Goal: output the mature plant density in each crop phase

# event sequence: seed dropped - chisel - overwinter - field cultivator - emerge - survive - new seed  
  
# create a function   
# vec: starting seed column  
# poh: post-harvest tillage  
# ow: over winter seed survival  
# prt: pre-planting-tillage  
# em: emergence  
# sv: seed survival rate and seedling to maturity success rate  
# seed: fecundity  
  
rot\_2year\_conv <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,  
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S){  
   
 sv\_C[3,3] <- .006 #99.4 % efficacy wrt plant density  
 sv\_C[4,4] <- .006  
 sv\_C[5,5] <- .006  
 # sv\_C[6,6] <- .01  
# sv\_C[7,7] <- .01  
  
  
  
 sv\_S[3,3] <- .006  
 sv\_S[4,4] <- .006  
 sv\_S[5,5] <- .006  
# sv\_S[6,6] <- .01  
# sv\_S[7,7] <- .01  
  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
 list(pl\_dens\_corn, pl\_dens\_soy )  
   
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "seed production in corn", "seed production in soybean")  
# l  
}  
  
rot\_2year\_low <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,  
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S){  
   
   
 sv\_C[3,3] <- .001 #99.9 % efficacy  
 sv\_C[4,4] <- .002  
 sv\_C[5,5] <- .003 # 99.8% efficacy  
  
  
  
  
 sv\_S[3,3] <- .001  
 sv\_S[4,4] <- .002  
 sv\_S[5,5] <- .003  
  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
   
 list(pl\_dens\_corn , pl\_dens\_soy )  
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "seed production in corn", "seed production in soybean")  
# l  
  
}

##### with corn under conventional weed management {-}  
rot\_2year\_conv(vec = starting\_point ,  
 poh\_C = fall\_tillage$C2\_conv,  
 ow\_C = overwinter$C2\_conv,  
 prt\_C = spring\_tillage$C2\_conv,  
 em\_C = emergence$C2\_conv,  
 sv\_C = summer\_survival$C2\_conv,  
 seed\_C = fecundity18$C2\_conv,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S2\_conv,  
 ow\_S = overwinter$S2\_conv,  
 prt\_S = spring\_tillage$S2\_conv,  
 em\_S = emergence$S2\_conv,  
 sv\_S = summer\_survival$S2\_conv,  
 seed\_S = fecundity18$S2\_conv)

## [[1]]  
## [,1]  
## [1,] 3.902680e+03  
## [2,] 2.986379e+03  
## [3,] 7.077919e-03  
## [4,] 7.884992e-02  
## [5,] 1.179103e-04  
## [6,] 7.860689e-04  
## [7,] 7.860689e-04  
## [8,] 1.965172e-04  
##   
## [[2]]  
## [,1]  
## [1,] 1.172918e+03  
## [2,] 2.945745e+03  
## [3,] 5.250905e-01  
## [4,] 1.327683e-01  
## [5,] 3.778692e-02  
## [6,] 6.150368e-01  
## [7,] 1.293138e-02  
## [8,] 1.694780e-02

##### with corn under low herbicide weed management {-}  
rot\_2year\_low(vec = starting\_point ,  
 poh\_C = fall\_tillage$C2\_low,  
 ow\_C = overwinter$C2\_low,  
 prt\_C = spring\_tillage$C2\_low,  
 em\_C = emergence$C2\_low,  
 sv\_C = summer\_survival$C2\_low,  
 seed\_C = fecundity18$C2\_low,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S2\_low,  
 ow\_S = overwinter$S2\_low,  
 prt\_S = spring\_tillage$S2\_low,  
 em\_S = emergence$S2\_low,  
 sv\_S = summer\_survival$S2\_low,  
 seed\_S = fecundity18$S2\_low)

## [[1]]  
## [,1]  
## [1,] 3.869338e+03  
## [2,] 2.986379e+03  
## [3,] 8.838421e-03  
## [4,] 8.873738e-02  
## [5,] 1.252071e-02  
## [6,] 1.206992e-01  
## [7,] 9.627072e-02  
## [8,] 2.291930e-02  
##   
## [[2]]  
## [,1]  
## [1,] 1.149138e+03  
## [2,] 2.820558e+03  
## [3,] 3.433943e-02  
## [4,] 1.619902e-02  
## [5,] 5.240448e-03  
## [6,] 4.388304e-02  
## [7,] 2.402000e-04  
## [8,] 2.402000e-04

rot\_3year\_conv <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,   
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S ,  
 poh\_O, ow\_O, prt\_O, em\_O, sv\_O, seed\_O){  
   
   
 sv\_C[3,3] <- .0001  
 sv\_C[4,4] <- .0001  
 sv\_C[5,5] <- .0001  
 sv\_C[6,6] <- .0001  
 sv\_C[7,7] <- .0001  
 sv\_C[8,8] <- .0001  
  
  
  
 sv\_S[3,3] <- .0001  
 sv\_S[4,4] <- .0001  
 sv\_S[5,5] <- .0001  
 sv\_S[6,6] <- .0001  
 sv\_S[7,7] <- .0001  
 sv\_S[8,8] <- .0001  
   
 ## Extra control efficacy in oat is now needed   
 sv\_O[5,5] <- .01  
 sv\_O[6,6] <- .01  
 sv\_O[7,7] <- .01  
 sv\_O[8,8] <- .01  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
 after\_soy <- ow\_S %\*% poh\_S %\*% seed\_S %\*% sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
 # oat phase dynamics  
 after\_oat <- ow\_O %\*% poh\_O %\*% seed\_O %\*% sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 pl\_dens\_oat <- sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 seed\_dens\_oat <- seed\_O[1,3:8] \* pl\_dens\_oat[3:8]   
   
 list(pl\_dens\_corn , pl\_dens\_soy, pl\_dens\_oat)  
   
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# sum(pl\_dens\_oat[6:8]), sum(pl\_dens\_oat[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy, seed\_dens\_oat)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "oat\_last3", "oat\_total",  
# "seed production in corn", "seed production in soybean", "seed production in oat")  
# l  
}  
  
### low herbicide weed management  
## Manipulation note: if cohorts 1 through 3 were reduced to rlnorm(1, 2.65, 0.89), alphas are around 0.5 --> super "safe", but hard  
## cohorts 1 through 3 at rlnorm(1, 5.2, 0.51): more realistic  
rot\_3year\_low <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,   
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S ,  
 poh\_O, ow\_O, prt\_O, em\_O, sv\_O, seed\_O){  
   
   
   
  
 sv\_C[3,3] <- .0001  
 sv\_C[4,4] <- .003  
 sv\_C[5,5] <- .003  
  
  
  
  
 sv\_S[3,3] <- .0001  
 sv\_S[4,4] <- .003  
 sv\_S[5,5] <- .003  
  
  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
 after\_soy <- ow\_S %\*% poh\_S %\*% seed\_S %\*% sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
 # oat phase dynamics  
 after\_oat <- ow\_O %\*% poh\_O %\*% seed\_O %\*% sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 pl\_dens\_oat <- sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 seed\_dens\_oat <- seed\_O[1,3:8] \* pl\_dens\_oat[3:8]   
   
 list(pl\_dens\_corn , pl\_dens\_soy, pl\_dens\_oat)   
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# sum(pl\_dens\_oat[6:8]), sum(pl\_dens\_oat[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy, seed\_dens\_oat)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "oat\_last3", "oat\_total",  
# "seed production in corn", "seed production in soybean", "seed production in oat")  
# l  
}

rot\_3year\_conv(vec = starting\_point,  
 poh\_C = fall\_tillage$C3\_conv,  
 ow\_C = overwinter$C3\_conv,  
 prt\_C = spring\_tillage$C3\_conv,  
 em\_C = emergence$C3\_conv,  
 sv\_C = summer\_survival$C3\_conv,  
 seed\_C = fecundity18$C3\_conv,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S3\_conv,  
 ow\_S = overwinter$S3\_conv,  
 prt\_S = spring\_tillage$S3\_conv,  
 em\_S = emergence$S3\_conv,  
 sv\_S = summer\_survival$S3\_conv,  
 seed\_S = fecundity18$S3\_conv,  
   
 #oat dynamics   
 poh\_O = fall\_tillage$O3\_conv,  
 ow\_O = overwinter$O3\_conv,  
 prt\_O = spring\_tillage$O3\_conv,  
 em\_O = emergence$O3\_conv,  
 sv\_O = summer\_survival$O3\_conv,  
 seed\_O = fecundity18$O3\_conv)

## [[1]]  
## [,1]  
## [1,] 3.883565e+03  
## [2,] 2.986379e+03  
## [3,] 4.312859e-04  
## [4,] 3.831128e-03  
## [5,] 4.255402e-06  
## [6,] 7.127674e-05  
## [7,] 4.255402e-06  
## [8,] 4.255402e-06  
##   
## [[2]]  
## [,1]  
## [1,] 9.488609e+02  
## [2,] 2.496192e+03  
## [3,] 4.373158e-03  
## [4,] 8.726814e-04  
## [5,] 2.167826e-04  
## [6,] 1.849871e-05  
## [7,] 3.772835e-05  
## [8,] 8.279193e-05  
##   
## [[3]]  
## [,1]  
## [1,] 1.998824e+03  
## [2,] 2.545056e+03  
## [3,] 1.961895e-01  
## [4,] 3.592657e-01  
## [5,] 2.299029e-02  
## [6,] 1.463036e-02  
## [7,] 9.603383e-04  
## [8,] 2.022509e-04

##### with corn under low herbicide weed management {-}   
rot\_3year\_low(vec = starting\_point,  
 poh\_C = fall\_tillage$C3\_conv,  
 ow\_C = overwinter$C3\_low,  
 prt\_C = spring\_tillage$C3\_low,  
 em\_C = emergence$C3\_low,  
 sv\_C = summer\_survival$C3\_low,  
 seed\_C = fecundity18$C3\_low,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S3\_low,  
 ow\_S = overwinter$S3\_low,  
 prt\_S = spring\_tillage$S3\_low,  
 em\_S = emergence$S3\_low,  
 sv\_S = summer\_survival$S3\_low,  
 seed\_S = fecundity18$S3\_low,  
   
 #oat dynamics   
 poh\_O = fall\_tillage$O3\_low,  
 ow\_O = overwinter$O3\_low,  
 prt\_O = spring\_tillage$O3\_low,  
 em\_O = emergence$O3\_low,  
 sv\_O = summer\_survival$O3\_low,  
 seed\_O = fecundity18$O3\_low)

## [[1]]  
## [,1]  
## [1,] 3.795660e+03  
## [2,] 2.986379e+03  
## [3,] 2.592570e-03  
## [4,] 3.385056e-01  
## [5,] 3.206322e-02  
## [6,] 6.689140e-01  
## [7,] 2.191422e-01  
## [8,] 5.476482e-02  
##   
## [[2]]  
## [,1]  
## [1,] 9.912845e+02  
## [2,] 2.545572e+03  
## [3,] 2.861120e-03  
## [4,] 1.685020e-02  
## [5,] 3.924499e-03  
## [6,] 1.468561e-03  
## [7,] 1.319669e-03  
## [8,] 4.279874e-03  
##   
## [[3]]  
## [,1]  
## [1,] 1.785758e+03  
## [2,] 2.402365e+03  
## [3,] 1.892087e-01  
## [4,] 3.311498e-01  
## [5,] 1.092764e+00  
## [6,] 7.289405e-01  
## [7,] 2.412404e-01  
## [8,] 8.188913e-02

### conventional weed management  
rot\_4year\_conv <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,   
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S ,  
 poh\_O, ow\_O, prt\_O, em\_O, sv\_O, seed\_O,  
 poh\_A, ow\_A, prt\_A, em\_A, sv\_A, seed\_A){  
   
 sv\_C[3,3] <- .0001  
 sv\_C[4,4] <- .001  
 sv\_C[5,5] <- .001  
 sv\_C[6,6] <- .005  
 sv\_C[7,7] <- .005  
 sv\_C[8,8] <- .005  
  
  
  
 sv\_S[3,3] <- .0001  
 sv\_S[4,4] <- .001  
 sv\_S[5,5] <- .001  
 sv\_S[6,6] <- .005  
 sv\_S[7,7] <- .005  
 sv\_S[8,8] <- .005  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
 after\_soy <- ow\_S %\*% poh\_S %\*% seed\_S %\*% sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
 # oat phase dynamics  
 after\_oat <- ow\_O %\*% poh\_O %\*% seed\_O %\*% sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 pl\_dens\_oat <- sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 seed\_dens\_oat <- seed\_O[1,3:8] \* pl\_dens\_oat[3:8]   
 # alfalfa phase dynamics  
 after\_alfalfa <- ow\_A %\*% poh\_A %\*% seed\_A %\*% sv\_A %\*% em\_A %\*% prt\_A %\*% after\_oat   
   
 pl\_dens\_alfalfa <- sv\_A %\*% em\_A %\*% prt\_A %\*% after\_oat   
   
 seed\_dens\_alfalfa <- seed\_A[1,3:8] \* pl\_dens\_alfalfa[3:8]  
   
 list(pl\_dens\_corn , pl\_dens\_soy, pl\_dens\_oat, pl\_dens\_alfalfa)  
   
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# sum(pl\_dens\_oat[3:8]), sum(pl\_dens\_alfalfa[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy, seed\_dens\_oat, seed\_dens\_alfalfa)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "oat\_total", "alfalfa\_total",  
# "seed production in corn", "seed production in soybean",  
# "seed production in oat", "seed production in alfalfa")  
# l  
   
}  
  
### low herbicide weed management  
rot\_4year\_low <- function(vec, poh\_C, ow\_C, prt\_C, em\_C, sv\_C, seed\_C,   
 poh\_S, ow\_S, prt\_S, em\_S, sv\_S, seed\_S ,  
 poh\_O, ow\_O, prt\_O, em\_O, sv\_O, seed\_O,  
 poh\_A, ow\_A, prt\_A, em\_A, sv\_A, seed\_A){  
 sv\_C[3,3] <- .0001  
 sv\_C[4,4] <- .001  
 sv\_C[5,5] <- .009  
 sv\_C[6,6] <- .05  
  
  
  
  
 sv\_S[3,3] <- .0001  
 sv\_S[4,4] <- .001  
 sv\_S[5,5] <- .009  
 sv\_S[6,6] <- .05  
   
 # corn phase dynamics   
 after\_corn <- ow\_C %\*% poh\_C %\*% seed\_C %\*% sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
   
 pl\_dens\_corn <- sv\_C %\*% em\_C %\*% prt\_C %\*% vec   
 seed\_dens\_corn <- seed\_C[1,3:8] \* pl\_dens\_corn[3:8]  
 # soybean phase dynamics  
 after\_soy <- ow\_S %\*% poh\_S %\*% seed\_S %\*% sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn  
   
 pl\_dens\_soy <- sv\_S %\*% em\_S %\*% prt\_S %\*% after\_corn   
   
 seed\_dens\_soy <- seed\_S[1,3:8] \* pl\_dens\_soy[3:8]   
   
 # oat phase dynamics  
 after\_oat <- ow\_O %\*% poh\_O %\*% seed\_O %\*% sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 pl\_dens\_oat <- sv\_O %\*% em\_O %\*% prt\_O %\*% after\_soy   
   
 seed\_dens\_oat <- seed\_O[1,3:8] \* pl\_dens\_oat[3:8]   
 # alfalfa phase dynamics  
 after\_alfalfa <- ow\_A %\*% poh\_A %\*% seed\_A %\*% sv\_A %\*% em\_A %\*% prt\_A %\*% after\_oat   
   
 pl\_dens\_alfalfa <- sv\_A %\*% em\_A %\*% prt\_A %\*% after\_oat   
   
 seed\_dens\_alfalfa <- seed\_A[1,3:8] \* pl\_dens\_alfalfa[3:8]   
  
 list(pl\_dens\_corn , pl\_dens\_soy, pl\_dens\_oat, pl\_dens\_alfalfa)  
   
 # seed at harvest  
# l <- list(sum(pl\_dens\_corn[3:5]), sum(pl\_dens\_corn[3:8]),  
# sum(pl\_dens\_soy[3:5]), sum(pl\_dens\_soy[3:8]),  
# sum(pl\_dens\_oat[3:8]), sum(pl\_dens\_alfalfa[3:8]),  
# seed\_dens\_corn, seed\_dens\_soy, seed\_dens\_oat, seed\_dens\_alfalfa)  
# names(l) <- c("corn\_first3", "corn\_total",  
# "soybean\_first3", "soybean\_total",   
# "oat\_total", "alfalfa\_total",  
# "seed production in corn", "seed production in soybean",  
# "seed production in oat", "seed production in alfalfa")  
# l  
}

##### with corn under conventional weed management {-}  
rot\_4year\_conv(vec = starting\_point,  
 poh\_C = fall\_tillage$C4\_conv,  
 ow\_C = overwinter$C4\_conv,  
 prt\_C = spring\_tillage$C4\_conv,  
 em\_C = emergence$C4\_conv,  
 sv\_C = summer\_survival$C4\_conv,  
 seed\_C = fecundity18$C4\_conv,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S4\_conv,  
 ow\_S = overwinter$S4\_conv,  
 prt\_S = spring\_tillage$S4\_conv,  
 em\_S = emergence$S4\_conv,  
 sv\_S = summer\_survival$S4\_conv,  
 seed\_S = fecundity18$S4\_conv,  
   
 #oat dynamics   
 poh\_O = fall\_tillage$O4\_conv,  
 ow\_O = overwinter$O4\_conv,  
 prt\_O = spring\_tillage$O4\_conv,  
 em\_O = emergence$O4\_conv,  
 sv\_O = summer\_survival$O4\_conv,  
 seed\_O = fecundity18$O4\_conv,  
   
 #alfalfa dynamics   
 poh\_A = fall\_tillage$A4\_conv,  
 ow\_A = overwinter$A4\_conv,  
 prt\_A = spring\_tillage$A4\_conv,  
 em\_A = emergence$A4\_conv,  
 sv\_A = summer\_survival$A4\_conv,  
 seed\_A = fecundity18$A4\_conv)

## [[1]]  
## [,1]  
## [1,] 3.682504e+03  
## [2,] 2.986379e+03  
## [3,] 3.357335e-03  
## [4,] 3.142233e-01  
## [5,] 3.467879e-04  
## [6,] 1.733939e-03  
## [7,] 1.733939e-03  
## [8,] 1.733939e-03  
##   
## [[2]]  
## [,1]  
## [1,] 1.405324e+03  
## [2,] 3.205207e+03  
## [3,] 1.694461e-04  
## [4,] 3.427786e-04  
## [5,] 8.506217e-06  
## [6,] 2.868225e-04  
## [7,] 2.868225e-04  
## [8,] 2.868225e-04  
##   
## [[3]]  
## [,1]  
## [1,] 6.178561e+02  
## [2,] 1.774744e+03  
## [3,] 1.218406e-02  
## [4,] 3.442758e-02  
## [5,] 1.164518e-01  
## [6,] 6.676019e-02  
## [7,] 4.140618e-02  
## [8,] 3.992300e-03  
##   
## [[4]]  
## [,1]  
## [1,] 185.71110213  
## [2,] 964.28474241  
## [3,] 4.27734941  
## [4,] 9.61916729  
## [5,] 0.08169891  
## [6,] 7.28996751  
## [7,] 1.76041328  
## [8,] 0.48426428

##### with corn under low herbicide weed management {-}   
rot\_4year\_low(vec = starting\_point,  
 poh\_C = fall\_tillage$C4\_low,  
 ow\_C = overwinter$C4\_low,  
 prt\_C = spring\_tillage$C4\_low,  
 em\_C = emergence$C4\_low,  
 sv\_C = summer\_survival$C4\_low,  
 seed\_C = fecundity18$C4\_low,  
   
 #soybean dynamics   
 poh\_S = fall\_tillage$S4\_low,  
 ow\_S = overwinter$S4\_low,  
 prt\_S = spring\_tillage$S4\_low,  
 em\_S = emergence$S4\_low,  
 sv\_S = summer\_survival$S4\_low,  
 seed\_S = fecundity18$S4\_low,  
   
 #oat dynamics   
 poh\_O = fall\_tillage$O4\_low,  
 ow\_O = overwinter$O4\_low,  
 prt\_O = spring\_tillage$O4\_low,  
 em\_O = emergence$O4\_low,  
 sv\_O = summer\_survival$O4\_low,  
 seed\_O = fecundity18$O4\_low,  
   
 #alfalfa dynamics   
 poh\_A = fall\_tillage$A4\_low,  
 ow\_A = overwinter$A4\_low,  
 prt\_A = spring\_tillage$A4\_low,  
 em\_A = emergence$A4\_low,  
 sv\_A = summer\_survival$A4\_low,  
 seed\_A = fecundity18$A4\_low)

## [[1]]  
## [,1]  
## [1,] 3.130943e+03  
## [2,] 2.986379e+03  
## [3,] 1.781759e-02  
## [4,] 8.238826e-01  
## [5,] 5.477131e-01  
## [6,] 2.373091e+00  
## [7,] 1.575220e+00  
## [8,] 3.809348e-01  
##   
## [[2]]  
## [,1]  
## [1,] 1.381087e+03  
## [2,] 3.164443e+03  
## [3,] 1.332110e-04  
## [4,] 4.214246e-04  
## [5,] 1.765902e-03  
## [6,] 4.732304e-03  
## [7,] 9.464608e-04  
## [8,] 1.200767e-03  
##   
## [[3]]  
## [,1]  
## [1,] 6.243753e+02  
## [2,] 1.763170e+03  
## [3,] 1.311375e-02  
## [4,] 3.198580e-02  
## [5,] 1.126833e-01  
## [6,] 7.052345e-02  
## [7,] 6.011809e-02  
## [8,] 2.837505e-02  
##   
## [[4]]  
## [,1]  
## [1,] 242.3445075  
## [2,] 957.9959509  
## [3,] 4.6176739  
## [4,] 10.3023794  
## [5,] 0.1527075  
## [6,] 7.8236699  
## [7,] 2.2022349  
## [8,] 0.8441708