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P5_2 Avian Affluence and Bovine Business Strategies

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Abstract

In the story "Jack and the Beanstalk", Jack obtains a golden egg from a goose owned by a giant. Using equations describing the curvature of avian eggs, the volume, mass and eventually the value of the egg were obtained. It was calculated that the egg had a value of £355.13 in 1845 when the popular Henry Cole rendition was published, which could have purchased 66 cows. This is a profit of 6500%.

Introduction

In the ancient tale "Jack and the Beanstalk", the protagonist, Jack, trades his family cow for magic beans. These grow into a towering beanstalk. Upon clambering to the top, Jack discovers a giant hoarding treasures: a golden harp, a bag of gold and finally a goose that lays.. *golden eggs*! These eggs must surely be an object to behold, but can the prosperity realised by the characters in the story be quantified? This paper aims to remedy the lackadaisical fiscal practice of Jack and his mother by providing an analysis of the geometric properties of the goose egg, followed by a determination of it's monetary value.

Theory

In order to calculate the volume of an avian egg, first the contour as projected onto two dimensions must be defined. This was found by V. Narushin [1] to be

$$y = \pm\sqrt{L^{2/(n+1)}x^{2n/(n+1)} - x^2} \tag{1}$$

in Cartesian coordinates, where

$$n = 1.057(\frac{L}{B})^{2.372}, \tag{2}$$

L is the length and B is the maximum diameter of the egg. The positive and negative equations together form the whole egg profile.

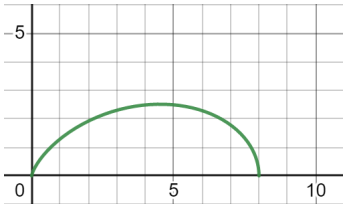

Figure 1: A plot of y against x for equation (1) with values $L = 8$ and $B = 5$.

A solution for the volume of a general egg can be obtained via a solid of revolution. Integrating between the L value of the egg and zero:

$$V_{egg} = \pi \int_0^L y^2 dx \tag{3}$$

Substituting (1) for y in (3) gives:

$$V_{egg} = \frac{2\pi L^3}{3(3n+1)} \tag{4}$$

Inputting values of $L = 90$ mm and $B = 55$ mm, the length and diameter of an average Goose egg

[2], we obtain a value of 1.363×10^{-4} m^3. From this, assuming that the egg is solid gold, the mass of the egg can be calculated:

$$m_{egg} = \rho V_{egg} \tag{5}$$

Here ρ is density. After inputting a value of 19.32 gcm^{-3} [3] for the density of gold in equation (5), a value of 2.63 kg was determined for the mass of a single golden egg.

Discussion

Jack made a high risk initial investment of a single cow, against the will of his mother. These calculated values of volume give us the ability to ascertain whether his investment turned over a profit at the end of the story and if so how much. In 1845, when the edition which popularized the story was published, the value of gold was $21 per troy ounce [4]. From this it can be determined that the monetary value of a single golden egg was £355.13. This has a modern equivalent spending power of £21,448.03 [5].

Conclusion

After obtaining a single golden egg, with a determined value of £355.13, it can be found that Jack could have purchased 66 cows for the farm [5], a favourable outcome for him and his mother, as only a single cow was given in exchange for the magic beans initially. Additionally, if Jack wished to go to the local public house, where the price of beer was 1 penny [6] or £1/24 [7], this egg would have purchased him 8523.12 pints of beer. Regardless of where they proceeded to apply their newfound capitol, the mother and son would have seen their day to day lives drastically changed. Assuming that Jack and his mother were average farm labourers, their salary would have increased from £42 per year [8] to the sum received from the sale of the egg, which would have been approximately equivalent to the yearly salary of an admiral in the Royal Navy [9].

References

[1] V. Narushin. "AP—Animal Production Technology: Shape Geometry of the Avian Egg". In: *Journal of Agricultural Engineering Research* 79 (Aug. 2001), pp. 441–448. DOI: 10.1006/jaer.2001.0721.

[2] *Egg Sizes and Dimensions - Brinsea*. Accessed on 19.10.2022. URL: https://brinsea.co.uk/latest/resource-centre/egg-sizes/.

[3] T.L. Brown, H.E. LeMay, and B.E. Bursten. *Chemistry: The Central Science*. Chemistry: The Central Science. Prentice Hall, 2000. ISBN: 9780130852656. URL: https://books.google.co.uk/books?id=NGCHvQEACAAJ.

[4] *Smart Capital Mind*. Accessed on 19.10.2022. URL: https://www.smartcapitalmind.com/what-is-the-historical-price-of-gold.

[5] *National Archives*. Accessed on 19.10.2022. URL: https://www.nationalarchives.gov.uk/currency-converter/#currency-result.

[6] *Old Bailey Online*. Accessed on 19.10.2022. URL: https://www.oldbaileyonline.org/static/Coinage.jsp.

[7] *All Coin Values*. Accessed on 19.10.2022. URL: https://www.allcoinvalues.com/united-kingdom/queen-victoria-era-uk-penny-values.html.

[8] *Immigration : report from the Immigration Agent upon immigration*. 1851. URL: https://find.slv.vic.gov.au/discovery/fulldisplay?context=L&vid=61SLV_INST:SLV&search_scope=MyInstitution&tab=searchProfile&docid=alma9910337373607636.

[9] D. Steel. *The Ship-master's Assistant and Owner's Manual*. D. Steel, 1801. URL: https://books.google.co.uk/books?id=20w9AAAAYAAJ.