

The agricultural economic impact of the 1859 introduction of European rabbits (*Oryctolagus cuniculus*) to Australia

Research Question: To what extent has the introduction of European rabbits (*Oryctolagus cuniculus*) in Australia has affected GDP from agriculture.

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Introduction:

Discovered nearly 10,000 years ago, agriculture has been a core part for the human life to this day. In less economically developed countries, agriculture is a necessity for a large fraction of that country's people. This is because, agriculture provides food as well as income for the people to make a living. So, agriculture starts to be a part of the economy of that country. As a country starts to grow economically, it starts to utilize other varied branches such as industry, exportation, importation, businesses etc. In the case of Australia which present in the southern hemisphere, and which is a country and a continent that was founded by British colonies in 1788 and gained independence in 1901, is not so different from this. Even though it was founded by the already goliath Kingdom of Great Britain and has resources beyond imagining to, Australia's prone to agriculture. This is because of its great biodiversity climate, different soil types and large agricultural areas. To this day Agriculture is still a part of the Australian economy. In 2020-2021 12% of goods and services exports and 55% of Australian land use and 24% of water extractions were accounted for by Australian agriculture. (*Snapshot of Australian agriculture 2022*)

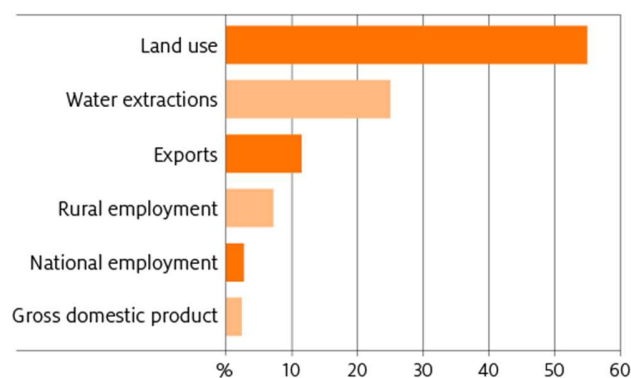


Figure 1: Selected contributions of agriculture in Australia

Because of my family history consisting of mainly farmers and done work relevant to agriculture, I have been exposed to various branches, important matters about agriculture. One of this was the presence of invasive species. Which was also handled in the Environmental Systems and Societies lesson. I have known and witnessed the various consequences and outcomes of invasive species firsthand which caused the crops of my granddad to die and get destroyed. Therefore, I decided to focus on how invasive species can affect the agricultural economy of a country, how that country resolved this issue and how the outcomes of these actions were for that country.

1.1 European Rabbits (*Oryctolagus cuniculus*) in Australia:

1.1.2 Ecology About European Rabbits (*Oryctolagus cuniculus*):

European rabbits are a rabbit species native mainly to Spain, Portugal, and southwestern France, western France, and the northern Atlas Mountains in northwest Africa. These European rabbits are considered as invasive species (Department of Jobs, Precincts and Regions *European rabbit*) (for more information see 1.1.3). As a result of them being invasive species and them being introduced to the continent and country of Australia, they can be found at many different habitats all across Australia, from deserts to coastal areas, where they can dig their living tunnels. These rabbits dig small connecting tunnels (called warren) to live inside when they are not hunting for food. They are scarce in areas with clay soily and abundant where soils are deep and sandy, such as in the north-east of South Australia (*European rabbit* *Animalia*).

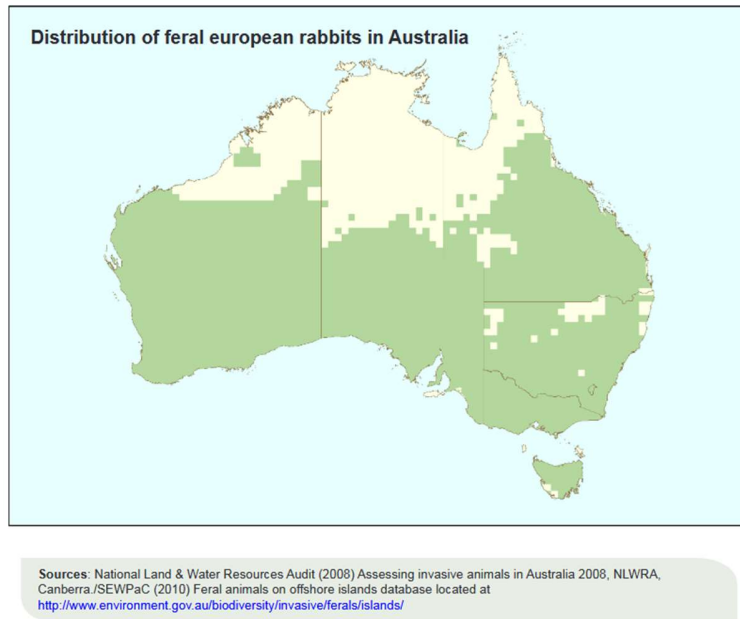


Figure 2: Distribution of European rabbits across Australia

In figure 2, we can see how the rabbits have spread through the southern parts of Australia. European rabbits, usually live in tropical and temperate climate habitat (*European rabbit Animalia*). In the southern parts of Australia, temperate and tropical forest climates are widespread. European rabbits like many rabbit species have a very high birth rate. Does, which are the female rabbits, give birth to between 3-7 rabbits after their gestation period of 30 days. (*European rabbit Animalia*) These rabbits are grazers. They mainly eat green grass and herbs. They also dig around to reach some roots and seeds to eat.



Figure 3: A photo of a European rabbit (Oryctolagus cuniculus)

1.1.3 Background Information About Invasive Species:

European rabbits are ranked as invasive species (Department of Jobs, Precincts and Regions *European rabbit*). To understand the severity of this situation, the meaning of invasive species should be talked about. An invasive species is an organism that causes ecological or economic harm in a new environment where it is not native. Invasive species can harm both the natural resources in an ecosystem as well as threaten human use of these resources. An invasive species can be introduced to a new area via the ballast water of oceangoing ships, intentional and accidental releases of aquaculture species, aquarium specimens or bait, and other means. Invasive species can cause extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats (US Department of Commerce *What is an invasive species?*). This affects both the environmental systems and can have huge the economic impacts. To prevent these invasive species from doing any harm to the environment and the species living in it, their population must be kept under control and be kept under a level where they will no longer be considered as a threat to the environment.

1.1.4 How were European rabbits introduced to Australia:

In 1859, European rabbits were brought to Australia and set free into the wilderness to be hunted by wealthy settlers. Rabbits have an extremely high reproductive rate, with a single pair of rabbits being able to increase to 184 individuals within 18 months (*How European rabbits took over Australia*). With their release the rabbits started to rapidly reproduce, these European rabbits scattered across the entire continent of Australia. Approximately 60 years later, the European rabbit population was estimated to be nearly 10 billion which inhabits almost 70% of the Australian continent which is around 5.3 million km². It was possible to spot rabbits from almost everywhere. With this invasion came consequences for the people residing in Australia which will be seen from 1860s to present day.

1.1.5 The Destruction Caused by the European Rabbits to the Environment:

Ecological Damage

The rabbits in Australia do not have any natural predators and are able to reproduce at an alarming rate, leading to an overpopulation problem that has caused widespread ecological damage. The overgrazing of pastures has resulted in soil erosion, increased weed growth, and reduced soil fertility, leading to a decline in the overall health of the ecosystem. This has also had a negative impact on the native animals, many of whom depend on the natural habitat that is being destroyed by the rabbits. For instance, the destruction of the vegetation has caused erosion and siltation of rivers, streams, and wetlands, resulting in a decline in water quality and a loss of habitat for fish and other aquatic life.

Damage to Agriculture

Rabbits also pose a significant threat to crops. They are known to eat a wide range of crops, including wheat, barley, and vegetables. This can lead to significant crop losses, particularly for farmers who rely on a single crop or a small range of crops. For example, a single rabbit population can completely decimate a lettuce crop, leaving farmers with nothing to sell.

The damage caused by rabbits is not limited to the crops themselves. When rabbits feed on crops, they can also damage the roots and stem of the plants, which can weaken or kill the crop. This damage can lead to reduced yields, making it harder for farmers to make a living. Rabbits also create pathways through crops, which can lead to soil erosion and further damage to crops.

(DCCEEW Feral European Rabbit)

In addition to direct damage to crops and land, rabbits can also cause significant financial losses for farmers. The cost of controlling rabbit populations can be substantial, and many farmers have to spend large sums of money on fencing, pesticides, and other measures to keep rabbits away from their crops. This cost can be particularly high for small-scale farmers who do not have access to the same resources as larger agribusinesses.

The impact of rabbits on Australia's agriculture is not limited to the current farming standards. The damage they have caused over the past century has led to significant environmental damage, and this damage can continue for decades or even centuries. For example, overgrazing by rabbits can lead to soil erosion, which can reduce the quality of soil for future generations. This, in turn, can lead to reduced yields and lower profitability for farmers in the future. *(DCCEEW Feral European Rabbit)*

Destruction of Native Flora and Fauna

The rabbit population in Australia has had a profound impact on native flora and fauna. The destruction of vegetation by rabbits has led to the loss of habitat and food sources for many native species, resulting in a decline in their populations. The lack of vegetation also contributes to soil erosion, which can further damage the ecosystem. This has led to a significant decline in the biodiversity of Australia, with many species now at risk of extinction.

In addition, rabbits are known to consume the bark and leaves of trees, which can lead to the death of entire forests. This has a cascading effect on the ecosystem, as the loss of forests leads to changes in the composition of the soil, water quality, and other ecological factors. This can also have a negative impact on the overall health of the ecosystem and contribute to the loss of biodiversity.

1.1.6 How the Australian Government Tried To Solve This Issue:

With the rabbit population increasing constantly, the damages that were identified in 1.1.5 have also increased and with this increase, the agricultural economy of Australia also took a hit. To protect the farmers and the agriculture on their lands from receiving many more damage and to protect their agricultural economy, the government has taken action in various ways.

The first attempt to control the rabbit population in Australia was through the introduction of predators, such as foxes and feral cats. However, this strategy was largely ineffective, as the predators also preyed on native species and were unable to keep up with the rapid reproductive rate of rabbits. In the early 1950s, the myxoma virus was introduced, which caused a dramatic decline in the rabbit population. The virus was initially successful in reducing the rabbit

population, but the rabbits eventually developed immunity to the virus, and its effectiveness diminished over time.

In the 1990s, a new virus known as the calicivirus was introduced to control the rabbit population. The virus was originally discovered in Europe and was introduced to Australia illegally by farmers seeking to control the rabbit population on their own properties. The virus quickly spread throughout the country, and by 1996, it had reduced the rabbit population by over 90 percent in some areas. However, the calicivirus also had unintended consequences, such as the death of native animals that ate the infected rabbit carcasses.

In addition to biological control methods, the Australian government also implemented physical barriers to prevent rabbits from spreading. Rabbit-proof fencing was first introduced in the early 1900s and was designed to prevent rabbits from moving into new areas. The fencing was initially successful in containing the rabbit population, but it eventually became expensive to maintain and was largely replaced by other control methods.

Today, the Australian government continues to implement a range of measures to control the rabbit population, including biological control methods and physical barriers. The use of biological control methods has become more targeted and refined, with research focused on developing more effective viruses and improving the delivery methods of these viruses to rabbit populations. Physical barriers, such as electric fencing, have also become more popular in recent years, particularly in rural areas where rabbits are most prevalent. (*Pest animals*)

2. Method of Investigation:

To investigate this research question, it is not possible to get and use any primary data to lead to a conclusion. The secondary data collection will involve a review of academic literature, government reports, and industry data. The sources will be identified through a systematic search of online databases and libraries, including Google Scholar, JSTOR, and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). The data collected from these sources will be used to provide context and background information on the topic and to support the findings of the primary research. The results of the data analysis will be presented using tables, charts, and graphs to help visualize the findings. The findings will be discussed in relation to the research question and existing literature on the topic.

Limitations:

The study may be limited by the availability and quality of data sources. While the study will aim to use the most up-to-date and reliable sources of data, there may be gaps in the data or discrepancies between different data sources.

Another limitation is the scope of the study, which focuses specifically on the effects of rabbits on the agricultural economy. Other factors, such as climate change, extreme weather events, and changes in global markets, may also impact the agricultural sector and need to be considered in a broader analysis. Furthermore, the study may not be able to capture the full range of impacts that rabbits have had on different types of crops and agricultural practices. Some farmers may have developed strategies to mitigate rabbit damage or may have adapted their farming practices in response to the presence of rabbits. The study may not be able to capture these nuances without a more detailed analysis of specific agricultural practices and regions.

A further limitation is the potential for confounding variables in the data. For example, the relationship between rabbit populations and crop yields may be influenced by factors such as soil quality, irrigation practices, and pest management strategies. The study will seek to control for these variables to the extent possible by including questions on these topics in the survey and interviews and by reviewing relevant literature on agricultural practices.

3. Data and Analysis:

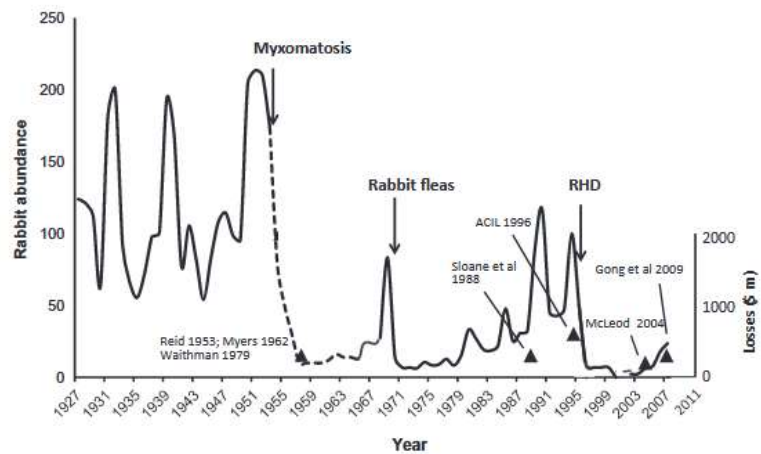


Figure 4: A graph showing the number of rabbits in Australia from 1927 to 2011.

GDP from Agriculture in Australia decreased to 14364 AUD Million in the fourth quarter of 2022 from 14742 AUD Million in the third quarter of 2022. source: Australian Bureau of Statistics

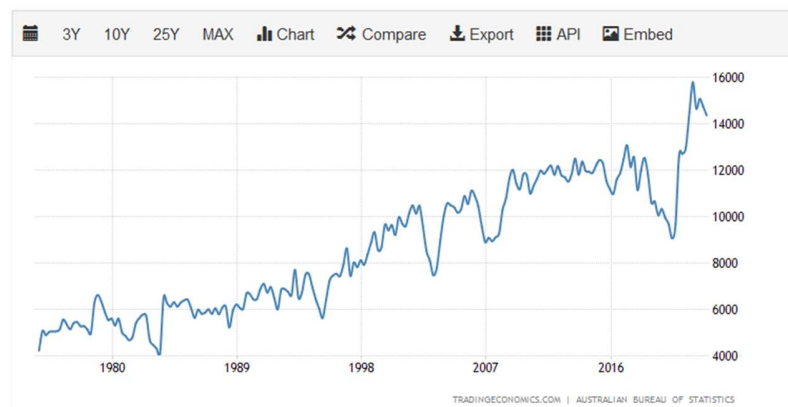


Figure 5: GDP from Agriculture in Australia decreased to 14364 AUD Million in the fourth quarter of 2022 from 14742 AUD Million in the third quarter of 2022.

With the following figures that were given above, it is possible to get an estimate values of both the rabbit abundance and the Agricultural GPD of Australia. With this we can create a raw data table and have data for us to analyse.

Raw Data:

Years	Rabbit Abundance (in millions)
1979	~10
1983	~15
1987	~19
1991	~40
1995	~100

Table 1: Rabbit Abundance Over the Years (1979-1983-1987-1991-1995)

Years	Agricultural GPD (in million \$ dollars)
1979	~5500
1983	~5700
1987	~6100
1991	~6000
1995	~7700

Table 2: Agricultural GPD of Australia Over the Years (1979-1983-1987-1991-1995)

With the raw data provided, we can conduct a T-Test to have a representation of their correlation with each other.

To perform a t-test, we need to calculate the means, standard deviations, and sample sizes for each group. From the data we gathered, we can calculate the following:

Group 1 (Rabbit Numbers)

- Mean: 36.8
- Standard deviation: 38.5
- Sample size: 5

Group 2 (Agricultural GDP)

- Mean: 6200
- Standard deviation: 962.25
- Sample size: 5

We can now perform a two-sample t-test using these values. Since we are using a significance level of 0.05, we will use a two-tailed test.

The null hypothesis is that there is no significant difference between the means of the two groups. The alternative hypothesis is that there is a significant difference between the means of the two groups.

Using a t-test calculator, we get a t-value of -0.3024 and a p-value of 0.7704. Since the p-value is greater than 0.05, we fail to reject the null hypothesis.

Therefore, based on the data provided, we can conclude that there is no significant difference between the rabbit number and agricultural GDP in the two groups.

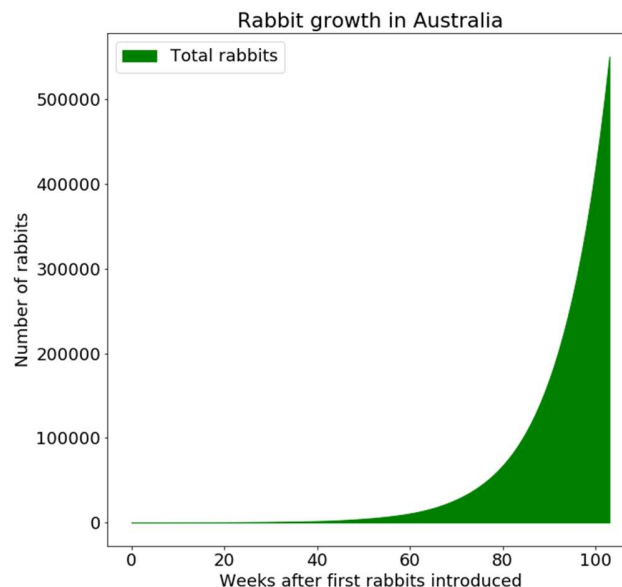


Figure 6: Graph of the rabbit growth in Australia for the hundred weeks since their introduction.

From figure 4, we can interpret that under nearly 2 years the population of rabbits has increased drastically reaching more than five hundred thousand rabbits. According to ABARES (Australian Government's Department of Agriculture, Water and the Environment) currently there are between 200-300 million rabbits in Australia.

With the percent change equation we can find the annual percent growth rate of European rabbits population in Australia;

$$\text{Percent Change} = 100 \times \frac{\text{Present Value} - \text{Past Value}}{\text{Past Value}}$$
$$100 \times \frac{(250000000 - 500000)}{500000} = 49900$$

With this percent change value we can find the annual percent growth rate;

$$\frac{\text{Percent Change}}{\text{Number of Years}} = \frac{49900}{164} = 304.268\%$$

If this annual percent growth rate remains the same, the destruction caused by the European rabbits will eventually have irreversible damage to both the environment and the agricultural economy of Australia.

For a living species, such as European rabbits, their population will definitely have rises and falls in their populations. There are various factors at play here such as;

- Predation: Predators can significantly reduce the population of a species if they are not able to defend themselves or if their numbers are already low due to other factors.
- Habitat destruction: The destruction of natural habitats can limit the resources available to a species, leading to a decline in population size.

- Disease: Disease outbreaks can cause significant mortality in a population and reduce the reproductive success of individuals.
- Competition: Competition for resources such as food, water, and shelter can limit the size of a population, particularly if the competition is intense.
- Environmental changes: Changes in temperature, rainfall, and other environmental factors can impact the survival and reproduction of a species.
- Availability of resources: The availability of resources such as food, water, and shelter can have a direct impact on the growth and reproduction of a population. A lack of resources can lead to decreased survival and reproduction rates.

Other than these, factors there have also been influences made by the Australian government to balance the population of rabbits. In figure 5 between 1951 and 1955 a virus called the Myxoma virus (MV) was used to reduce their population. From the abundance of approximately 170 it has fallen down to below 50. Even though this worked, after 1967, there was a surge in the rabbit population. To solve this the Australian government used Rabbit fleas (*Spilopsyllus cuniculli*) which carries various diseases that could lower the population. Between 1971 and 1991 there have been small increases, but no reaction from the government. After 199 the government used RHD(rabbit hemorrhagic disease) which is a highly contagious disease virus that causes rabbits to have a sudden death, fever, hesitance to eat or show respiratory and nervous problems.

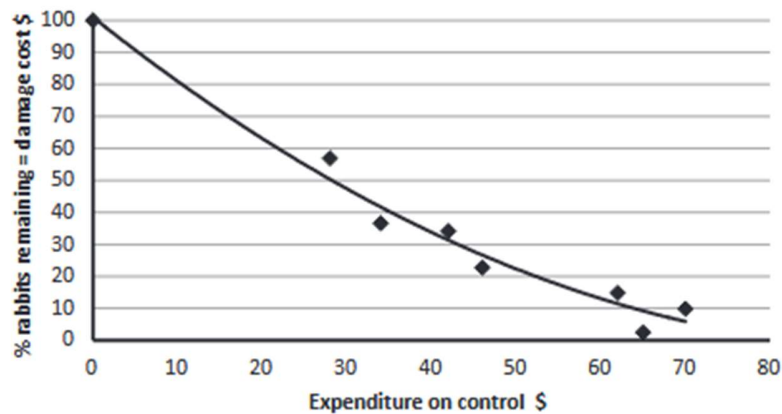


Figure 7: Damage cost in dollars by European rabbits vs. Expenditure on control in dollar graph

With these actions, the government is spending millions of dollars to reduce their population. Even though, million were being spent, after some time the destruction and damage caused by the rabbits have started to decrease. Resulting in, reducing the economical impact on the agriculture industry in Australia. With the economical impact lessening, more agriculture can start being done on land where the rabbits have invaded and were living on.

With figure 5, we can see that after 1950s, there has been a steady growth in GDP of Australia. If we take the decrease of the rabbit population, and this leading to agriculture being improved and saved, we can assume that with their correlations, that the expensive actions that the government have taken were a success.

For LEDCs (less economically developed countries) agriculture is the main source of income, in which they grow animals and crops and consume themselves and sell internationally. For MEDCs (more economically developed countries), such as Australia, there are lots of sectors, such as Industry. It can be supposed that agriculture has fallen off as an important sector.

Even though there is a trend about the decreasing percentage of agriculture, it is still an influential area to its economy.

4. Conclusion

In conclusion, the introduction of European rabbits to Australia has had a profound impact on the country's agricultural economy. The rabbits have caused widespread damage to crops and pastures, resulting in significant economic losses for farmers and the wider economy. The government has taken a range of actions to address this issue, including the introduction of biological control methods, and the development of new technologies to control rabbit populations. While these efforts have been successful to some extent, there are still challenges to be overcome in managing the rabbit population and mitigating the impact on the environment and the economy.

The data and analysis presented in this essay have highlighted the complex interactions between ecological, economic, and social factors that influence the population dynamics of the European rabbit in Australia. The introduction of the rabbit has created a situation where the environment, economy, and society are all affected in various ways. On the one hand, the rabbits have caused significant economic losses for farmers and the wider economy, leading to the implementation of various control strategies. On the other hand, the control methods themselves have raised concerns about their environmental impact and their effects on animal welfare. Rabbits have caused damage to crops and pastures, leading to decreased productivity and increased costs for farmers. They have also impacted natural ecosystems by altering vegetation patterns and reducing biodiversity.

However, these control methods are not without their limitations and drawbacks. There are concerns about the long-term effectiveness of biological control methods, particularly in the face of evolving rabbit populations. Additionally, there are concerns about the environmental impact of some control methods, particularly in relation to non-target species. There are also ethical concerns related to the use of certain control methods, such as poisoning or shooting, which can cause suffering for rabbits and other animals.

In light of these complex issues, it is clear that managing the rabbit population in Australia is not a simple task. It requires a holistic approach that takes into account the ecological, economic, social, and cultural dimensions of the problem. While the government's control strategies have had some success, there is still much to be done to ensure the long-term sustainability of rabbit control in Australia. This may require the development of new, more innovative approaches that take into account the changing nature of the rabbit population and its impact on the environment and the economy.

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