University of Basel

One Health: Connecting Humans, Animals and the Environment
Video Transcript

Solving the formula, part 2: Check your calculations

[Jakob Zinsstag]: Welcome back. So, after you have finished calculating to the year 21, you see that the growth stabilises after year 10. To visualise this, create now the sum of all animals for every time interval and calculate the relative proportion of each class-- calves, heifers, cows-- to the total population. This yields the normed Eigenvector. You see that the normed Eigenvector oscillates at the beginning but becomes stable after about 10 iterations. We say the population composition is in equilibrium. Divide now the total population of year 1 by the one of year 0. This yields the Eigenvalue.

To continue, you have to divide the sum of year 2 by the sum of year 1, and so on. Strictly speaking, the calculation of the Eigenvalue is more complicated, and we refer to general matrix calculus. You should now have values as presented here. The growth rate oscillates at the beginning and becomes stable. The stable growth rate is called the ’Eigenvalue.‘ We say the population structure is in equilibrium. This does not mean that the population does not grow, but the proportions of the age classes are stable. You can calculate the total population growth with the formula ’P equal to P at time 0 times e to the power of lambda times t‘. You don't have to understand this completely. We just want to show that the growth will be a little bit faster because the population vector doesn't have to equilibrate, as you can see in this figure.

You have now applied a matrix model to a livestock population. Try different birth and survival rates to see how the population growth changes. This is how we estimate losses of productivity from disease. The most interesting property of matrix models is that they tend to equilibrate around Eigenvalue and Eigenvector. Bear in mind that this is only a three-dimensional vector. More complex matrix models become very delicate and may not necessarily equilibrate and may turn into deterministic chaos. For our purpose, which is to simulate livestock production, most of the time we stay in parameter ranges that lead to stable herd structures, allowing us to compare different influencing factors like disease control.