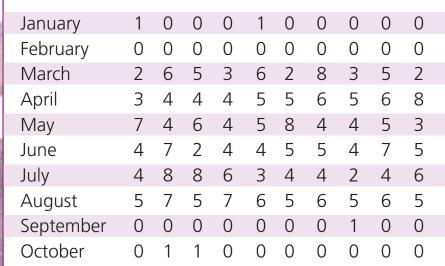A simulation is a model of a real situation and can be used to estimate the population growth of animal pests to help farmers plan for the future.

Number of rabbits born each month last year for 10 female rabbits

January	1	0	0	0	1	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0
March	2	6	5	3	6	2	8	3	5	2
April	3	4	4	4	5	5	6	5	6	8
May	7	4	6	4	5	8	4	4	5	3
June	4	7	2	4	4	5	5	4	7	5
July	4	8	8	6	3	4	4	2	4	6
August	5	7	5	7	6	5	6	5	6	5
September	0	0	0	0	0	0	0	1	0	0
October	0	1	1	0	0	0	0	0	0	0

Analyse last year's monthly birth data.

Develop a probability model and design a simulation to model the birth of rabbits over two years.

Female rabbits are 4 months old when they first give birth and they have a **litter every month**.

growing food

growing food

MONTH	Number of mature females.	Number of rabbits per litter.	Number of baby males per litter.	Number of baby females per litter.	Total baby males.	Total baby females.	Month newly born females will give birth.
START	1	–	–	–	–	–	–
January	1						
February							
March							
April							
May							
June							
July							
August							
September							
October							
November		0	0	0	0	0	**March**
December		0	0	0	0	0	**April**

Assume all births occur on the first day of the month. The first birth is on the 1st January.

Rabbits   **Rabbit rabbit rabbit simulation recording sheet year 1**

MONTH	Number of mature females.	Number of rabbits per litter.	Number of baby males per litter.	Number of baby females per litter.	Total baby males.	Total baby females.	Month newly born females will give birth.
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							

Rabbits: Rabbit rabbit rabbit simulation

Rabbit, rabbit, rabbit | **Help**

Year	Month	Number of mature females	Number of Rabbits per litter	Number of baby males per litter	Number of baby females per litter	Total baby males (Cumulative)	Total baby females (Cumulative)	The Month newly born females will give birth
1	January	1	2	1	1	1 (1)	1 (1)	May
1	February	1	1	1	0	1 (2)	0 (1)	June
1	March	1	1	0	1	0 (2)	1 (2)	July
1	April	1	2	1	1	1 (3)	1 (3)	August
1	May	2	2	1	1	2 (5)	2 (5)	September
1	June	2	2	0	2	0 (5)	4 (9)	October
1	July	3	2	0	2	0 (5)	6 (15)	November
1	August	4	2	1	1	4 (9)	4 (19)	December
1	September	6	2	1	1	6 (15)	6 (25)	January
1	October	10	2	1	1	10 (25)	10 (35)	February
1	November	16	2	1	1	16 (41)	16 (51)	March
1	December	20	2	1	1	20 (61)	20 (71)	April

Growing food : Rabbits

Description

A probability model is developed from historical data which is then used to simulate the breeding of rabbits in a field and consider the likely damage to the farmer's crop.

Activity 1: Rabbit rabbit rabbit

In Rabbit rabbit rabbit pupils estimate the number of rabbits born during a two year period starting with one female rabbit giving birth on 1st January. Their estimates are based on monthly data on the number of births from 10 female rabbits from the previous year. The activity begins with an analysis of this historical data, for example, to find the average number of births for the whole year, to find the total for each number of births, to find the monthly totals and so on. There are a range of probability models which can lead to a good estimate of next year's rabbit population. A whole class discussion will be helpful to assess on what information from the historical data a predictive model could be based and to devise together a good probability model. One possible model is developed here.

This model is based on the frequencies of the litter sizes. Pupils working with this model begin by choosing a way to represent the chances of a litter size when randomly chosen. There are 120 bits of data and the numbers have been chosen to allow them to be modelled, for example, by picking from a set of 20 appropriately numbered tokens.

0	0	0	0	0
0	0	1	2	3
4	4	4	5	5
5	6	6	7	8

This raises an opportunity to discuss proportionality and its role in representing a large set of data by a smaller one.

The model can be refined by separating out January, February, September and October from the other months so that there are two probability models at work. The data becomes unwieldy if a different litter size is assigned to each female rabbit – for each month assume that females have the same size litter with the same gender split. Your pupils will have to think about how to assign a gender to each newly born rabbit, perhaps by tossing sets of coins – tossing 8 coins where the litter size is 8 and so on. It will be helpful to have pupils working in groups of three – one to select the litter size, one to determine the gender distribution and one to record the results. Running the simulation is a challenging organisational task and the recording sheets are designed to help the pupils keep track of births, the number of males and females and the maturity of the rabbits. All members of the group should take responsibility for making sure that the calculations are correct and properly recorded.

Growing food : Rabbits

Ask your pupils to run a simulation over two years starting with one female rabbit giving birth on the 1st January and assuming that female rabbits can give birth every month when sexually mature. Pupils should record their results on Rabbit rabbit rabbit simulation recording sheet Year 1 and Rabbit rabbit rabbit simulation recording sheet Year 2.

The results might look like this:

Support your pupils in analysing their results to show how the rabbit population is increasing and to think about the damage they might cause. Rabbits eat approximately 0.5kg of food per day.

Using a spreadsheet and plotting a bar graph to show the number of rabbits each month is a good way to see how the population is growing. Compare and contrast the outcomes from the different groups – there are likely to be considerable differences.

This should provoke discussion about the difficulty of basing decisions for action on predictive probability models both in agriculture and more generally.

MONTH	Number of mature females.	Number of rabbits per litter.	Number of baby males per litter.	Number of baby females per litter.	Total baby males.	Total baby females.	Month newly born females will give birth.
START	1	–	–	–	–	–	–
January	1	1	0	1	0	1	May
February	1	3	1	2	1	2	June
March	1	5	2	3	2	3	July
April	1	4	4	0	4	0	August
May	2	3	1	2	2	4	September
June	4	6	4	2	16	8	October
July	7						

Encourage discussion about the limitations of the simulation. For example, it does not take account of rabbit deaths. Ask your pupils to predict how the rabbit population might be affected if this factor is taken into consideration before re-running the simulation using the Rabbit rabbit rabbit simulation spreadsheet. Probabilities for the litter size, gender and deaths can be varied on the spreadsheet.

The mathematics

In this activity pupils analyse data and work with probabilities and probability models, draw bar graphs and compare results.