# When Do Dogs Pay Off?: A Literature Review of Biotechnology in the Archaeological Record

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## Background

- The long-term goal of this project is to understand how and if dogs that were utilized as hunting tools shaped subsistence patterns, animal-human relationships, and environmental resilience.
- Wolves (*Canis lupus*) were domesticated approximately 14,000 years before present (BP) and present in North America since 10,000 BP (Perri et al., 2019).

- No data explicitly discussing peak hunting performance in dogs is available at this moment.
  - However: peak speed is reached around 2.5 to 3.3 years of age (Täubert et al., 2007).
  - Bermingham et al. (2014) suggest the mean maintenance energy requirements for adult dogs, regardless of age or sex, is 1351± 639.8 kcal/day.

## Theory

When dogs are included in prey choice models, the results may vary. Dogs can reduce search time and increase encounter rates, effectively increasing their profitability. However, the risk of no return rises with energetically expensive prey. Dogs may shift prey rankings when search costs decrease; however, expensive prey may remain limited in the diet due to the handling costs (Lupo, 2017). Larger prey may require more energy to process than what the hunters will receive from it.

The patch investment model is $t^* = g_1 i_{1\rightarrow 2}/g_2\text{-}g_1$. Which can be used to compare the energetic gain rate with or without investment (Mohlenhoff & Codding, 2017). Pack animals, such as dogs, are most effective when hunting in groups. In some ethnographic populations, dogs are trained via imitation of adult hunting dogs (Koster & Tankersley, 2012). Little investment by humans is put into the dogs' training when there are multiple dogs of varying ages. In other populations, puppies are fed small live prey, taught ways to identify larger prey, and given blood from a recently deceased animal (Koungoulos & Brumm, 2023).

## Predictions

If dogs were deployed as hunting dogs during periods of hunting intensification, their presence should correlate with increased representation of medium to large prey in faunal assemblages (e.g., deer and pronghorn), burials and shelters, and selective prey-mortality profiles (e.g,. young and vulnerable prey rather than healthy adult males). On the contrary, no measurable shift in prey distribution or hunting efficiency following the introduction of domestic dogs would weaken the hunting tool hypothesis.

## Methodology

- **Computer Simulation**
  - I conducted experiments to test if the investment in hunting dogs is worthwhile
  - Using Stardew Valley as virtual laboratory
  - This video game was chosen for its foraging mechanic, value ascribed to resources, and the ability to use a horse.
  - The horse takes the place of hunting dogs in these experiments.
- **Patch Investment with Biotechnology Exercise**
  - On one in-game day, the player forages for resources on foot
  - On another day, the player uses a horse to locate resources
  - Both days: the player records total resources, money earned, and the in-game time after the foraging sessions are complete.
  - Once both sessions are complete, apply data to the patch investment model

**Investment model: $t^* = g_1 i_{1\rightarrow 2}/g_2\text{-}g_1$**

$g_1$ represents kcal/hr without investment (total gold earned by foot)

$g_2$ represents kcal/hr with investment (total gold earned by horse)

$i_{1\rightarrow 2}$ represents the required investment time in hours (time it takes to build stable) [40 hours]

## Results

This exercise is successful in testing if biotechnology is a worthy investment. When the model comes out to ≤ 0, you should always invest. If the result is ≥ 0, that is when the investment is dependent on the marginal value gains. During test sessions, the model always resulted in a negative number. That outcome remained the same despite values varying during each test. There was a patch the horse had difficulty navigating (Cindersap Forest) but the reduced overall search time made up for the inaccessible patches. The forest was inaccessible for the horse due to weeds blocking the tiles. In order to remove them, the player needs to dismount from the horse and cut the weeds with a scythe as weeds regenerate each day. Even without the forest, the increased speed helped the player move through patches and locate resources more quickly. The consistency in the results suggest that investing in the horse is worth the time. This remained true when using total time (1580 in-game hours) required to gather resources and build a horse stable rather than only the time required to build a horse stable (40 in-game hours). The next steps of this project is to test these preliminary results on an archaeological sample.

## References

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