Saffron: A High-Value, Low-Input Crop for Small Farms in New Mexico

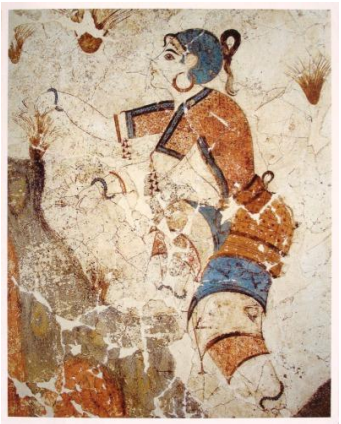
Saeid Zehtab Salmasi, PhD
saeidzs@nmsu.edu
Associate Professor and Research Director
Sustainable Agriculture Science Center at Alcalde
Plant and Environmental Sciences Department
College of Agricultural, Consumer, Environmental Sciences
New Mexico State University



BE BOLD. Shape the Future.®
New Mexico State University

Origin of Saffron (*Crocus sativus* L.)

- Earliest evidence of saffron use appears in Minoan frescoes from Crete and Santorini (~1700–1500 BC).
- Cultivated saffron is a sterile triploid species propagated vegetatively by corms.
- Recent genomic studies identified wild *Crocus cartwrightianus* as the direct ancestor of saffron.
- The word saffron comes from the Persian word zafarān , meaning "gold-strung"), which traveled via Arabic and Old French safran into English.
- While its roots are Mediterranean/Greek, the vast majority of the world's saffron today (roughly 80% to 90%) is produced in Iran.





Crocus cartwrightianus



Crocus sativus
(Saffron crocus)

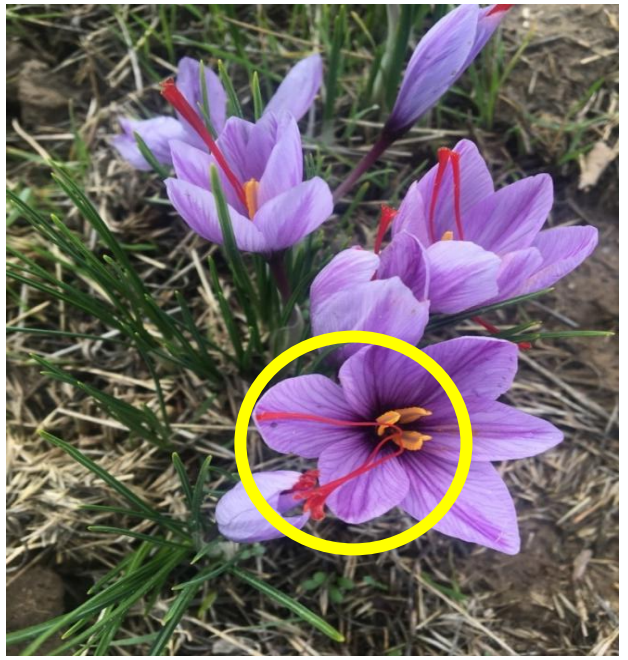


Crocus *vs* Saffron



Crocus





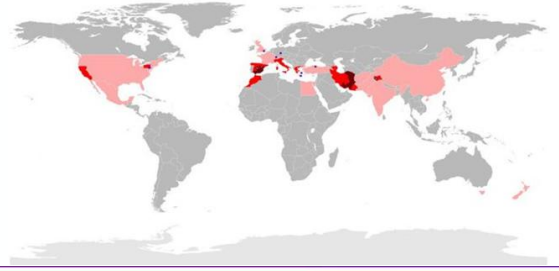
Saffron

Crocus sativus

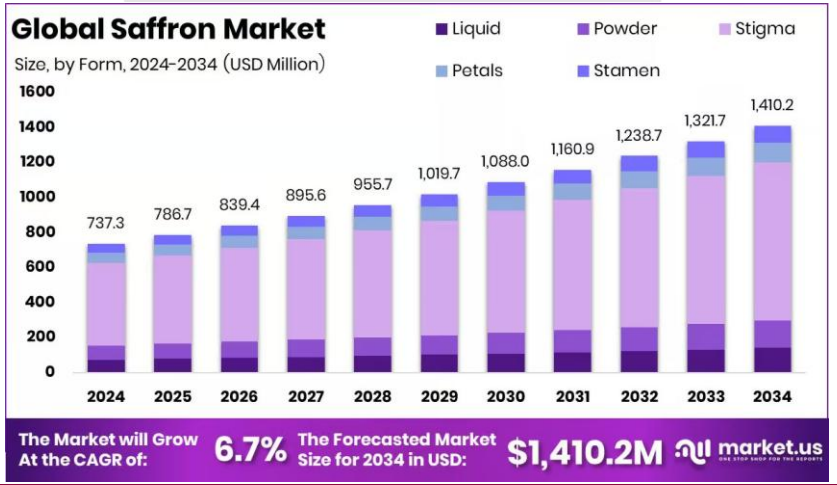
Family: Iridaceae

Introduction

Saffron (*Crocus sativus*) is a high-value specialty crop with expanding culinary, medicinal, and nutraceutical markets worldwide.



- Saffron thrives in dry, hot summers and cool, wet winters, mainly across the Mediterranean region, Iran, and Kashmir. Iran leads production, followed by Spain, Greece, Morocco, India, and Italy.
- Global saffron production is declining because of climate change and unsustainable farming practices.



Introduction

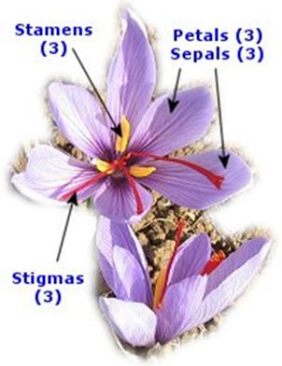
- Saffron holds a high economic value as the world's most expensive spice. The price of a gram can range from $10 to $75 at retail.
- The unique chemical composition of saffron is responsible for its premium market value and diverse health-promoting properties.
- Can be grown in USDA plant hardiness zones 4-8



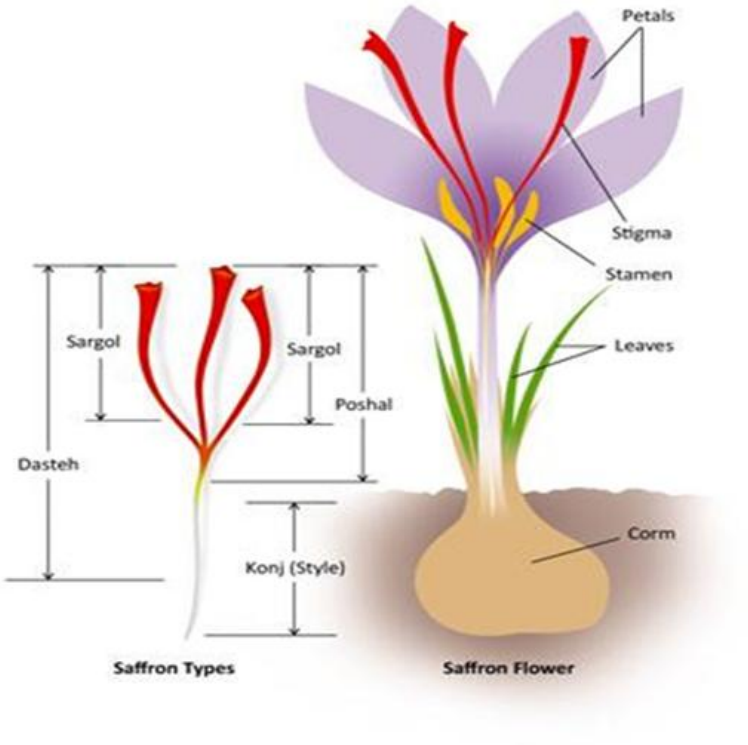


Saffron Botany









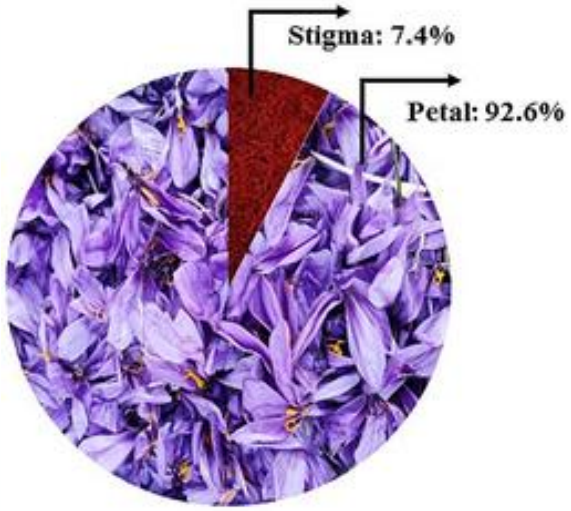
Saffron Leaf

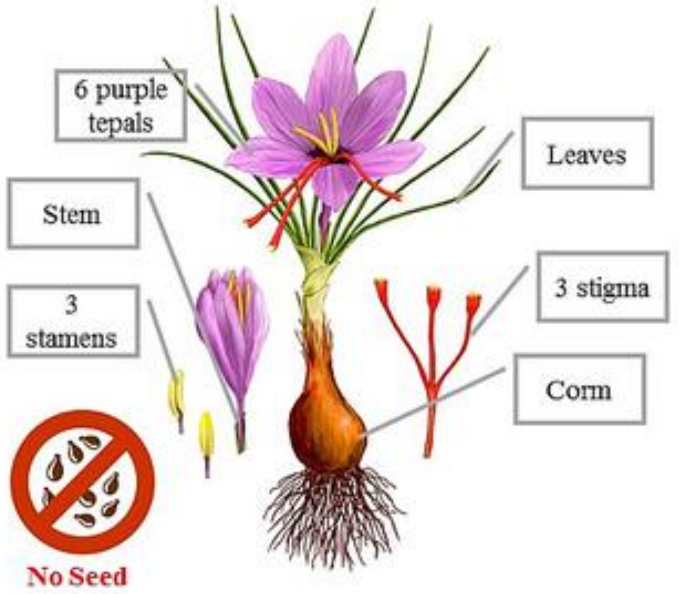


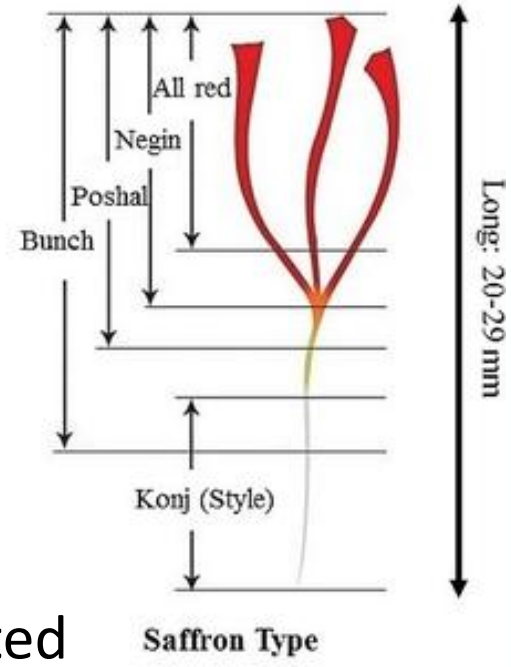




Botany





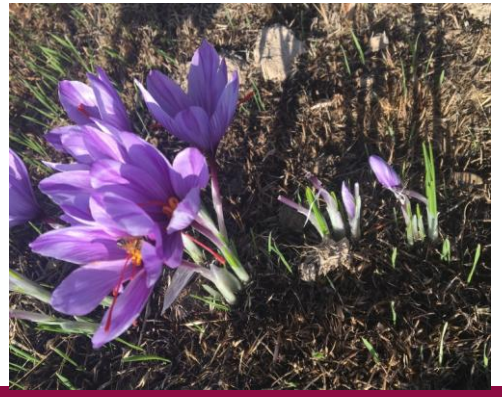


- Perennial; sterile triploid propagated through underground corms

Growing cycle









Planting







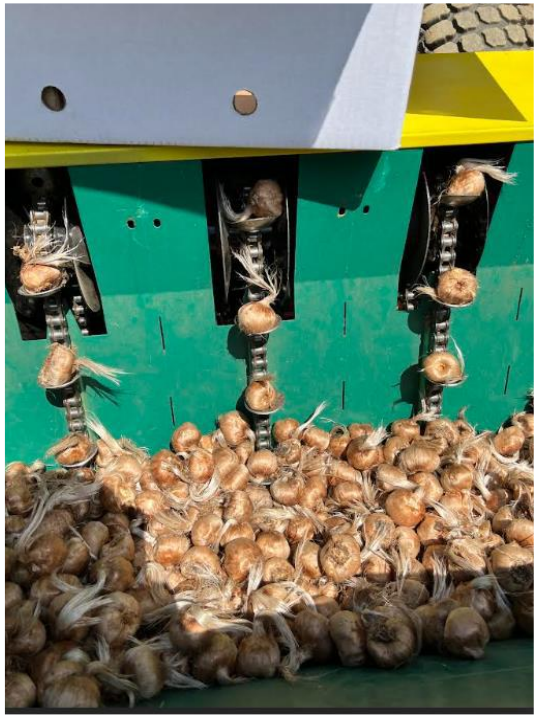




- Planting in early- to mid-August increases the flower and stigma yield, especially in the first year. Based on research results in the US, 6*6 or 12*4 inches is the recommended planting space.

Planting









- It is reported that the highest yield is obtained when corms are planted at a depth of 6-8 inches

Saffron Fertility Management

Why Nutrition Matters

- Healthy daughter corms are the foundation of high flower yield.
- Balanced nutrition improves flower production, stigma yield, and corm multiplication.

Key Nutrients

- **N:** Leaf growth & photosynthesis
- **P:** Root & corm development
- **K:** Flowering, stress tolerance & corm vigor

Best Practices

- Apply **compost or well-decomposed manure** before planting.
- Base fertilizer applications on **soil-test results**.
- Combine **organic and inorganic fertilizers (INM)** for sustainable production.
- Avoid excessive nitrogen.



Irrigation

Saffron Irrigation Management

Why Irrigation Matters

- Saffron is **drought-tolerant but responds to supplemental irrigation**, particularly in arid regions.
- Proper irrigation improves **flower yield, stigma yield, and daughter corm production**.

Critical Irrigation Stages

💧 **Pre-flowering irrigation (late summer/early fall)**

- Triggers sprouting and flowering
- Most critical irrigation event

💧 **Vegetative growth (winter–spring)**

- Supports leaf growth, photosynthesis, and corm development
- Avoid prolonged water stress

💧 **Corm dormancy (summer)**

- Little irrigation required
- Excess moisture may increase corm diseases









Harvesting Saffron Flowers

At what stage should the flowers be picked?

- **Pick flowers when fully elongated and just starting to open.**
- Harvesting too early (closed flowers) → shorter stigmas.
- Waiting until wilted → harder to pick, stigmas may shrivel or get dirty.
- Length matters since each stigma weighs only a fraction of a gram.





Harvesting Saffron Flowers

- **Flowering season lasts 4–6 weeks**, mid-October to early November in Alcalde.
- Early season: **harvest every other day**; peak bloom: **pick daily**.
- Avoid delays longer than **2–3 days**.
- Bees, butterflies, and hover flies often visit flowers—gently flick to encourage exit. Saffron provides a valuable late-season food source for beneficial insects.



Harvesting Saffron Flowers

How do you pick the flowers?

- **Cut flowers at the base** using your thumbnail and index finger to remove them completely.
- **Pick only clean, fresh flowers**; discard any that are dirty or moldy.
- **Handle flowers gently** to avoid crushing or damage.
- **Do not pick leaves;** they grow through winter and help produce next year's corms.



Harvesting Saffron Flowers

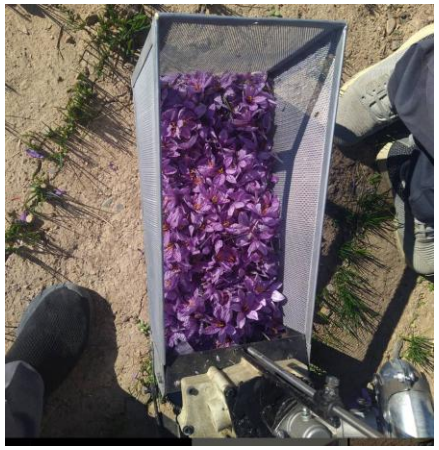
How should you handle the flowers after picking?

- **Place flowers on a clean tray or wide basket** for handling.
- **Avoid deep piles** to prevent crushing and condensation.
- **Keep harvested flowers covered and out of direct sunlight** to maintain quality.



Harvesting Saffron Flowers









Processing Saffron Flowers

When should you process the flowers?

- **Separate stigmas as soon as possible after picking**; wilted flowers make removal harder.
- Most growers **pick flowers, bring them indoors, then separate parts**.
- Some **remove stigmas in the field with tweezers**, leaving other parts—this may be faster if only stigmas are needed.
- If immediate processing isn't possible:
  - **Spread flowers on a paper towel on a tray**.
  - **Store in the refrigerator** until ready to process. **Process within 24 hours** of harvest.







Processing Saffron Flowers

Where should you do the flower separation?

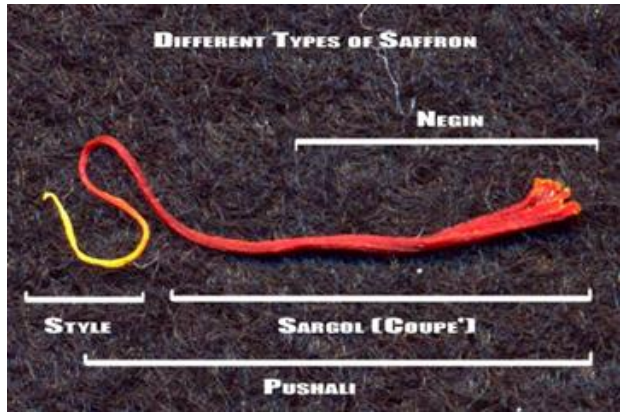
- **Saffron is a food crop—handle it with care and hygiene.**
- Wash hands with soap **before each handling step.**
- **Sanitize work surfaces and containers** before use.
- Maintain a **written SOP** for harvesting, separating, drying, and storing saffron.



Processing Saffron Flowers

- **Growers typically use their thumbnail to separate flowers.**
- Trim the flower **at the base, just below the junction of stigmas and stamens**; petals often fall away naturally.
- **Saffron stigma has four sections**.
- Quality is judged by which part of the stigma is included:
  - **Sargol saffron** = highest quality, includes only the top section.





Processing Saffron Flowers

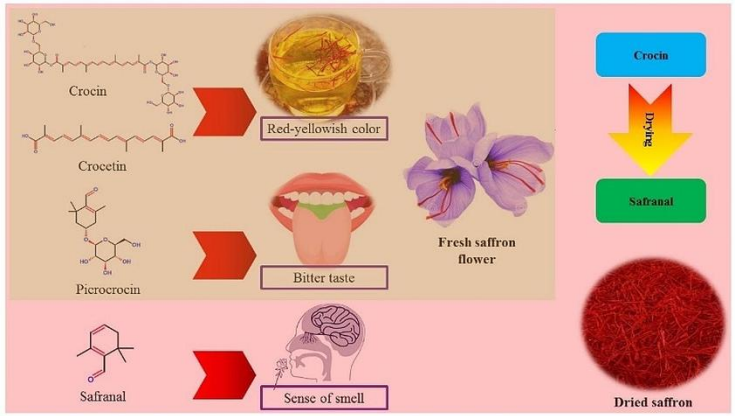


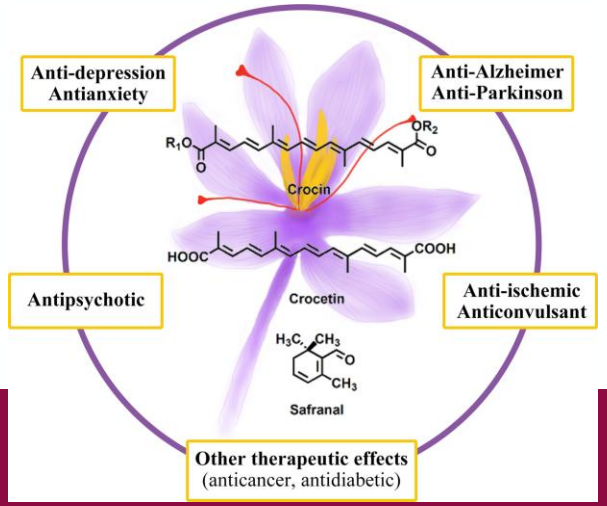




Saffron Quality

- **Saffron contains at least 28 compounds** that influence color, taste, and aroma.
- Key bioactive compounds in stigmas:
  - **Crocin** ($C_{44}H_{64}O_{24}$) → responsible for **color**.
  - **Picrocrocin** ($C_{16}H_{26}O_7$) → contributes to **flavor**.
  - **Safranal** ($C_{10}H_{14}O$) → gives **aroma**.
- **Quality depends on concentrations** of these compounds.
- Influencing factors:
  - **Geographical origin**
  - **Climate conditions**
  - **Farm management practices**
  - **Post-harvest handling** (drying, storage, etc.)





Drying Saffron Flowers

- **Three dehydration temperature levels**:
  - High
  - Medium (mild)
  - Low (room or air temperature)
- Spanish study (Manuel et al., 2005) tested drying effects on color, bitterness, aroma, and moisture.
- **Room-temperature drying** → significantly lower quality (color, flavor, aroma) and higher moisture.
- **High-temperature drying (194 °F / 90 °C and 230 °F / 110 °C)** → better quality compared to room temperature.





Drying Saffron Flowers

- **Study by North American Center for Saffron Research and Development on Vermont-grown saffron.**
- Tested three oven-drying temperature regimes:
  - **High:** ~210 °F (100 °C) for 7–10 minutes.
  - **Medium:** ~170 °F (77 °C) for 25 minutes.
  - **Low:** ~130 °F (55 °C) for 60 minutes.
- **High temperature produced more safranal and crocins** than lower temperatures.
- **No significant effect on picrocrocin** across temperatures.
- Conclusion: **High temperature (~210 °F) is optimal for robust flavor and aroma.**





Drying Saffron Flowers

- After drying, **allow stigmas to cool completely** to prevent condensation.
- Store saffron in **aluminum or glass containers** with tight lids, in the dark at room temperature. Store in **airtight glass jars or snap-top vials**; avoid plastic or paper (compounds may leach).
- Avoid leaving saffron out on **humid days**—it absorbs moisture easily.
- If moisture content is **above 12%,** saffron may mold and become unusable.
- Some reports suggest **waiting one month before use** to enhance flavor (not scientifically confirmed).



Saffron Flowers Petals

Utilize the Whole Flower
Stigma: ~0.006 g
Six petals: ~0.055 g
Three stamens: ~0.005 g



✅ **Increase your profits by processing petals and stamens for dye or medicinal uses.**

Saffron Flowers Petals







Harvesting Saffron Flowers

Time and Labor

- **Pick 1,000 flowers**: 45–55 minutes.
- **Remove stigmas from 1,000 flowers**: 100–130 minutes.
- To produce **1 kg of dried saffron**: **~370–470 hours total**.



Yield and Revenue

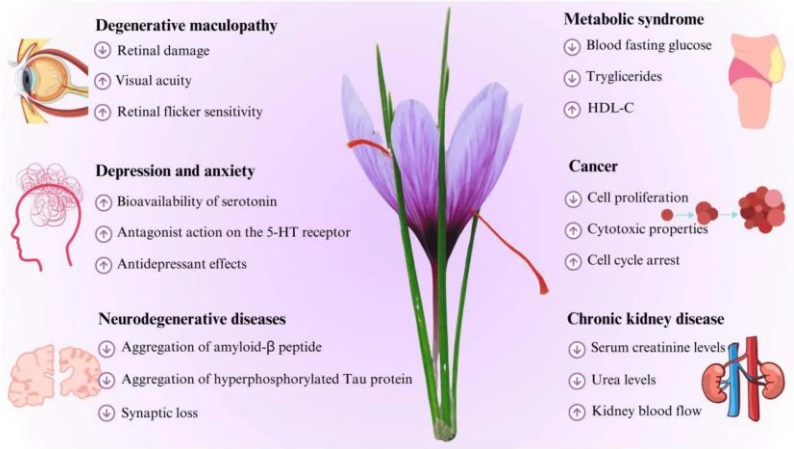
- Each flower yields **~0.006 g of dry saffron** → ~167 flowers per gram.
- **1 acre of saffron** can gross up to **$100,000**, assuming retail price of $20/gram (actual revenue varies by yield and market price).



Major Uses of Saffron

Multiple food, pharmaceutical, and wellness applications continue to drive global demand for saffron.

- Saffron spice is frequently utilized as a seasoning and coloring component in Asian and European cooking. It is also believed to possess medicinal attributes, thereby elevating its economic significance compared to other spices. It contains bioactive elements that are beneficial in addressing depression, cancer cells, Alzheimer's disease, and cardiovascular ailments.



How to Use Saffron for Maximum Flavor and Color

1. Grind

- Grind a small pinch of saffron threads into a fine powder.

2. Brew

Hot Method (15–20 min)

- Add hot water (60–80°C).

Ice Method (30–40 min)

- Add a few ice cubes and allow to melt slowly.

3. Add

- Use the entire infusion in rice, desserts, sauces, tea, or …



Saffron Recipes















Saffron Tepals

- **Potential Markets for Saffron Byproducts**

Private chefs → petal dust, dried petals
Local restaurants → fresh and dried petals
Fine dining & catering chefs → petal dust, dried petals, dried stamens
Tea shops → dried petals
Distilleries → fresh petals
Soap & lotion makers → petals for natural color and fragrance







Saffron benefits

- Profitability
- Perennial
- Low input, low fertility demand, low N
- Attractive for organic farming
- Wide range of environments, dry climates
- Low water demand, irrigated only four times a year in Iran
- Low output, suitable for sustainable farming
- No serious pest/diseases (except rodents!)
- Can be intercropped during summer/early fall
- Integrating saffron into vegetable farming
- Can be grown in marginal lands







Major issues?

- Weed control (no saffron plant to see

  May – September!)

- Harvesting and processing of flowers

  are labor intensive

- Rodent?









New Mexico State Saffron Research Program

Overall feasibility

Assess survival, flowering consistency, stigma yield, and fit with local farm systems in north-central New Mexico.

Key agronomic variables

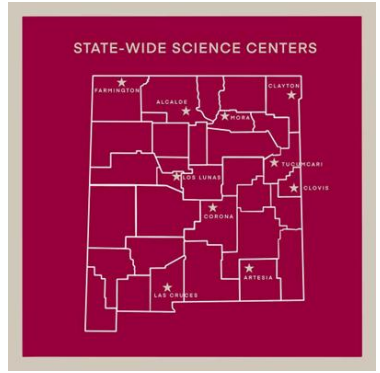
Test corm size, planting time, and irrigation frequency to guide yield-focused, low-cost recommendations.

Cropping system integration

Evaluate intercropping with New Mexico chile and shallow-root crops to complement diversified cropping schedules.

Organic corm protocols

Develop organic corm production methods to support long-term sustainability and reduce reliance on imports.





Why Saffron in New Mexico?



- **High-value, low-input crop;** Strong U.S. demand in culinary, medicinal, and niche markets makes it attractive for small-scale, high-margin diversification
- **Fits arid and semi-arid conditions;** Relatively drought-tolerant; minimal irrigation; cooler-season growth can reduce evapotranspiration and water use
- **Good match for organic, small farms;** Lower pest and disease pressure supports low-input production and aligns with rising demand for organic and locally sourced specialty crops



Materials & Methods

- Saffron corms were planted 6 to 8 inches in depth and 6 inches apart on September 19, 2023. The saffron flowers were harvested in 2023 and 2024.



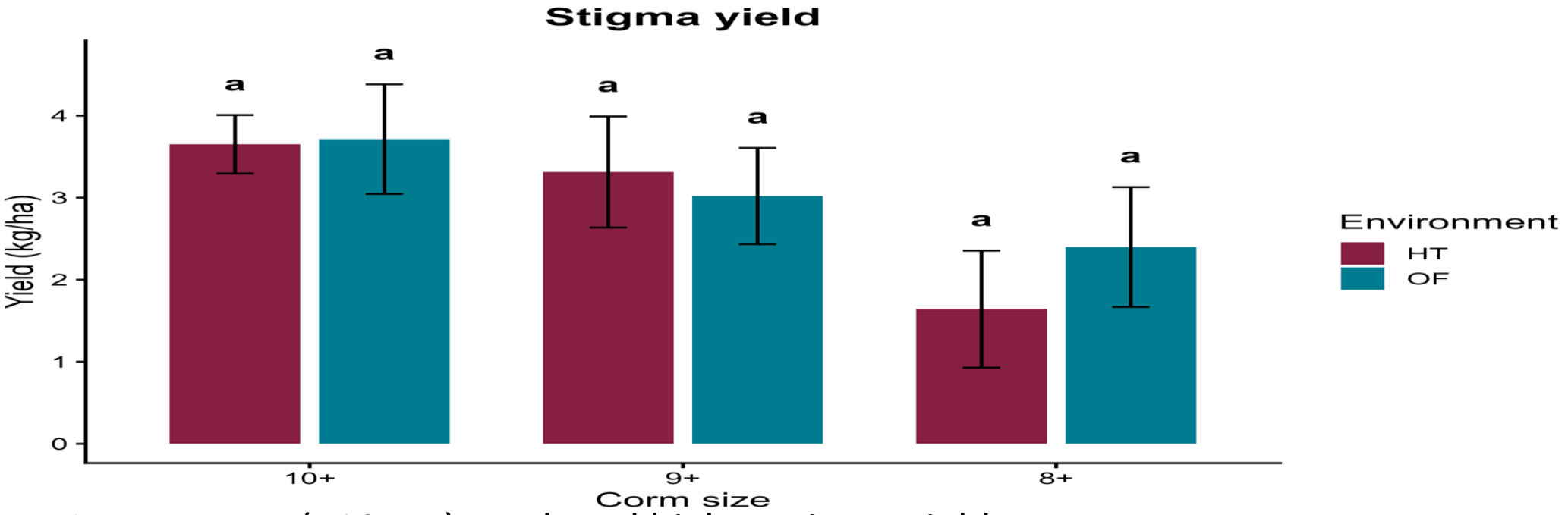









Results

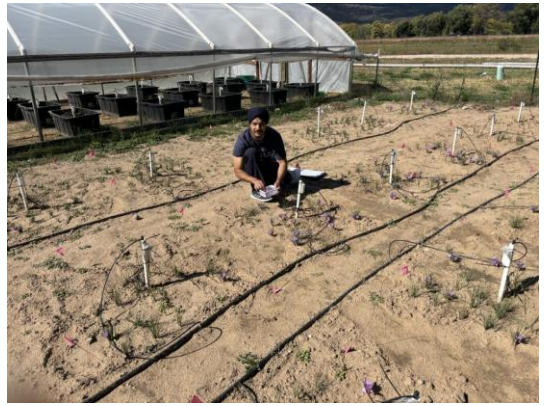


- Large corms (>10 cm) produced higher stigma yield
- The difference between saffron yield in high tunnel and open field production systems was not significant.
  - Stigma yield increased from 3 kg/ha (2023) to 5 kg/ha (2024).

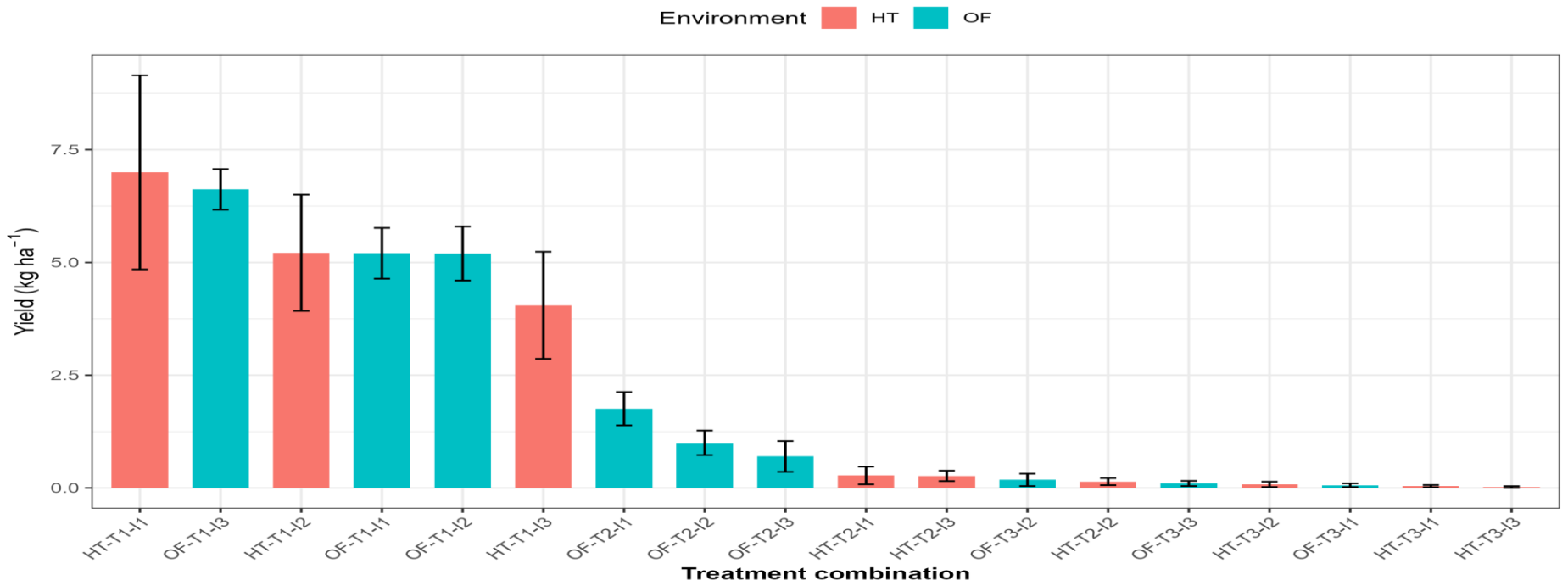
Materials & Methods

Planting times	Irrigation Treatment applied
T1 - 13 August 2024 (T1)	I1 (weekly)
T2 - 29 August 2024 (T2)	I2 (Bi- weekly)
T3 - 17 September 2024 (T3)	I3 (Tri-weekly)



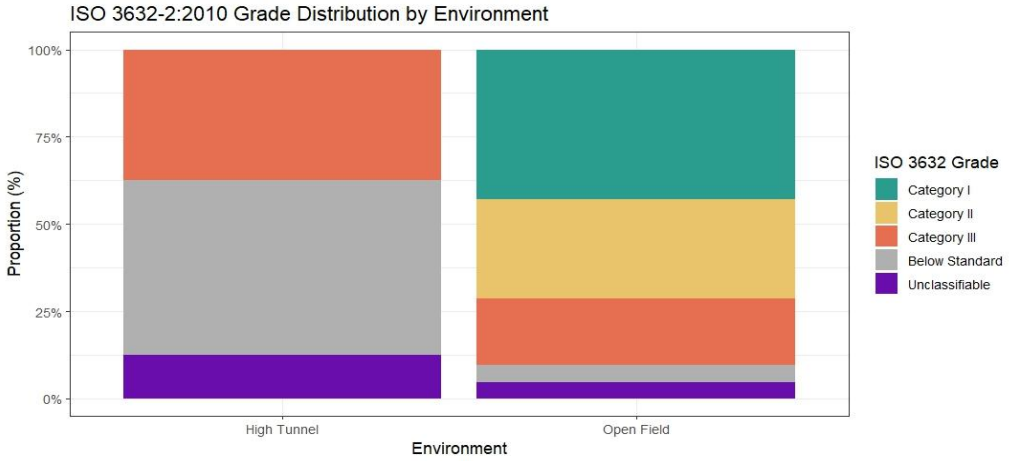


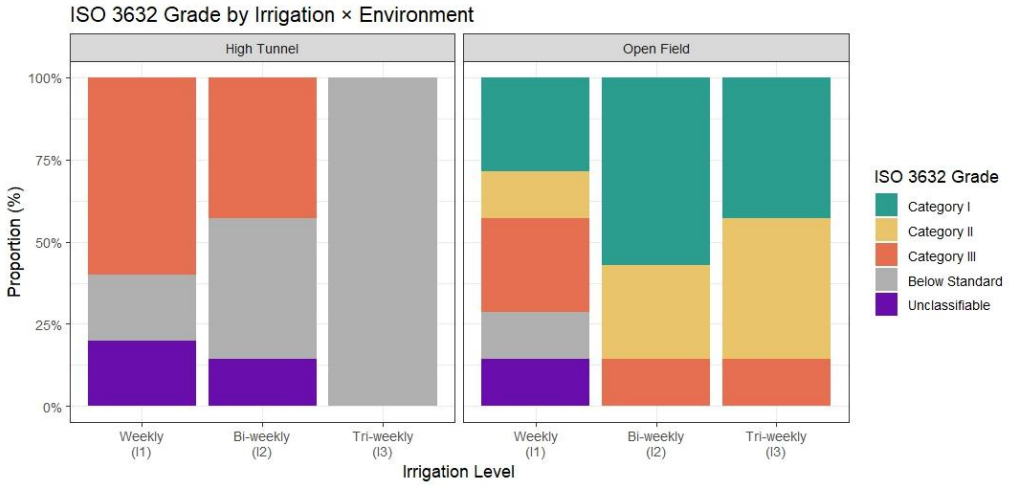

Treatment Ranking for Stigma Yield (kg.ha^{-1})



- Top 5 ranked treatments belonged to Early planting (T1)
- Delaying planting to T2 reduced yield by ~ 75 -90% compared with T1
- T3 produced negligible commercial yield (< 0.3 kg .ha $^{-1}$)

ISO Grade Distribution of Saffron





Key Findings:

- Open field produced superior commercial-grade saffron
- 9 of 21 samples (42.9%) were Category I
- 6 of 21 samples (28.6%) were Category II
- Overall 71.4% samples open –field were classified as (Category I + Category II)

High Tunnel :

- 6 samples (37.5%) were Category III
- (50%) of samples were below standard
- 2 samples (12.5%) were unclassifiable)
- In high tunnels, changing irrigation frequency did not improve commercial quality

Materials & Methods

- **Alcalde, northern NM, 5,700 ft (1,737 m); Los Lunas, central NM, 4,997 ft (1,523 m) ; Leyendecker, southern NM, 3,900 ft (1,190 m)**
- **In addition to saffron-only test plots, we are growing saffron in combination with Crop A (New Mexico chile at all three locations) and Crop B (mustard, artichoke, and spinach), along with monoculture plots of Crop A and Crop B for comparison.**



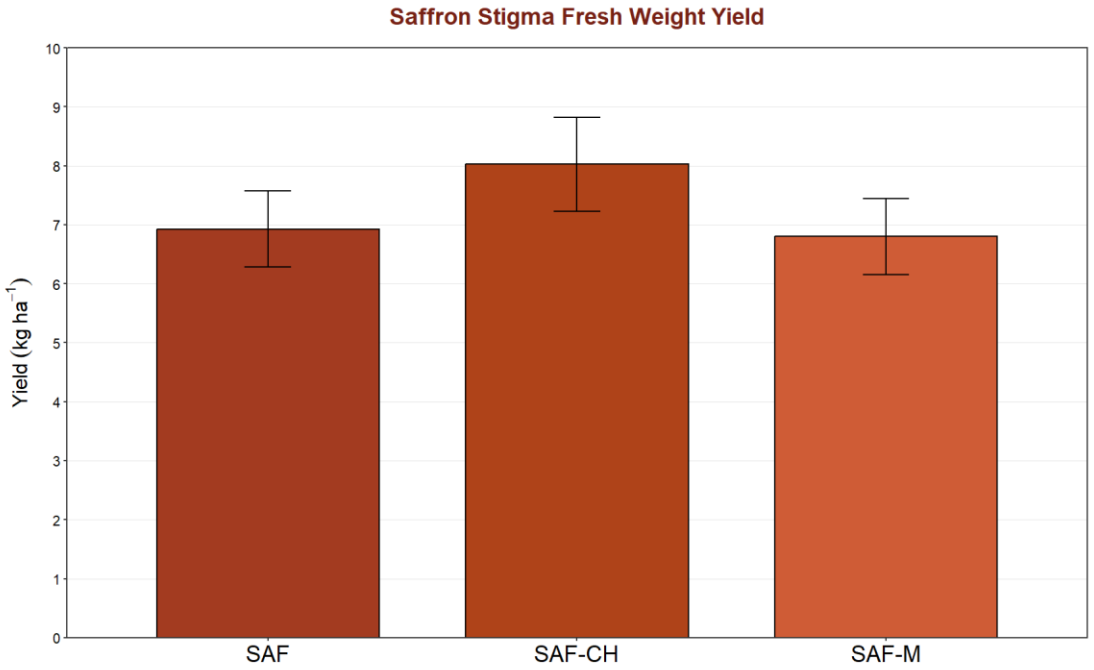


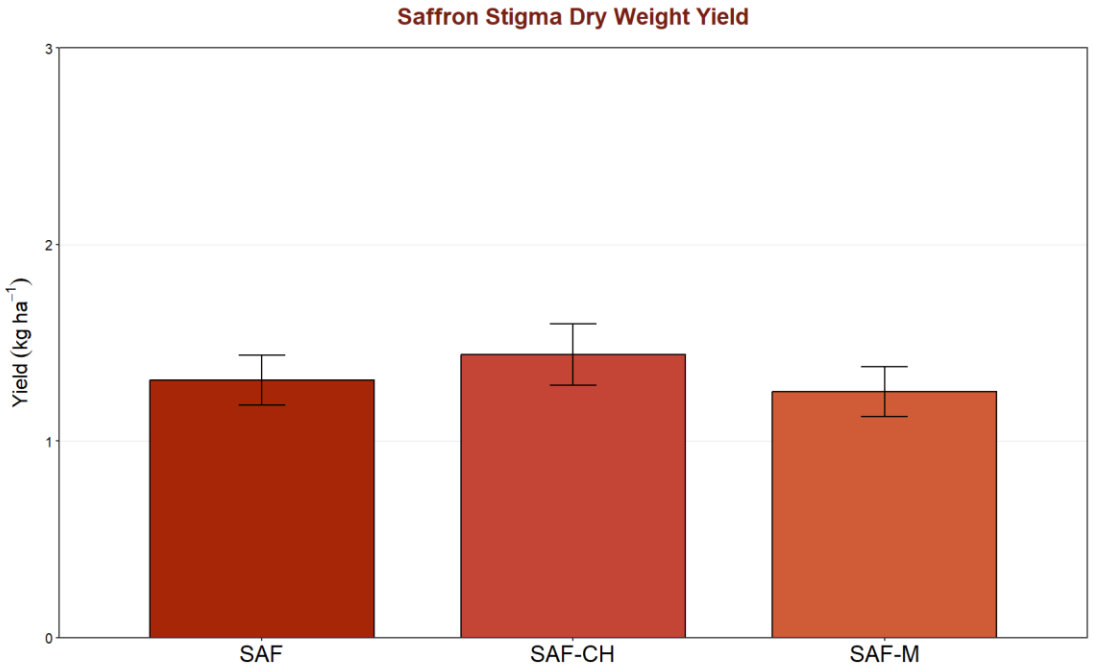



Intercropping systems were designed to evaluate whether saffron can enhance productivity and profitability without reducing companion crop performance.




Results- Alcalde northern NM





Intercropping with chile or mustard did not significantly affect saffron stigma fresh or dry yield, indicating that saffron maintained its economic yield under intercropping conditions at Alcalde.

Economic Performance of Saffron Intercropping Systems - Alcalde northern NM

Saffron + Chile (SC)

Saffron partial LER:

$$\frac{1.4410}{1.3105} = 1.0996$$

Chile partial LER:

$$\frac{20127.5960}{25675.4895} = 0.7839$$

Total LER:

$$LER_{SC} = 1.0996 + 0.7839 = 1.8835$$

LER (Saffron + Chile) = 1.88

Saffron + Mustard (SM)

Saffron partial LER:

$$\frac{1.2522}{1.3105} = 0.9555$$

Mustard partial LER:

$$\frac{11443.8197}{12380.2790} = 0.9244$$

Total LER:

$$LER_{SM} = 0.9555 + 0.9244 = 1.8799$$

LER (Saffron + Mustard) = 1.88

Land Equivalent Ratio (LER) was 1.88 for both saffron-chile and saffron-mustard intercropping systems, indicating substantial land-use advantages over monocropping.

Takeaway points

- Saffron is the world's most valuable spice and is used in food, medicine, and health-related products.
- Despite its high value, saffron requires relatively low inputs, including limited water and fertilizer compared with many traditional crops.
- Successful saffron production depends on proper planting, harvesting, drying, and storage practices.
- Research at New Mexico State University shows that saffron can be successfully grown in New Mexico and other semi-arid regions.
- Saffron offers opportunities for sustainable agriculture, crop diversification, and increased farm profitability in water-limited environments.

Saffron Production in NM

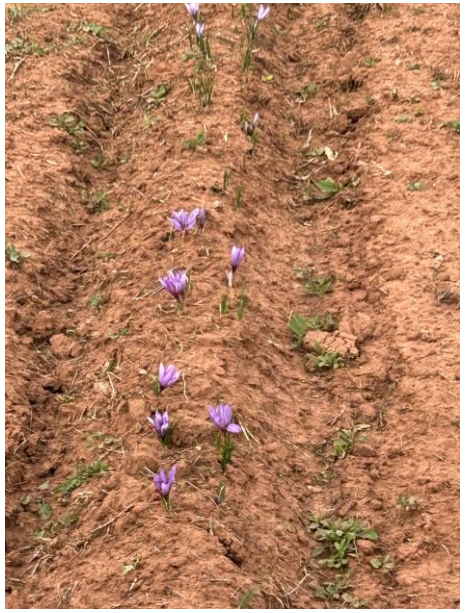
- **Douglas Oberwortman, ranch da Kissila, Ribera, NM**

100k corms 2025















Saffron Production in NM

- **Apache Creek Deaf & Youth Ranch, Reserve, NM**

50k corms 2026















Acknowledgments

- Marisa Thompson, Chanz Robins, Sawssan Boufous, Ivette Guzman, Lovepreet Singh



https://alcaldesc.nmsu.edu/saffron-alcalde.html



saeidzs@nmsu.edu

Thank you



