0
        dataset4(ctr2).daysleftinf=0
        dataset4(ctr2).dayexposed=0
        dataset4(ctr2).daystatus2=0
        dataset4(ctr2).daystatus4=0
        dataset4(ctr2).typeofspread=0
    next
end if
next
end sub

sub sentvacc
dim ctr1,ctr2,tempid,nsent,a,b,v0,v1,v2,sen,shedctr as integer
dim z as float

for shedctr=1 to nsheds
    if shedctr=1 then
        nsent=nsentinels

```



```

do while nsent>0
  tempid=uniform(1,nbirds/nsheds)
  if dataset1(tempid).sentinel=0 then
    dataset1(tempid).sentinel=1
    nsent=nsent-1
  end if
loop
elseif shedctr=2 then
  nsent=nsentinels
  do while nsent>0
    tempid=uniform(1,nbirds/nsheds)
    if dataset2(tempid).sentinel=0 then
      dataset2(tempid).sentinel=1
      nsent=nsent-1
    end if
  loop
elseif shedctr=3 then
  nsent=nsentinels
  do while nsent>0
    tempid=uniform(1,nbirds/nsheds)
    if dataset3(tempid).sentinel=0 then
      dataset3(tempid).sentinel=1
      nsent=nsent-1
    end if
  loop
elseif shedctr=4 then
  nsent=nsentinels
  do while nsent>0
    tempid=uniform(1,nbirds/nsheds)
    if dataset4(tempid).sentinel=0 then
      dataset4(tempid).sentinel=1
      nsent=nsent-1
    end if
  loop
end if
next

for ctr2=1 to nbirds
  if ctr2<=nbirds/nsheds then

```

```
if dataset1(ctr2).sentinel=0 then
  if random()<=vacc_efficacy then
    dataset1(ctr2).vacc=2
    nvacc=nvacc+1
  else
    dataset1(ctr2).vacc=0
  end if
end if
elseif ctr2<=2*nbirds/nsheds then
  ctr1=ctr2-nbirds/nsheds
  if dataset2(ctr1).sentinel=0 then
    if random()<=vacc_efficacy then
      dataset2(ctr1).vacc=2
      nvacc=nvacc+1
    else
      dataset2(ctr1).vacc=0
    end if
  end if
elseif ctr2<=3*nbirds/nsheds then
  ctr1=ctr2-2*nbirds/nsheds
  if dataset3(ctr1).sentinel=0 then
    if random()<=vacc_efficacy then
      dataset3(ctr1).vacc=2
      nvacc=nvacc+1
    else
      dataset3(ctr1).vacc=0
    end if
  end if
elseif ctr2<=4*nbirds/nsheds then
  ctr1=ctr2-3*nbirds/nsheds
  if dataset4(ctr1).sentinel=0 then
    if random()<=vacc_efficacy then
      dataset4(ctr1).vacc=2
      nvacc=nvacc+1
    else
      dataset4(ctr1).vacc=0
    end if
  end if
end if
```

```

next
end sub

sub seedinf
dim ctr2,tempid,cid,rid,randshed as integer

'+1 added to counters because update counters is called twice - initially then at end of day 1

initcount=1                                     'this is added so initial results
not captured in tables

startexp=uniform(1,exposed)
randshed=uniform(1,nsheds)

for ctr2 = 1 to startexp                         'always starts shed1
  x=0
  tempid=uniform(1,nbirds/nsheds)
  dataset1(tempid).dayexposed=day
  do case dataset1(tempid).vacc
    case 0
      dataset1(tempid).status=1
      if duck=1 and dataset1(tempid).sentinel=0 then
        dataset1(tempid).daysleftlat=uniform(dlplnv,dlphnv)+1
      else
        dataset1(tempid).daysleftlat=uniform(clplnv,clphnv)+1
      end if
    case 2
      if random()<=suscv then
        dataset1(tempid).status=1
        if duck=1 then
          dataset1(tempid).daysleftlat=uniform(dlplv,dlphv)+1
        elseif duck=0 then
          dataset1(tempid).daysleftlat=uniform(clplv,clphv)+1
        end if
      else
        dataset1(tempid).status=3
      end if
    end case
  end case
end case

```

```

next

end sub

sub promotestatus

dim ctr1, ctr2, shedctr as integer

for ctr2=1 to nbirds
  shedctr=(ctr2-1)\(nbirds/nsheds)+1
  if shedctr=1 then
    x=0
    if dataset1(ctr2).status=1 and dataset1(ctr2).daysleftlat=0 then
      dataset1(ctr2).status=2
      dataset1(ctr2).daystatus2=day
      nlat(shedctr)=nlat(shedctr)-1
      do case dataset1(ctr2).vacc
      case 0
      if duck=1 and dataset1(ctr2).sentinel=0 then
        dataset1(ctr2).daysleftinf=uniform(diplnv, diphnv)
      else
        dataset1(ctr2).daysleftinf=beta_pert(ciplnv, cipmv, ciphv)
      end if
      ninf0(shedctr)=ninf0(shedctr)+1
      if (duck=0 and random()<=cPdienv) or (duck=1 and (dataset1(ctr2).sentinel=0 and
        random()<=dPdienv) or (dataset1(ctr2).sentinel=1 and random()<=cPdienv)) then
        dataset1(ctr2).todie=1
      end if
      case 2
      if duck=1 then
        dataset1(ctr2).daysleftinf=beta_pert(diplv, dipmv, diphv)
        if random()<=dPdiev then
          dataset1(ctr2).todie=1
        end if
      elseif duck=0 then
        dataset1(ctr2).daysleftinf=beta_pert(ciplv, cipmv, ciphv)
        if random()<=dPdiev then
          dataset1(ctr2).todie=1
        end if
      end if
    end if
  end if
end for

```

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        end if
        ninf2(shedctr)=ninf2(shedctr)+1
    end case
elseif dataset1(ctr2).status=2 then
    if dataset1(ctr2).daysleftinf=0 then
        do case dataset1(ctr2).vacc
        case 0
            ninf0(shedctr)=ninf0(shedctr)-1
        case 1
            ninf1(shedctr)=ninf1(shedctr)-1
        case 2
            ninf2(shedctr)=ninf2(shedctr)-1
        end case

        if dataset1(ctr2).todie=0 then
            nimm(shedctr)=nimm(shedctr)+1
            dataset1(ctr2).status=3
        elseif dataset1(ctr2).todie=1 then
            ndead(shedctr)=ndead(shedctr)+1
            dataset1(ctr2).status=4
            if dataset1(ctr2).sentinel=1 and reportday=0 then
                howend="sentineldead"
                reportday=day
            end if
        end if
    end if
end if
elseif shedctr=2 then
    ctr1=ctr2-nbirds/nsheds
    x=0
    if dataset2(ctr1).status=1 and dataset2(ctr1).daysleftlat=0 then
        dataset2(ctr1).status=2
        dataset2(ctr1).daystatus2=day
        nlat(shedctr)=nlat(shedctr)-1
        do case dataset2(ctr1).vacc
        case 0
            if duck=1 and dataset2(ctr1).sentinel=0 then
                dataset2(ctr1).daysleftinf=uniform(diplnv,diphnv)
            else

```

```

        dataset2(ctrl1).daysleftinf=beta_pert(ciplnv,cipmv,ciphnv)
    end if
    ninf0(shedctr)=ninf0(shedctr)+1
    if (duck=0 and random()<=cPdienv) or (duck=1 and (dataset2(ctrl1).sentinel=0 and
        random()<=dPdienv) or (dataset2(ctrl1).sentinel=1 and random()<=cPdienv)) then
        dataset2(ctrl1).todie=1
    end if
    case 2
        if duck=1 then
            dataset2(ctrl1).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset2(ctrl1).todie=1
            end if
        elseif duck=0 then
            dataset2(ctrl1).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=dPdiev then
                dataset2(ctrl1).todie=1
            end if
        end if
        ninf2(shedctr)=ninf2(shedctr)+1
    end case
elseif dataset2(ctrl1).status=2 then
    if dataset2(ctrl1).daysleftinf=0 then
        do case dataset2(ctrl1).vacc
        case 0
            ninf0(shedctr)=ninf0(shedctr)-1
        case 1
            ninf1(shedctr)=ninf1(shedctr)-1
        case 2
            ninf2(shedctr)=ninf2(shedctr)-1
        end case

        if dataset2(ctrl1).todie=0 then
            nimm(shedctr)=nimm(shedctr)+1
            dataset2(ctrl1).status=3
        elseif dataset2(ctrl1).todie=1 then
            ndead(shedctr)=ndead(shedctr)+1
            dataset2(ctrl1).status=4
            if dataset2(ctrl1).sentinel=1 and reportday=0 then

```

```

                howend="sentineldead"
                reportday=day
            end if
        end if
    end if
end if
elseif shedctr=3 then
    ctr1=ctr2-2*nbirds/nsheds
    x=0
    if dataset3(ctr1).status=1 and dataset3(ctr1).daysleftlat=0 then
        dataset3(ctr1).status=2
        dataset3(ctr1).daystatus2=day
        nlat(shedctr)=nlat(shedctr)-1
        do case dataset3(ctr1).vacc
        case 0
            if duck=1 and dataset3(ctr1).sentinel=0 then
                dataset3(ctr1).daysleftinf=uniform(diplnv,diphnv)
            else
                dataset3(ctr1).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
            end if
            ninf0(shedctr)=ninf0(shedctr)+1
            if (duck=0 and random()<=cPdienv) or (duck=1 and (dataset3(ctr1).sentinel=0 and
                random()<=dPdienv) or (dataset3(ctr1).sentinel=1 and random()<=cPdienv)) then
                dataset3(ctr1).todie=1
            end if
        case 2
            if duck=1 then
                dataset3(ctr1).daysleftinf=beta_pert(diplv,dipmv,diphv)
                if random()<=dPdiev then
                    dataset3(ctr1).todie=1
                end if
            elseif duck=0 then
                dataset3(ctr1).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
                if random()<=dPdiev then
                    dataset3(ctr1).todie=1
                end if
            end if
            ninf2(shedctr)=ninf2(shedctr)+1
        end case
    end if
end case

```

```

elseif dataset3(ctrl1).status=2 then
  if dataset3(ctrl1).daysleftinf=0 then
    do case dataset3(ctrl1).vacc
      case 0
        ninf0(shedctr)=ninf0(shedctr)-1
      case 1
        ninf1(shedctr)=ninf1(shedctr)-1
      case 2
        ninf2(shedctr)=ninf2(shedctr)-1
    end case

    if dataset3(ctrl1).todie=0 then
      nimm(shedctr)=nimm(shedctr)+1
      dataset3(ctrl1).status=3
    elseif dataset3(ctrl1).todie=1 then
      ndead(shedctr)=ndead(shedctr)+1
      dataset3(ctrl1).status=4
      if dataset3(ctrl1).sentinel=1 and reportday=0 then
        howend="sentineldead"
        reportday=day
      end if
    end if
  end if
end if
elseif shedctr=4 then
  ctrl1=ctr2-3*nbirds/nsheds
  x=0
  if dataset4(ctrl1).status=1 and dataset4(ctrl1).daysleftlat=0 then
    dataset4(ctrl1).status=2
    dataset4(ctrl1).daystatus2=day
    nlat(shedctr)=nlat(shedctr)-1
    do case dataset4(ctrl1).vacc
      case 0
        if duck=1 and dataset4(ctrl1).sentinel=0 then
          dataset4(ctrl1).daysleftinf=uniform(diplnv,diphnv)
        else
          dataset4(ctrl1).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
        end if
      end if
    end case
    ninf0(shedctr)=ninf0(shedctr)+1
  end if
end if

```



```

if (duck=0 and random()<=cPdienv) or (duck=1 and (dataset4(ctrl1).sentinel=0 and
random()<=dPdienv) or (dataset4(ctrl1).sentinel=1 and random()<=cPdienv)) then
dataset4(ctrl1).todie=1
end if
case 2
  if duck=1 then
    dataset4(ctrl1).daysleftinf=beta_pert(diplv,dipmv,diphv)
    if random()<=dPdiev then
      dataset4(ctrl1).todie=1
    end if
  elseif duck=0 then
    dataset4(ctrl1).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
    if random()<=dPdiev then
      dataset4(ctrl1).todie=1
    end if
  end if
  ninf2(shedctr)=ninf2(shedctr)+1
end case
elseif dataset4(ctrl1).status=2 then
  if dataset4(ctrl1).daysleftinf=0 then
    do case dataset4(ctrl1).vacc
    case 0
      ninf0(shedctr)=ninf0(shedctr)-1
    case 1
      ninf1(shedctr)=ninf1(shedctr)-1
    case 2
      ninf2(shedctr)=ninf2(shedctr)-1
    end case

    if dataset4(ctrl1).todie=0 then
      nimm(shedctr)=nimm(shedctr)+1
      dataset4(ctrl1).status=3
    elseif dataset4(ctrl1).todie=1 then
      ndead(shedctr)=ndead(shedctr)+1
      dataset4(ctrl1).status=4
      if dataset4(ctrl1).sentinel=1 and reportday=0 then
        howend="sentineldead"
        reportday=day
      end if
    end if
  end if

```

```

        end if
    end if
end if
end if
next

end sub

sub updatecounters
dim shedctr, ctr1, ctr2, a, b, ns, nl, nin0, nin1, nin2, nim, nd, nser, nlatent, infec as integer
dim olddead as integer

ntoseroconvert=0
nseroconv=0
nsusceptible=0
ndeadttotal=0
olddead=0

for shedctr=1 to nsheds
    nsus(shedctr)=0
    nlat(shedctr)=0
    ninf0(shedctr)=0
    ninf1(shedctr)=0
    ninf2(shedctr)=0
    nimm(shedctr)=0
    ndead(shedctr)=0
    nsero(shedctr)=0
    nsurvsero(shedctr)=0
    nsurvinf(shedctr)=0
    newdead(shedctr)=0
    olddead=ndead(shedctr)

    for ctr1=1 to nbirds/nsheds
        if shedctr=1 then
            do case dataset1(ctr1).status
            case 0
                nsus(shedctr)=nsus(shedctr)+1
            case 1

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```

        nlat(shedctr)=nlat(shedctr)+1
        dataset1(ctrl).daysleftlat=dataset1(ctrl).daysleftlat-1
    case 2
        dataset1(ctrl).daysleftinf=dataset1(ctrl).daysleftinf-1
        if dataset1(ctrl).vacc=0 then
            ninf0(shedctr)=ninf0(shedctr)+1
            ninf0total=ninf0total+1
        elseif dataset1(ctrl).vacc=2 then
            ninf2(shedctr)=ninf2(shedctr)+1
            ninf2total=ninf2total+1
        end if
    case 3
        nimm(shedctr)=nimm(shedctr)+1
    case 4
        ndead(shedctr)=ndead(shedctr)+1
    end case
elseif shedctr=2 then
    do case dataset2(ctrl).status
    case 0
        nsus(shedctr)=nsus(shedctr)+1
    case 1
        nlat(shedctr)=nlat(shedctr)+1
        dataset2(ctrl).daysleftlat=dataset2(ctrl).daysleftlat-1
    case 2
        dataset2(ctrl).daysleftinf=dataset2(ctrl).daysleftinf-1
        if dataset2(ctrl).vacc=0 then
            ninf0(shedctr)=ninf0(shedctr)+1
            ninf0total=ninf0total+1
        elseif dataset2(ctrl).vacc=2 then
            ninf2(shedctr)=ninf2(shedctr)+1
            ninf2total=ninf2total+1
        end if
    case 3
        nimm(shedctr)=nimm(shedctr)+1
    case 4
        ndead(shedctr)=ndead(shedctr)+1
    end case
elseif shedctr=3 then
    do case dataset3(ctrl).status

```

```

case 0
  nsus(shedctr)=nsus(shedctr)+1
case 1
  nlat(shedctr)=nlat(shedctr)+1
  dataset3(ctrl).daysleftlat=dataset3(ctrl).daysleftlat-1
case 2
  dataset3(ctrl).daysleftinf=dataset3(ctrl).daysleftinf-1
  if dataset3(ctrl).vacc=0 then
    ninf0(shedctr)=ninf0(shedctr)+1
    ninf0total=ninf0total+1
  elseif dataset3(ctrl).vacc=2 then
    ninf2(shedctr)=ninf2(shedctr)+1
    ninf2total=ninf2total+1
  end if
case 3
  nimm(shedctr)=nimm(shedctr)+1
case 4
  ndead(shedctr)=ndead(shedctr)+1
end case
elseif shedctr=4 then
do case dataset4(ctrl).status
case 0
  nsus(shedctr)=nsus(shedctr)+1
case 1
  nlat(shedctr)=nlat(shedctr)+1
  dataset4(ctrl).daysleftlat=dataset4(ctrl).daysleftlat-1
case 2
  dataset4(ctrl).daysleftinf=dataset4(ctrl).daysleftinf-1
  if dataset4(ctrl).vacc=0 then
    ninf0(shedctr)=ninf0(shedctr)+1
    ninf0total=ninf0total+1
  elseif dataset4(ctrl).vacc=2 then
    ninf2(shedctr)=ninf2(shedctr)+1
    ninf2total=ninf2total+1
  end if
case 3
  nimm(shedctr)=nimm(shedctr)+1
case 4
  ndead(shedctr)=ndead(shedctr)+1

```

```

        end case
    end if
next

newdead(shedctr)=ndead(shedctr)-olddead
if reportday=0 and newdead(shedctr)/(nbirds-olddead)>=0.01 then
    reportday=day
    howend="1%"
end if
if nbirds/nsheds-ndead(shedctr)>1000 then    'equation for sampling to detect disease in finite pop p47 dohoo
    if ninf0(shedctr)+ninf1(shedctr)+ninf2(shedctr)>0 then
        nsurvinf(shedctr)=int((1-0.05^(1/(ninf0(shedctr)+ninf1(shedctr)+ninf2(shedctr))))*((nbirds/nsheds-
ndead(shedctr))-(ninf0(shedctr)
        +ninf1(shedctr)+ninf2(shedctr)-1)/2))+1
    end if
else
    if ninf0(shedctr)+ninf1(shedctr)+ninf2(shedctr)>0 then
        'nsurvinf(shedctr)=int(log(0.05)/log(1-((ninf0(shedctr)+ninf1(shedctr)+ninf2(shedctr))/(nbirds/nsheds-
ndead(shedctr)))))+1
    end if
end if

nlatent=nlatent+nlat(shedctr)
infec=ninf0(shedctr)+ninf2(shedctr)
nsusceptible=nsusceptible+nsus(shedctr)
ndeadtotal=ndeadtotal+ndead(shedctr)
next

if nlatent=0 and infec=0 then
    if reportday=0 then
        howend="diedout"
    end if
    lastday=day
end if

end sub

sub results
dim shedctr, ctr2 as integer

```

```

for shedctr=1 to nsheds
  for ctr2 = 1 to nbirds/nsheds
    if shedctr=1 then
      insert into records
values(itctr,day,ctr2,shedctr,dataset1(ctr2).vacc,dataset1(ctr2).sentinel,dataset1(ctr2).status,

      dataset1(ctr2).clinx,dataset1(ctr2).daysleftlat,dataset1(ctr2).daysleftinf,dataset1(ctr2).daystatus2,dataset1(c
tr2).daystatus4,
      dataset1(ctr2).typeofspread)
    elseif shedctr=2 then
      insert into records
values(itctr,day,ctr2,shedctr,dataset2(ctr2).vacc,dataset2(ctr2).sentinel,dataset2(ctr2).status,

      dataset2(ctr2).clinx,dataset2(ctr2).daysleftlat,dataset2(ctr2).daysleftinf,dataset2(ctr2).daystatus2,dataset2(c
tr2).daystatus4,
      dataset2(ctr2).typeofspread)
    elseif shedctr=3 then
      insert into records
values(itctr,day,ctr2,shedctr,dataset3(ctr2).vacc,dataset3(ctr2).sentinel,dataset3(ctr2).status,

      dataset3(ctr2).clinx,dataset3(ctr2).daysleftlat,dataset3(ctr2).daysleftinf,dataset3(ctr2).daystatus2,dataset3(c
tr2).daystatus4,
      dataset3(ctr2).typeofspread)
    elseif shedctr=4 then
      insert into records
values(itctr,day,ctr2,shedctr,dataset4(ctr2).vacc,dataset4(ctr2).sentinel,dataset4(ctr2).status,

      dataset4(ctr2).clinx,dataset4(ctr2).daysleftlat,dataset4(ctr2).daysleftinf,dataset4(ctr2).daystatus2,dataset4(c
tr2).daystatus4,
      dataset4(ctr2).typeofspread)
    end if
  next
next
end sub

sub progresswin

```

```

if itctr=1 and day=1 then
  open table "d:\AIModel\Screen\blank" as blank
  map from blank
    width 5 height 0.5
  set window windowID(1)
    title "Loading data ..."
else
  set window windowID(1) 'win_id1
  front
  title " Simulation progress: Run " + str$(itctr) + " of " + str$(iterations) + ", "
    + " Day " + str$(day) + " of " + str$(lastday) + " , " + str$(ninf0total+ninf2total) + " infected"
end if

```

end sub

withinfarmmodel_spread.mbo

```

include "mapbasic.def"
include "withinfarmmodel.def"

```

```

sub diseasespread

```

```

dim shedctr,ctr2,ctr3,ctr1,ctr4,tempid,startbird,endbird,nbg,nsh,infec,ntries,contacts,randshed,contactid as integer
dim how as string
dim z, sus, psread, sd as float

```

```

for ctr2=1 to nbirds
  shedctr=(ctr2-1)\(nbirds/nsheds)+1
  ctr1=ctr2-(shedctr-1)*nbirds/nsheds
  if shedctr=1 then
    if duck=1 and dataset1(ctr1).sentinel=0 then
      contacts=poisson(4.7) 'vdg 2008
    else
      sd=0.1275
      contacts=normal(1.43,sd) '(Tiensin et al 2007b)
    end if
    ntries=0
    if dataset1(ctr1).status=2 then
      ntries=0
    end if
  end if

```

```

do
  randshed=uniform(1,nsheds)
  contactid=Uniform(1,nbirds/nsheds)
  ntries=ntries+1
  if randshed=1 then
    if dataset1(contactid).status<>4 then
      contacts=contacts-1
      pspread=1
      if dataset1(contactid).status=0 then
        if dataset1(ctrl).vacc=2 then
          if dataset1(contactid).vacc=2 then
            pspread=pspread*Pvv
            sus=suscv
          elseif dataset1(contactid).vacc=0 then
            pspread=pspread*Pvvnv
            sus=1
          end if
        elseif dataset1(ctrl).vacc=0 then
          if dataset1(contactid).vacc=2 then
            pspread=pspread*Pvvnv
            sus=suscv
          elseif dataset1(contactid).vacc=0 then
            pspread=pspread*Pvvnv
            sus=1
          end if
        end if
      end if
      z=random()
      if z<=pspread then
        dataset1(contactid).status=1
        dataset1(contactid).dayexposed=day
        dataset1(contactid).typeofspread="C"
        nlat(randshed)=nlat(randshed)+1
        nsus(randshed)=nsus(randshed)-1
        do case dataset1(contactid).vacc
        case 0
          if duck=1 and dataset1(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
          else
            x=uniform(clplnv,clphnv)
          end if
        end case
      end if
    end if
  end if
end do

```



```

end if
if x=0 then
  dataset1(contactid).status=2
  if duck=1 and dataset1(contactid).sentinel=0 then
    dataset1(contactid).daysleftinf=uniform(diplnv,diphnv)
    if random()<=dPdienv then
      dataset1(contactid).todie=1
    end if
  else
    dataset1(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
    if random()<=cPdienv then
      dataset1(contactid).todie=1
    end if
  end if
else
  dataset1(contactid).daysleftlat=x
end if
case 2
if duck=1 then
  x=uniform(dlplv,dlphv)
elseif duck=0 then
  x=uniform(clplv,clphv)
end if
if x=0 then
  dataset1(contactid).status=2
  if duck=1 then
    dataset1(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
    if random()<=dPdiev then
      dataset1(contactid).todie=1
    end if
  elseif duck=0 then
    dataset1(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
    if random()<=cPdiev then
      dataset1(contactid).todie=1
    end if
  end if
else
  dataset1(contactid).daysleftlat=x
end if

```

```

        end case
    elseif dataset1(contactid).vacc=2 then
        dataset1(contactid).status=3
        dataset1(contactid).dayexposed=day
        dataset1(contactid).typeofspread="R"
    end if
end if
end if
end if
elseif randshed=2 then
    if dataset2(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset2(contactid).status=0 then
            if dataset1(ctrl1).vacc=2 then
                if dataset2(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    pspread=pspread*Pvvn
                    sus=1
                end if
            elseif dataset1(ctrl1).vacc=0 then
                if dataset2(contactid).vacc=2 then
                    pspread=pspread*Pvvn
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    pspread=pspread*Pvvn
                    sus=1
                end if
            end if
        elseif dataset1(ctrl1).vacc=0 then
            if dataset2(contactid).vacc=2 then
                pspread=pspread*Pvvn
                sus=suscv
            elseif dataset2(contactid).vacc=0 then
                pspread=pspread*Pvvn
                sus=1
            end if
        end if
    end if
    z=random()
    if z<=pspread then
        dataset2(contactid).status=1
        dataset2(contactid).dayexposed=day
        dataset2(contactid).typeofspread="C"
        nlat(randshed)=nlat(randshed)+1
        nsus(randshed)=nsus(randshed)-1
        do case dataset2(contactid).vacc

```

```

case 0
  if duck=1 and dataset2(contactid).sentinel=0 then
    x=uniform(dlplnv,dlphnv)
  else
    x=uniform(clplnv,clphnv)
  end if
  if x=0 then
    dataset2(contactid).status=2
    if duck=1 and dataset2(contactid).sentinel=0 then
      dataset2(contactid).daysleftinf=uniform(diplnv,diphnv)
      if random()<=dPdienv then
        dataset2(contactid).todie=1
      end if
    else
      dataset2(contactid).daysleftinf=beta_pert(ciplnv,cipmrv,ciphnv)
      if random()<=cPdienv then
        dataset2(contactid).todie=1
      end if
    end if
  else
    dataset2(contactid).daysleftlat=x
  end if
case 2
  if duck=1 then
    x=uniform(dlplv,dlphv)
  elseif duck=0 then
    x=uniform(clplv,clphv)
  end if
  if x=0 then
    dataset2(contactid).status=2
    if duck=1 then
      dataset2(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
      if random()<=dPdiev then
        dataset2(contactid).todie=1
      end if
    elseif duck=0 then
      dataset2(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
      if random()<=cPdiev then
        dataset2(contactid).todie=1
      end if
    end if
  end if

```

```

                end if
            end if
        else
            dataset2(contactid).daysleftlat=x
        end if
    end case
elseif dataset2(contactid).vacc=2 then
    dataset2(contactid).status=3
    dataset2(contactid).dayexposed=day
    dataset2(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=3 then
    if dataset3(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset3(contactid).status=0 then
            if dataset1(ctrl1).vacc=2 then
                if dataset3(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset3(contactid).vacc=0 then
                    pspread=pspread*Pvnv
                    sus=1
                end if
            elseif dataset1(ctrl1).vacc=0 then
                if dataset3(contactid).vacc=2 then
                    pspread=pspread*Pnvv
                    sus=suscv
                elseif dataset3(contactid).vacc=0 then
                    pspread=pspread*Pnvnv
                    sus=1
                end if
            end if
        end if
        z=random()
        if z<=pspread then
            dataset3(contactid).status=1
            dataset3(contactid).dayexposed=day
        end if
    end if
end if

```

```

dataset3(contactid).typeofspread="C"
nlat(randshed)=nlat(randshed)+1
nsus(randshed)=nsus(randshed)-1
do case dataset3(contactid).vacc
case 0
  if duck=1 and dataset3(contactid).sentinel=0 then
    x=uniform(dlplnv,dlphnv)
  else
    x=uniform(clplnv,clphnv)
  end if
  if x=0 then
    dataset3(contactid).status=2
    if duck=1 and dataset3(contactid).sentinel=0 then
      dataset3(contactid).daysleftinf=uniform(diplnv,diphnv)
      if random()<=dPdienv then
        dataset3(contactid).todie=1
      end if
    else
      dataset3(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
      if random()<=cPdienv then
        dataset3(contactid).todie=1
      end if
    end if
  else
    dataset3(contactid).daysleftlat=x
  end if
case 2
  if duck=1 then
    x=uniform(dlplv,dlphv)
  elseif duck=0 then
    x=uniform(clplv,clphv)
  end if
  if x=0 then
    dataset3(contactid).status=2
    if duck=1 then
      dataset3(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
      if random()<=dPdiev then
        dataset3(contactid).todie=1
      end if
    end if
  end if

```

```

        elseif duck=0 then
            dataset3(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset3(contactid).todie=1
            end if
        end if
    else
        dataset3(contactid).daysleftlat=x
    end if
end case
elseif dataset3(contactid).vacc=2 then
    dataset3(contactid).status=3
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=4 then
    if dataset4(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset4(contactid).status=0 then
            if dataset1(ctrl1).vacc=2 then
                if dataset4(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset4(contactid).vacc=0 then
                    pspread=pspread*Pvnv
                    sus=1
                end if
            elseif dataset1(ctrl1).vacc=0 then
                if dataset4(contactid).vacc=2 then
                    pspread=pspread*Pnvv
                    sus=suscv
                elseif dataset4(contactid).vacc=0 then
                    pspread=pspread*Pnvv
                    sus=1
                end if
            end if
        end if
    end if
end if

```

```

end if
z=random()
if z<=pspread then
  dataset4(contactid).status=1
  dataset4(contactid).dayexposed=day
  dataset4(contactid).typeofspread="C"
  nlat(randshed)=nlat(randshed)+1
  nsus(randshed)=nsus(randshed)-1
  do case dataset4(contactid).vacc
  case 0
    if duck=1 and dataset4(contactid).sentinel=0 then
      x=uniform(dlplnv,dlphnv)
    else
      x=uniform(clplnv,clphnv)
    end if
    if x=0 then
      dataset4(contactid).status=2
      if duck=1 and dataset4(contactid).sentinel=0 then
        dataset4(contactid).daysleftinf=uniform(diplnv,diphnv)
        if random()<=dPdienv then
          dataset4(contactid).todie=1
        end if
      else
        dataset4(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
        if random()<=cPdienv then
          dataset4(contactid).todie=1
        end if
      end if
    else
      dataset4(contactid).daysleftlat=x
    end if
  case 2
    if duck=1 then
      x=uniform(dlplv,dlphv)
    elseif duck=0 then
      x=uniform(clplv,clphv)
    end if
    if x=0 then
      dataset4(contactid).status=2

```

```

        if duck=1 then
            dataset4(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset4(contactid).todie=1
            end if
        elseif duck=0 then
            dataset4(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset4(contactid).todie=1
            end if
        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
end case
elseif dataset4(contactid).vacc=2 then
    dataset4(contactid).status=3
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="R"
end if
end if
end if
loop until contacts=0 or ntries=100
end if
elseif shedctr=2 then
    if duck=1 and dataset2(ctrl1).sentinel=0 then
        contacts=poisson(4.7)      'vdg 2008
    else
        sd=0.1275
        contacts=normal(1.43,sd)  '(Tiensin et al 2007b)
    end if
    ntries=0

    if dataset2(ctrl1).status=2 then
        ntries=0
        do
            if itctr>200 and itctr<=300 then
                if random()<=0.9 then
                    randshed=shedctr
                end if
            end if
        end do
    end if
end if

```



```

else
    randshed=shedctr+uniform(1,nsheds-1)
    if randshed>nsheds then
        randshed=randshed-nsheds
    end if
end if
else
    randshed=uniform(1,nsheds)
end if
contactid=Uniform(1,nbirds/nsheds)
ntries=ntries+1
if randshed=1 then
    if dataset1(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset1(contactid).status=0 then
            if dataset2(ctr1).vacc=2 then
                if dataset1(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset1(contactid).vacc=0 then
                    pspread=pspread*Pvnv
                    sus=1
                end if
            elseif dataset2(ctr1).vacc=0 then
                if dataset1(contactid).vacc=2 then
                    pspread=pspread*Pnv
                    sus=suscv
                elseif dataset1(contactid).vacc=0 then
                    pspread=pspread*Pnvnv
                    sus=1
                end if
            end if
        end if
        z=random()
        if z<=pspread then
            dataset1(contactid).status=1
            dataset1(contactid).dayexposed=day
            dataset1(contactid).typeofspread="C"
            nlat(randshed)=nlat(randshed)+1
        end if
    end if
end if

```

```

nsus(randshed)=nsus(randshed)-1
do case dataset1(contactid).vacc
case 0
  if duck=1 and dataset1(contactid).sentinel=0 then
    x=uniform(dlplnv,dlphnv)
  else
    x=uniform(clplnv,clphnv)
  end if
  if x=0 then
    dataset1(contactid).status=2
    if duck=1 and dataset1(contactid).sentinel=0 then
      dataset1(contactid).daysleftinf=uniform(diplnv,diphnv)
      if random()<=dPdienv then
        dataset1(contactid).todie=1
      end if
    else
      dataset1(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
      if random()<=cPdienv then
        dataset1(contactid).todie=1
      end if
    end if
  else
    dataset1(contactid).daysleftlat=x
  end if
case 2
  if duck=1 then
    x=uniform(dlplv,dlphv)
  elseif duck=0 then
    x=uniform(clplv,clphv)
  end if
  if x=0 then
    dataset1(contactid).status=2
    if duck=1 then
      dataset1(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
      if random()<=dPdiev then
        dataset1(contactid).todie=1
      end if
    elseif duck=0 then
      dataset1(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
    end if
  end if
end if
end do

```

```

                if random()<=cPdiev then
                    dataset1(contactid).todie=1
                end if
            end if
        else
            dataset1(contactid).daysleftlat=x
        end if
    end case
elseif dataset1(contactid).vacc=2 then
    dataset1(contactid).status=3
    dataset1(contactid).dayexposed=day
    dataset1(contactid).typeofspread="R"
end if
end if
elseif randshed=2 then
    if dataset2(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset2(contactid).status=0 then
            if dataset2(ctr1).vacc=2 then
                if dataset2(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    pspread=pspread*Pvnv
                    sus=1
                end if
            elseif dataset2(ctr1).vacc=0 then
                if dataset2(contactid).vacc=2 then
                    pspread=pspread*Pnvv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    pspread=pspread*Pnvnv
                    sus=1
                end if
            end if
        end if
        z=random()
        if z<=pspread then

```

```

dataset2(contactid).status=1
dataset2(contactid).dayexposed=day
dataset2(contactid).typeofspread="C"
nlat(randshed)=nlat(randshed)+1
nsus(randshed)=nsus(randshed)-1
do case dataset2(contactid).vacc
case 0
  if duck=1 and dataset2(contactid).sentinel=0 then
    x=uniform(dlplnv,dlphnv)
  else
    x=uniform(clplnv,clphnv)
  end if
  if x=0 then
    dataset2(contactid).status=2
    if duck=1 and dataset2(contactid).sentinel=0 then
      dataset2(contactid).daysleftinf=uniform(diplnv,diphnv)
      if random()<=dPdienv then
        dataset2(contactid).todie=1
      end if
    else
      dataset2(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
      if random()<=cPdienv then
        dataset2(contactid).todie=1
      end if
    end if
  else
    dataset2(contactid).daysleftlat=x
  end if
case 2
  if duck=1 then
    x=uniform(dlplv,dlphv)
  elseif duck=0 then
    x=uniform(clplv,clphv)
  end if
  if x=0 then
    dataset2(contactid).status=2
    if duck=1 then
      dataset2(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
      if random()<=dPdiev then

```



```

    end if
end if
z=random()
if z<=pspread then
    dataset3(contactid).status=1
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset3(contactid).vacc
    case 0
        if duck=1 and dataset3(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset3(contactid).status=2
            if duck=1 and dataset3(contactid).sentinel=0 then
                dataset3(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset3(contactid).todie=1
                end if
            else
                dataset3(contactid).daysleftinf=beta_pert(ciplnv,cipmrv,ciphnv)
                if random()<=cPdienv then
                    dataset3(contactid).todie=1
                end if
            end if
        else
            dataset3(contactid).daysleftlat=x
        end if
    case 2
        if duck=1 then
            x=uniform(dlplv,dlphv)
        elseif duck=0 then
            x=uniform(clplv,clphv)
        end if
        if x=0 then

```

```

dataset3(contactid).status=2
if duck=1 then
  dataset3(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
  if random()<=dPdiev then
    dataset3(contactid).todie=1
  end if
elseif duck=0 then
  dataset3(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
  if random()<=cPdiev then
    dataset3(contactid).todie=1
  end if
end if
else
  dataset3(contactid).daysleftlat=x
end if
end case
elseif dataset3(contactid).vacc=2 then
  dataset3(contactid).status=3
  dataset3(contactid).dayexposed=day
  dataset3(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=4 then
  if dataset4(contactid).status<>4 then
    contacts=contacts-1
    pspread=1
    if dataset4(contactid).status=0 then
      if dataset2(ctrl1).vacc=2 then
        if dataset4(contactid).vacc=2 then
          pspread=pspread*Pvv
          sus=suscv
        elseif dataset4(contactid).vacc=0 then
          pspread=pspread*Pvnv
          sus=1
        end if
      end if
    elseif dataset2(ctrl1).vacc=0 then
      if dataset4(contactid).vacc=2 then
        pspread=pspread*Pnvv
      end if
    end if
  end if
end if

```

```

        sus=suscV
    elseif dataset4(contactid).vacc=0 then
        pspread=pspread*Pnvnv
        sus=1
    end if
end if
end if
z=random()
if z<=pspread then
    dataset4(contactid).status=1
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset4(contactid).vacc
    case 0
        if duck=1 and dataset4(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset4(contactid).status=2
            if duck=1 and dataset4(contactid).sentinel=0 then
                dataset4(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset4(contactid).todie=1
                end if
            else
                dataset4(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
                if random()<=cPdienv then
                    dataset4(contactid).todie=1
                end if
            end if
        else
            dataset4(contactid).daysleftlat=x
        end if
    case 2
        if duck=1 then

```



```

        x=uniform(dlplv,dlphv)
    elseif duck=0 then
        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset4(contactid).status=2
        if duck=1 then
            dataset4(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset4(contactid).todie=1
            end if
        elseif duck=0 then
            dataset4(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset4(contactid).todie=1
            end if
        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
end case
elseif dataset4(contactid).vacc=2 then
    dataset4(contactid).status=3
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="R"
end if
end if
end if
loop until contacts=0 or ntries=100
end if
elseif shedctr=3 then
    if duck=1 and dataset3(ctrl).sentinel=0 then
        contacts=poisson(4.7)      'vdg 2008
    else
        sd=0.1275
        contacts=normal(1.43,sd)  '(Tiensin et al 2007b)
    end if
    ntries=0
    if dataset3(ctrl).status=2 then

```

```

ntries=0
do
  if itctr>200 and itctr<=300 then
    if random()<=0.9 then
      randshed=shedctr
    else
      randshed=shedctr+uniform(1,nsheds-1)
      if randshed>nsheds then
        randshed=randshed-nsheds
      end if
    end if
  else
    randshed=uniform(1,nsheds)
  end if
  contactid=Uniform(1,nbirds/nsheds)
  ntries=ntries+1
  if randshed=1 then
    if dataset1(contactid).status<>4 then
      contacts=contacts-1
      pspread=1
      if dataset1(contactid).status=0 then
        if dataset3(ctrl1).vacc=2 then
          if dataset1(contactid).vacc=2 then
            pspread=pspread*Pvv
            sus=suscv
          elseif dataset1(contactid).vacc=0 then
            pspread=pspread*Pvnv
            sus=1
          end if
        elseif dataset3(ctrl1).vacc=0 then
          if dataset1(contactid).vacc=2 then
            pspread=pspread*Pnvv
            sus=suscv
          elseif dataset1(contactid).vacc=0 then
            pspread=pspread*Pnvv
            sus=1
          end if
        end if
      end if
    end if
  end if
  z=random()

```

```

if z<=pspread then
  dataset1(contactid).status=1
  dataset1(contactid).dayexposed=day
  dataset1(contactid).typeofspread="C"
  nlat(randshed)=nlat(randshed)+1
  nsus(randshed)=nsus(randshed)-1
  do case dataset1(contactid).vacc
  case 0
    if duck=1 and dataset1(contactid).sentinel=0 then
      x=uniform(dlplnv,dlphnv)
    else
      x=uniform(clplnv,clphnv)
    end if
    if x=0 then
      dataset1(contactid).status=2
      if duck=1 and dataset1(contactid).sentinel=0 then
        dataset1(contactid).daysleftinf=uniform(diplnv,diphnv)
        if random()<=dPdienv then
          dataset1(contactid).todie=1
        end if
      else
        dataset1(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
        if random()<=cPdienv then
          dataset1(contactid).todie=1
        end if
      end if
    else
      dataset1(contactid).daysleftlat=x
    end if
  case 2
    if duck=1 then
      x=uniform(dlplv,dlphv)
    elseif duck=0 then
      x=uniform(clplv,clphv)
    end if
    if x=0 then
      dataset1(contactid).status=2
      if duck=1 then
        dataset1(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)

```

```

        if random()<=dPdiev then
            dataset1(contactid).todie=1
        end if
    elseif duck=0 then
        dataset1(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
        if random()<=cPdiev then
            dataset1(contactid).todie=1
        end if
    end if
else
    dataset1(contactid).daysleftlat=x
end if
end case
elseif dataset1(contactid).vacc=2 then
    dataset1(contactid).status=3
    dataset1(contactid).dayexposed=day
    dataset1(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=2 then
    if dataset2(contactid).status<>4 then
        contacts=contacts-1
        psread=1
        if dataset2(contactid).status=0 then
            if dataset3(ctrl1).vacc=2 then
                if dataset2(contactid).vacc=2 then
                    psread=psread*Pvv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    psread=psread*Pvvnv
                    sus=1
                end if
            elseif dataset3(ctrl1).vacc=0 then
                if dataset2(contactid).vacc=2 then
                    psread=psread*Pvvnv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    psread=psread*Pvvnv
                end if
            end if
        end if
    end if
end if

```

```

        sus=1
    end if
end if
z=random()
if z<=pspread then
    dataset2(contactid).status=1
    dataset2(contactid).dayexposed=day
    dataset2(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset2(contactid).vacc
    case 0
        if duck=1 and dataset2(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset2(contactid).status=2
            if duck=1 and dataset2(contactid).sentinel=0 then
                dataset2(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset2(contactid).todie=1
                end if
            else
                dataset2(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
                if random()<=cPdienv then
                    dataset2(contactid).todie=1
                end if
            end if
        else
            dataset2(contactid).daysleftlat=x
        end if
    case 2
        if duck=1 then
            x=uniform(dlplv,dlphv)
        elseif duck=0 then
            x=uniform(clplv,clphv)
        end if

```

```

        if x=0 then
            dataset2(contactid).status=2
            if duck=1 then
                dataset2(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
                if random()<=dPdiev then
                    dataset2(contactid).todie=1
                end if
            elseif duck=0 then
                dataset2(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
                if random()<=cPdiev then
                    dataset2(contactid).todie=1
                end if
            end if
        else
            dataset2(contactid).daysleftlat=x
        end if
    end case
elseif dataset2(contactid).vacc=2 then
    dataset2(contactid).status=3
    dataset2(contactid).dayexposed=day
    dataset2(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=3 then
    if dataset3(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset3(contactid).status=0 then
            if dataset3(ctrl1).vacc=2 then
                if dataset3(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscV
                elseif dataset3(contactid).vacc=0 then
                    pspread=pspread*Pvvnv
                    sus=1
                end if
            elseif dataset3(ctrl1).vacc=0 then
                if dataset3(contactid).vacc=2 then

```

```

        pspread=pspread*Pnvv
        sus=suscV
    elseif dataset3(contactid).vacc=0 then
        pspread=pspread*Pnvv
        sus=1
    end if
end if
z=random()
if z<=pspread then
    dataset3(contactid).status=1
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset3(contactid).vacc
    case 0
        if duck=1 and dataset3(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset3(contactid).status=2
            if duck=1 and dataset3(contactid).sentinel=0 then
                dataset3(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset3(contactid).todie=1
                end if
            else
                dataset3(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
                if random()<=cPdienv then
                    dataset3(contactid).todie=1
                end if
            end if
        else
            dataset3(contactid).daysleftlat=x
        end if
    case 2
        if duck=1 then

```

```

        x=uniform(dlplv,dlphv)
    elseif duck=0 then
        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset3(contactid).status=2
        if duck=1 then
            dataset3(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset3(contactid).todie=1
            end if
        elseif duck=0 then
            dataset3(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset3(contactid).todie=1
            end if
        end if
    else
        dataset3(contactid).daysleftlat=x
    end if
end case
elseif dataset3(contactid).vacc=2 then
    dataset3(contactid).status=3
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=4 then
    if dataset4(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset4(contactid).status=0 then
            if dataset3(ctrl1).vacc=2 then
                if dataset4(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset4(contactid).vacc=0 then
                    pspread=pspread*Pvvnv
                end if
            end if
        end if
    end if
end if

```



```

        sus=1
    end if
elseif dataset3(ctrl1).vacc=0 then
    if dataset4(contactid).vacc=2 then
        pspread=pspread*Pnvv
        sus=suscV
    elseif dataset4(contactid).vacc=0 then
        pspread=pspread*Pnvv
        sus=1
    end if
end if
end if
z=random()
if z<=pspread then

    dataset4(contactid).status=1
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset4(contactid).vacc
    case 0
        if duck=1 and dataset4(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset4(contactid).status=2
            if duck=1 and dataset4(contactid).sentinel=0 then
                dataset4(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset4(contactid).todie=1
                end if
            else
                dataset4(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
                if random()<=cPdienv then
                    dataset4(contactid).todie=1
                end if
            end if
        end if
    end case
end if
end if

```

```

        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
case 2
    if duck=1 then
        x=uniform(dlplv,dlphv)
    elseif duck=0 then
        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset4(contactid).status=2
        if duck=1 then
            dataset4(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset4(contactid).todie=1
            end if
        elseif duck=0 then
            dataset4(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset4(contactid).todie=1
            end if
        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
end case
elseif dataset4(contactid).vacc=2 then
    dataset4(contactid).status=3
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="R"
end if
end if
    end if
        end if
            loop until contacts=0 or ntries=100
        end if
elseif shedctr=4 then
    if duck=1 and dataset4(ctrl1).sentinel=0 then
        contacts=poisson(4.7)      'vdg 2008

```

```

else
  sd=0.1275
  contacts=normal(1.43,sd) '(Tiensin et al 2007b)
end if
ntries=0
if dataset4(ctrl).status=2 then
  ntries=0
  do
    if itctr>200 and itctr<=300 then
      if random()<=0.9 then
        randshed=shedctr
      else
        randshed=shedctr+uniform(1,nsheds-1)
        if randshed>nsheds then
          randshed=randshed-nsheds
        end if
      end if
    else
      randshed=uniform(1,nsheds)
    end if
    contactid=Uniform(1,nbirds/nsheds)
    ntries=ntries+1
    if randshed=1 then
      if dataset1(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset1(contactid).status=0 then
          if dataset4(ctrl).vacc=2 then
            if dataset1(contactid).vacc=2 then
              pspread=pspread*Pvv
              sus=suscv
            elseif dataset1(contactid).vacc=0 then
              pspread=pspread*Pvvnv
              sus=1
            end if
          elseif dataset4(ctrl).vacc=0 then
            if dataset1(contactid).vacc=2 then
              pspread=pspread*Pvvnv
              sus=suscv
            end if
          end if
        end if
      end if
    end if
  end do
end if

```

```

elseif dataset1(contactid).vacc=0 then
    pspread=pspread*Pnvnv
    sus=1
end if
end if
z=random()
if z<=pspread then
    dataset1(contactid).status=1
    dataset1(contactid).dayexposed=day
    dataset1(contactid).typeofspread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset1(contactid).vacc
    case 0
        if duck=1 and dataset1(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset1(contactid).status=2
            if duck=1 and dataset1(contactid).sentinel=0 then
                dataset1(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset1(contactid).todie=1
                end if
            else
                dataset1(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
                if random()<=cPdienv then
                    dataset1(contactid).todie=1
                end if
            end if
        else
            dataset1(contactid).daysleftlat=x
        end if
    case 2
        if duck=1 then
            x=uniform(dlplv,dlphv)
        elseif duck=0 then

```

```

        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset1(contactid).status=2
        if duck=1 then
            dataset1(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset1(contactid).todie=1
            end if
        elseif duck=0 then
            dataset1(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset1(contactid).todie=1
            end if
        end if
    else
        dataset1(contactid).daysleftlat=x
    end if
end case
elseif dataset1(contactid).vacc=2 then
    dataset1(contactid).status=3
    dataset1(contactid).dayexposed=day
    dataset1(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=2 then
    if dataset2(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset2(contactid).status=0 then
            if dataset4(ctrl1).vacc=2 then
                if dataset2(contactid).vacc=2 then
                    pspread=pspread*Pvv
                    sus=suscv
                elseif dataset2(contactid).vacc=0 then
                    pspread=pspread*Pvnv
                    sus=1
                end if
            end if
        end if
    end if
end if

```

```

elseif dataset4(ctrl1).vacc=0 then
  if dataset2(contactid).vacc=2 then
    pspread=pspread*Pnvv
    sus=suscV
  elseif dataset2(contactid).vacc=0 then
    pspread=pspread*Pnvv
    sus=1
  end if
end if
z=random()
if z<=pspread then
  dataset2(contactid).status=1
  dataset2(contactid).dayexposed=day
  dataset2(contactid).typeofspread="C"
  nlat(randshed)=nlat(randshed)+1
  nsus(randshed)=nsus(randshed)-1
  do case dataset2(contactid).vacc
  case 0
    if duck=1 and dataset2(contactid).sentinel=0 then
      x=uniform(dlplnv,dlphnv)
    else
      x=uniform(clplnv,clphnv)
    end if
    if x=0 then
      dataset2(contactid).status=2
      if duck=1 and dataset2(contactid).sentinel=0 then
        dataset2(contactid).daysleftinf=uniform(diplnv,diphnv)
        if random()<=dPdienv then
          dataset2(contactid).todie=1
        end if
      else
        dataset2(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
        if random()<=cPdienv then
          dataset2(contactid).todie=1
        end if
      end if
    else
      dataset2(contactid).daysleftlat=x
    end if
  end if
end if

```

```

case 2
  if duck=1 then
    x=uniform(dlplv,dlphv)
  elseif duck=0 then
    x=uniform(clplv,clphv)
  end if
  if x=0 then
    dataset2(contactid).status=2
    if duck=1 then
      dataset2(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
      if random()<=dPdiev then
        dataset2(contactid).todie=1
      end if
    elseif duck=0 then
      dataset2(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
      if random()<=cPdiev then
        dataset2(contactid).todie=1
      end if
    end if
  else
    dataset2(contactid).daysleftlat=x
  end if
end case
elseif dataset2(contactid).vacc=2 then
  dataset2(contactid).status=3
  dataset2(contactid).dayexposed=day
  dataset2(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=3 then
  if dataset3(contactid).status<>4 then
    contacts=contacts-1
    pspread=1
    if dataset3(contactid).status=0 then
      if dataset4(ctrl1).vacc=2 then
        if dataset3(contactid).vacc=2 then
          pspread=pspread*Pvv
          sus=suscV
        end if
      end if
    end if
  end if
end if

```

```

elseif dataset3(contactid).vacc=0 then
    pspread=pspread*Pvnm
    sus=1
end if
elseif dataset4(ctrl1).vacc=0 then
    if dataset3(contactid).vacc=2 then
        pspread=pspread*Pvnm
        sus=susc
    elseif dataset3(contactid).vacc=0 then
        pspread=pspread*Pvnm
        sus=1
    end if
end if
z=random()
if z<=pspread then
    dataset3(contactid).status=1
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typespread="C"
    nlat(randshed)=nlat(randshed)+1
    nsus(randshed)=nsus(randshed)-1
    do case dataset3(contactid).vacc
    case 0
        if duck=1 and dataset3(contactid).sentinel=0 then
            x=uniform(dlplnv,dlphnv)
        else
            x=uniform(clplnv,clphnv)
        end if
        if x=0 then
            dataset3(contactid).status=2
            if duck=1 and dataset3(contactid).sentinel=0 then
                dataset3(contactid).daysleftinf=uniform(diplnv,diphnv)
                if random()<=dPdienv then
                    dataset3(contactid).todie=1
                end if
            else
                dataset3(contactid).daysleftinf=beta_pert(ciplnv,cipmnm,ciphnv)
                if random()<=cPdienv then
                    dataset3(contactid).todie=1
                end if
            end if
        end if
    end case
end if

```



```

        end if
    else
        dataset3(contactid).daysleftlat=x
    end if
case 2
    if duck=1 then
        x=uniform(dlplv,dlphv)
    elseif duck=0 then
        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset3(contactid).status=2
        if duck=1 then
            dataset3(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset3(contactid).todie=1
            end if
        elseif duck=0 then
            dataset3(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset3(contactid).todie=1
            end if
        end if
    else
        dataset3(contactid).daysleftlat=x
    end if
end case
elseif dataset3(contactid).vacc=2 then
    dataset3(contactid).status=3
    dataset3(contactid).dayexposed=day
    dataset3(contactid).typeofspread="R"
end if
end if
end if
elseif randshed=4 then
    if dataset4(contactid).status<>4 then
        contacts=contacts-1
        pspread=1
        if dataset4(contactid).status=0 then

```

```

if dataset4(ctrl1).vacc=2 then
  if dataset4(contactid).vacc=2 then
    pspread=pspread*Pvv
    sus=suscV
  elseif dataset4(contactid).vacc=0 then
    pspread=pspread*Pvnv
    sus=1
  end if
elseif dataset4(ctrl1).vacc=0 then
  if dataset4(contactid).vacc=2 then
    pspread=pspread*Pnvv
    sus=suscV
  elseif dataset4(contactid).vacc=0 then
    pspread=pspread*Pnvnv
    sus=1
  end if
end if
end if
z=random()
if z<=pspread then
  dataset4(contactid).status=1
  dataset4(contactid).dayexposed=day
  dataset4(contactid).typeofspread="C"
  nlat(randshed)=nlat(randshed)+1
  nsus(randshed)=nsus(randshed)-1
  do case dataset4(contactid).vacc
  case 0
    if duck=1 and dataset4(contactid).sentinel=0 then
      x=uniform(dlplnv,dlphnv)
    else
      x=uniform(clplnv,clphnv)
    end if
    if x=0 then
      dataset4(contactid).status=2
      if duck=1 and dataset4(contactid).sentinel=0 then
        dataset4(contactid).daysleftinf=uniform(diplnv,diphnv)
        if random()<=dPdienv then
          dataset4(contactid).todie=1
        end if
      end if
    end if
  end case
end if

```

```

        else
            dataset4(contactid).daysleftinf=beta_pert(ciplnv,cipmnv,ciphnv)
            if random()<=cPdienv then
                dataset4(contactid).todie=1
            end if
        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
case 2
    if duck=1 then
        x=uniform(dlplv,dlphv)
    elseif duck=0 then
        x=uniform(clplv,clphv)
    end if
    if x=0 then
        dataset4(contactid).status=2
        if duck=1 then
            dataset4(contactid).daysleftinf=beta_pert(diplv,dipmv,diphv)
            if random()<=dPdiev then
                dataset4(contactid).todie=1
            end if
        elseif duck=0 then
            dataset4(contactid).daysleftinf=beta_pert(ciplv,cipmv,ciphv)
            if random()<=cPdiev then
                dataset4(contactid).todie=1
            end if
        end if
    else
        dataset4(contactid).daysleftlat=x
    end if
end case
elseif dataset4(contactid).vacc=2 then
    dataset4(contactid).status=3
    dataset4(contactid).dayexposed=day
    dataset4(contactid).typeofspread="R"
end if
end if
end if

```

```
        loop until contacts=0 or ntries=100
      end if
    end if
  next
end sub
```

withinfarmmodel_functions.mbo

```
Include "Mapbasic.def"
```

```
include "withinfarmmodel.def"
```

```
function triangle (ByVal l as integer, ByVal m as integer, ByVal h as integer) as integer
```

```
  dim u,x1 as float
```

```
  u=random()
```

```
    if u<=(m-1)/(h-1) then x1=1+((h-1)*(m-1)*u)^0.5
```

```
    elseif u>(m-1)/(h-1) then x1=h-((h-1)*(h-m)*(1-u))^0.5
```

```
    end if
```

```
    triangle=round(x1,1)
```

```
end function
```

```
function uniform (ByVal l as integer, ByVal h as integer) as integer
```

```
  dim u,x1 as float
```

```
  u=random()
```

```
  x1=(u*(h-1)+1)
```

```
  uniform=round(x1,1)
```

```
end function
```

```
function poisson (ByVal la as float) as integer
```

```
'procedure for randomly selecting a number from a poisson distribution
```

```
dim a,r,u as float
```

```
dim n as integer
```

```
'la=lamba, average or expected value
```

```
  r=1
```

```
  n=-1
```

```
  a=exp(-la)
```

```
  do while r>a
```

```
    u=random()
```

```
    r=r*u
```

```
    n=n+1
```

```
  loop
```

```
  poisson=round(n,1)
```

```
end function
```

```
function beta_pert (ByVal l as integer, ByVal m as integer, ByVal h as integer) as integer
```

```
  dim f1, f2, f3, u, a1, a2, mode, x, y, pbetamode, pbeta, B_value, BP_value as float
```

```
  a1 = (4*m + h - 5*1)/(h-1)
```

```
  a2 = (5*h - 1 - 4*m)/(h-1)
```

```
  mode = (a1-1)/(a1+a2-2)
```

```
  n0 = a1-1
```

```
  call factorial
```

```
  f1=f
```

```
  n0 = a2-1
```

```
  call factorial
```

```
  f2=f
```

```
  n0 = a1+a2-1
```

```
  call factorial
```

```

f3=f

'beta probability density function
' for max density at mode

pbetamode = (mode^(a1-1))*((1-mode)^(a2-1))*f3/(f1*f2)
B_value = -1

do
    x = random()
    pbeta = (x^(a1-1))*((1-x)^(a2-1))*f3/(f1*f2)

    y = random()

    if y <=pbeta/pbetamode then
        B_value = x
    end if
loop while B_value = -1

beta_pert=round(1 + (h-1)*B_value,0.1)           'rescale B_value using pert parameters

end function

sub factorial

'Code to calculate factorial

dim i as integer

if n0 < 0 then
    note "Error: n0 (" + n0 + ") must be non-negative. Program will end."
    close all
    end program
elseif n0 = 0 then
    f = 1
else

```

```

        f = 1
        for i = 1 to n0
            f = f*i
        next
    end if

```

```
end sub
```

```
function tsp (ByVal l,m,h as integer, n as float) as integer
```

```
    'procedure for randomly drawing value from a two-sided power distribution
```

```
    dim u,w as float
```

```
    u=random()
```

```
    if u<=(m-1)/(h-1) then w=1+(m-1)*(u*(h-1)/(m-1))^(1/n)
```

```
        elseif u>(m-1)/(h-1) then w=h-(h-m)*((1-u)*(h-1)/(h-m))^(1/n)
```

```
    end if
```

```
    tsp=round(w,1)
```

```
end function
```

```
function normal (ByVal mean,sd as float) as integer
```

```
    'procedure for randomly selecting a number from a normal distribution
```

```
    dim u1,u2,v1,v2,r,w,y,r1 as float
```

```
    start:
```

```
        u1=random()
```

```
        u2=random()
```

```
        v1=2*u1-1
```

```
        v2=2*u2-1
```

```
        w=v1^2+v2^2
```

```
        if w<1 then
```

```
            y=sqr(-2*log(w)/w)
```

```

        r1=round(mean+sd*v1*y,1)
    else goto start
end if
if r1<0 then
    r1=0
end if

normal=r1

end function

function lognormal (ByVal mean,sd as float) as integer

    'procedure for randomly selecting a number from a lognormal distribution

    dim mlog,sdlog,r1,r2,r3,pi as float

    pi=3.141592654
    mlog=log(mean)-0.5*log((1+(sd/mean)^2))      'mean and SD of log distribution
    sdlog=sqr(log(1+(sd/mean)^2))

    r1=sqr(-2*log(random()))*sin(2*pi*random())
    r2=mlog+r1*sdlog
    r3=exp(r2)
    lognormal=round(r3,1)                        'returns integer value

end function

function weibull (ByVal alpha,beta,shift as float) as integer

    dim z,w as float

    z=random()
    w=beta*((-1*log(1-z))^(1/alpha))+shift

    weibull=round(w,1)

```



```

end function

function gamma (ByVal alpha as float, ByVal scale as float) as float

dim a,b,c,d,u1,u2,x,z as float

x=-1
if alpha<1 and alpha>0 then                                     'Method of Kundu and Gupta 2007

    d=1.0334-0.0766*exp(2.2942*alpha)
    a=(2^alpha)*(1-exp(-d/2))^alpha
    b=alpha*d^(alpha-1)*exp(-d)
    c=a+b

do
    u1=random()
    if u1<=a/c then
        z=-2*log(1-((c*u1)^(1/alpha))/2)
    else
        z=-log(c*(1-u1)/(alpha*d^(alpha-1)))
    end if

    u2=random()
    if z<=d then
        if u2<=(z^(alpha-1))*exp(-z/2)/((2^(alpha-1))*(1-exp(-z/2))^(alpha-1)) then
            x=z
        end if
    else
        if u2<=(d/z)^(1-alpha) then
            x=z
        end if
    end if
loop until x<>-1

```

```

elseif alpha=1 then
    x=-log(random())

elseif alpha>1 then
    Carlo Techniques" http://pdg.lbl.gov/2002/monterpp.pdf
    'Method detailed in "32. Monte

do
    u1=random()
    a=u1*(1-u1)
    b=(u1-0.5)*(c/a)^0.5

    if alpha+b-1>0 then
        u2=random()
        d=64*(a^3)*(u2^2)
        if d<=1-(2*b^2)/(alpha+b-1) or log(d)<=2*((alpha-1)*log((alpha+b-1)/(alpha-1))-b) then
            x=alpha+b-1
        end if
    end if
loop until x<>-1

end if

gamma=x/scale

end function

```