(a) The structure of the next generation matrix, (b) a schematic version of the next-generation matrix indicating transmission route involved with each element (taken from Hartemink *et al*. 2008) and (c) a list of equations used to calculate each element within the matrix (adapted from Hartemink *et al*. 2008). Equations utilise tick- and pathogen-specific parameters derived from the literature and parameters calculated from theoretical data generated in the current study (Tables 1 and 2).

(a)

*k*11  *k*12 *k*13  *k*14  0

*k*21  *k*22 *k*23  0 *k*25

K = *k*31  *k*32 *k*33  0 *k*35

*k*41  *k*42 *k*43  0 *k*45

*k*51  *k*52 *k*53  0 0

(b)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| transovarial | transovarial | transovarial | transovarial | 0 |
| cofeeding | cofeeding | cofeeding | 0 | host L |
| cofeeding | cofeeding | cofeeding | 0 | host N |
| cofeeding | cofeeding | cofeeding | 0 | host A |
| tick host | tick host | tick host | 0 | 0 |

(c)

*k*11 = *s*L*s*N*s*A*Er*A,

(number of infected eggs produced by a tick infected via transovarial transmission)

*k*12 = *s*N*s*A*Er*A,

(number of infected eggs produced by a tick that was infected as a larva)

*k*13 = *s*A*Er*A,

(number of infected eggs produced by a tick that was infected as a nymph)

*k*14 = *Er*A,

(number of infected eggs produced by a tick that was infected as an adult)

*k*15 = 0,

(vertebrate hosts cannot infect the eggs of ticks)

*k*21 = (*s*L*ø*LLCLL + *s*L*s*N*ø*NLCLN + *s*L*s*N sAøALCLA) *hc*,

(number of larvae infected by a tick infected as an egg)

*k*22 = (*s*N*ø*NLCLN + *s*N*s*A*ø*ALCLA) *hc*,

(number of larvae infected by a tick infected as an larva)

*k*23 = (*s*A*ø*ALCLA) *hc*,

(number of larvae infected by a tick infected as a nymph)

*k*24 = 0,

(female ticks infected while feeding as adults do not feed again and therefore cannot produce infected larvae)

*k*25 = *p*L*iN*LH

DL

(average number of feeding larvae infected by one systemically infected vertebrate host)

*k*31 = (*s*L*ø*LNCNL + *s*L*s*N*ø*NNCNN + *s*L*s*N sAøANCNA) *hc*,

(number of nymphs infected by a tick infected as an egg)

*k*32 = (*s*N*ø*NNCNN + *s*N*s*A*ø*ANCNA) *hc*,

(number of nymphs infected by a tick infected as a larva)

*k*33 = (*s*A*ø*ANCNA) *hc*,

(number of nymphs infected by a tick infected as a nymph)

*k*34 = 0,

(female ticks infected while feeding as adults do not feed again and therefore cannot produce infected nymphs)

*k*35 = *p*N*iN*NH

DN

(average number of feeding nymphs infected by one systemically infected vertebrate host)

*k*41 = (*s*L*ø*LACAL + *s*L*s*N*ø*NACAN + *s*L*s*N sAøAACAA) *hc*,

(number of adults infected by a tick infected as an egg)

*k*42 = (*s*N*ø*NACAN + *s*N*s*A*ø*AACAA) *hc*,

(number of adults infected by a tick infected as a larva)

*k*43 = (*s*A*ø*AACAA) *hc*,

(number of adults infected by a tick infected as a nymph)

*k*44 = 0,

(female ticks infected while feeding as adults do not feed again and therefore cannot produce infected adults)

*k*45 = *p*A*iN*AH

DA

(average number of adult female ticks infected by one systemically infected vertebrate host)

*k*51 = (*s*L*q*L + *s*L*s*N*q*N + *s*L*s*N sA*q*A) *hc*,

(number of vertebrate hosts infected by a tick infected as an egg)

*k*52 = (*s*N*q*N +*s*N *s*A*q*A) *hc*,

(number of vertebrate hosts infected by a tick infected as a larvae)

*k*53 = *s*A*q*A *hc*,

(number of vertebrate hosts infected by a tick infected as a nymph)

*k*54 = 0,

(female ticks infected while feeding as adults do not feed again and therefore cannot produce vertebrate hosts with a systemic infection)

*k*55 = 0,

(infected vertebrate hosts cannot infect other vertebrate hosts).