Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

Water efficiency in alfalfa cropping systems, reduction of the impact on water quantity and quality

Lloveras J. & Jézéquel S.

Parallel session 3

FROM 03 › TO 06 nov. 2025

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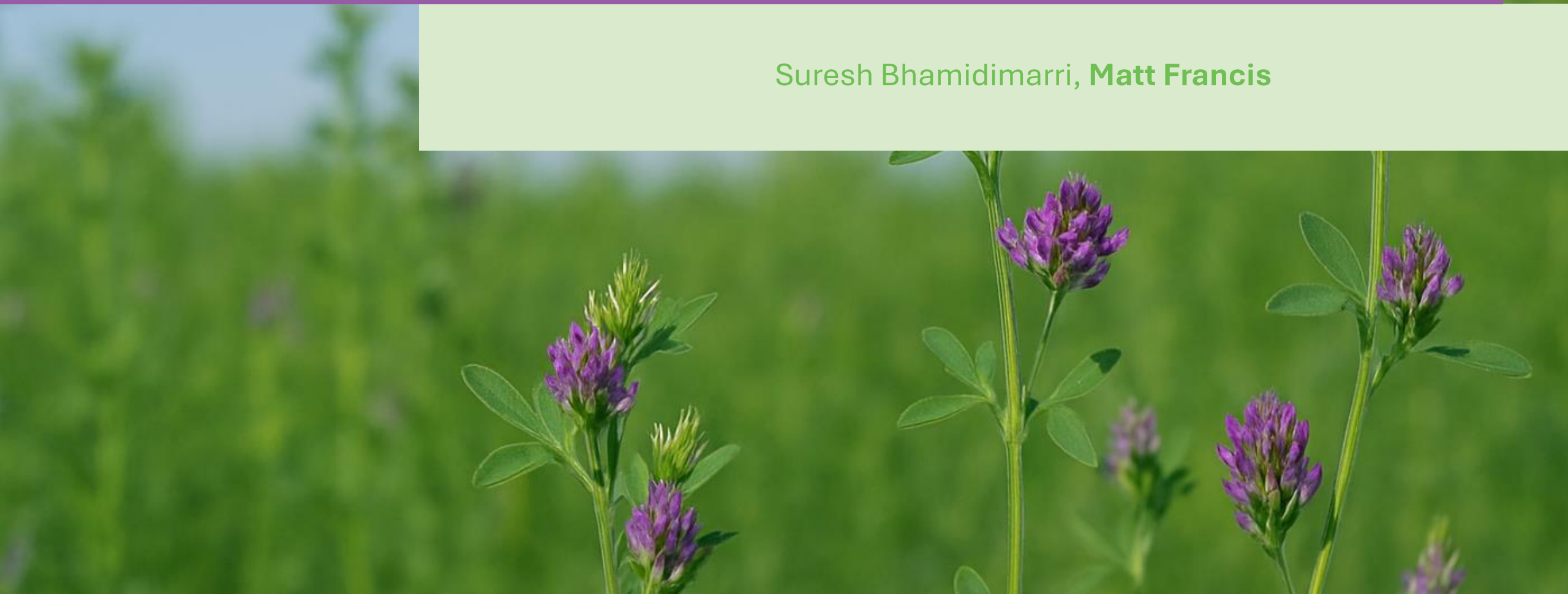
FRANCE REIMS-CHÂLONS

Breeding for Drought Tolerance in Alfalfa

Suresh Bhamidimarri, **Matt Francis**



Dansk Landbrugs Frøselskab

English translation:

Danish Agricultural Seed Company

We turn Science into Growth

Danish based seed company founded in 1872

World market leader within temperate forage and turf seeds. Supplying to more than 100 countries

7th largest seed company in the world

Leading research and development program to deliver valued added products to benefit producers around the world

Why breed for drought tolerance in alfalfa?

Context: A warming, water-limited future

- Rising global temperatures → more frequent and prolonged droughts
- Limited irrigation water for forage crops
- Forage production pushed to low input marginal land

Opportunity: Drought tolerant alfalfa cultivars

- Improve forage and livestock production in drought-prone regions
- Provide ecosystem services by fixing atmospheric N and improved soil health

Objective

Develop germplasm that persists/tolerates drought spanning various dormancy groups.

Germplasm development

Base population

- 25 experimental varieties
- Dormancy groups 2-6

Trial design and management

- Location: Woodland, CA
- 15’ x 4’ swards, 2 reps
- Sown at 20 lbs/ac in Fall, 2015
- Annual rainfall: 2016 (402 mm), 2017 (573 mm), 2018 (400mm)
- Irrigated during establishment year, no subsequent irrigation
- 28-day harvesting schedule

Sward plot trial - Woodland, CA

Oct 2017

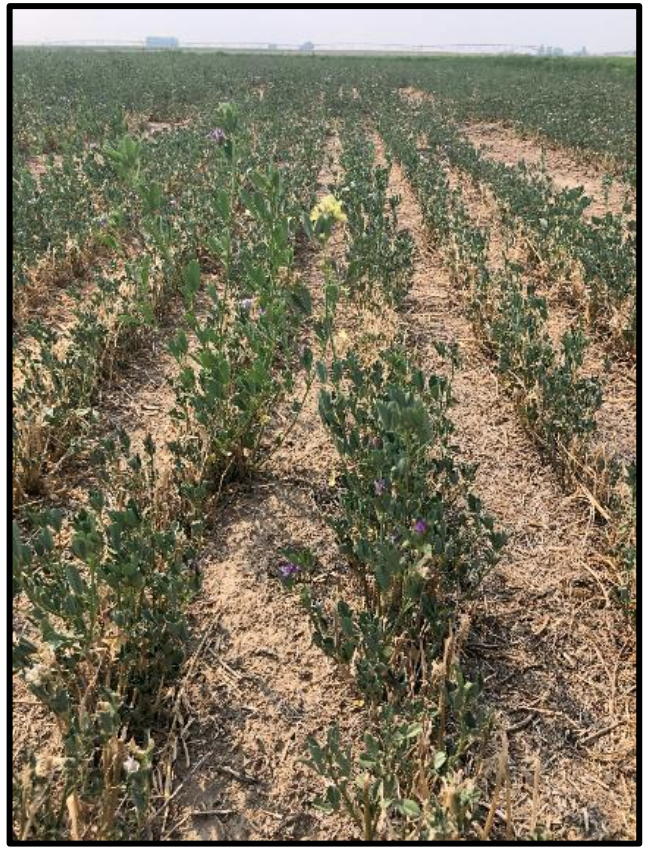
Feb 2018

Sward plot trial - Woodland, CA

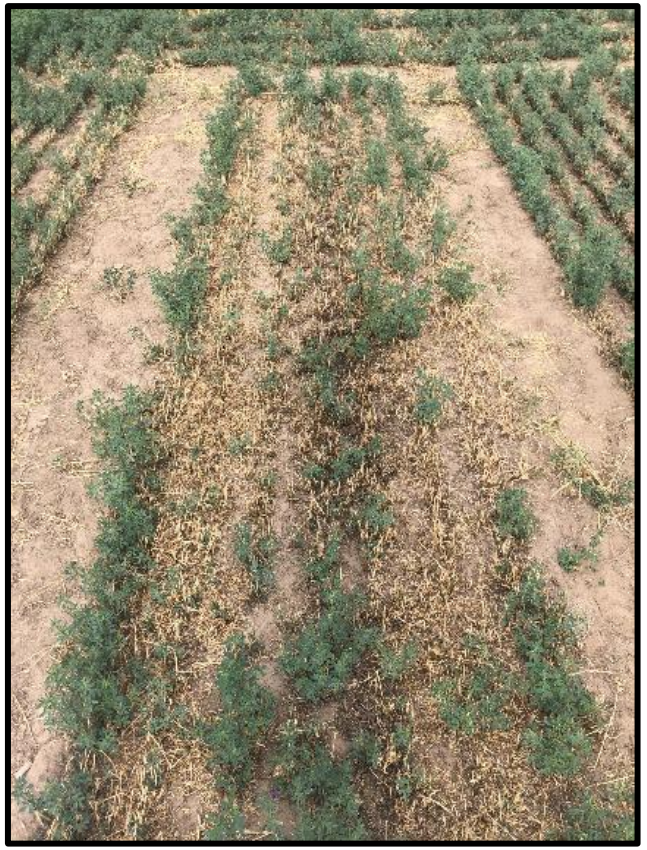
Sep 2018

Jan 2019

Germplasm development



Drought maintenance (DM)



Drought recovery (DR)

Two mechanisms identified enabling tolerance to prolonged drought

- **Drought maintenance**: continued growth despite drought conditions
- **Drought recovery**: plants that went dormant under drought conditions then recovered in winter/spring

14 synthetics developed from genotypes selected out of Woodland trial – 7 DM and 7 DR

Cycle 1 forage yield trials 2020-2022

Germplasm

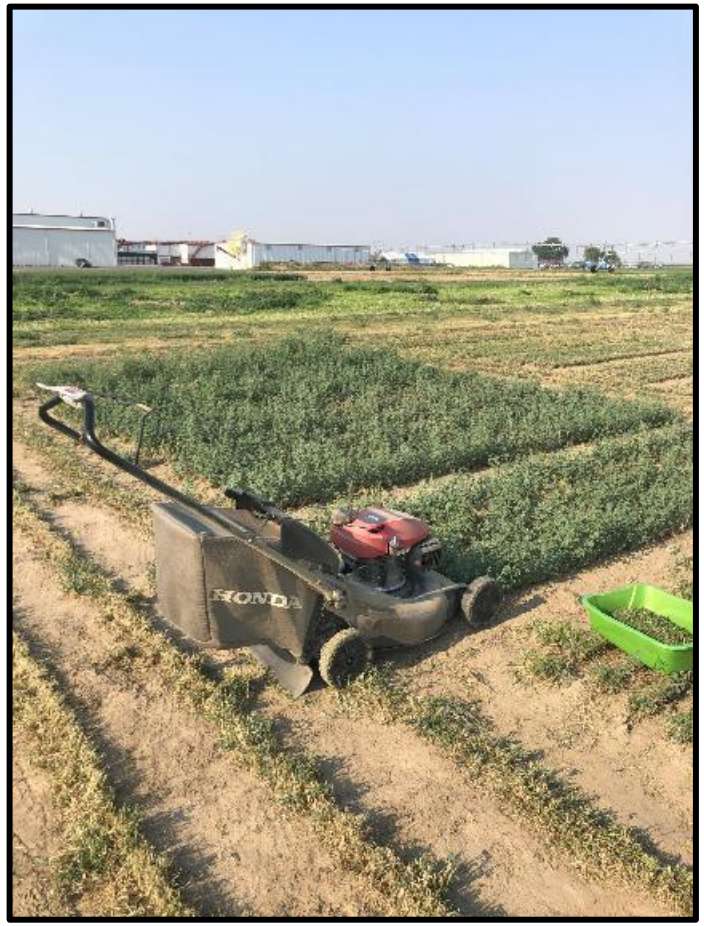
- 7 drought maintenance synthetics
- 7 drought recovery synthetics
- 6 checks

Trial design and management

- 2 Locations: Connell, WA and Rocky Ford, CO
- Plot trial, RCBD with 4 reps
- Sown at 20 lbs/ac in Fall, 2020
- Average annual precipitation: Connell, WA (220 mm), Rocky Ford, CO (315 mm)
- Drought treatment was imposed via deficit irrigation, i.e. full irrigation for 1st cut, 50% irrigation for 2nd cut and no irrigation for remaining cuts

Cycle 1 forage yield trials 2020-2022

Cut 2 2021 - Connell, WA



Cut 3 2021 - Connell, WA

Spatially adjusted BLUEs for forage yield (t/ac)

Entry	Group	Rocky Ford, CO				Connell, WA			Overall
		Year 1	Year 2	Year 3	Total	Year 2	Year 3	Total	
AFX192008	REC	5.0	9.4	7.9	22.2	1.2	3.7	4.9	13.6
AFX194005	MNT	4.9	9.3	8.0	22.2	1.3	3.5	4.8	13.5
NM1715PAR	CHK	4.8	9.6	8.1	22.4	1.1	3.4	4.5	13.5
AFX193009	REC	4.8	9.2	8.1	22.1	1.2	3.5	4.8	13.4
AFX194012	REC	4.8	9.3	8.2	22.3	1.1	3.2	4.4	13.3
AFX194003	MNT	4.9	9.3	7.9	22.0	1.0	3.6	4.6	13.3
AFX194011	REC	5.0	9.2	8.0	22.1	1.1	3.3	4.4	13.3
AFX194004	MNT	4.7	8.9	8.1	21.6	1.2	3.6	4.9	13.2
AFX192001	MNT	4.6	9.1	7.6	21.3	1.2	3.9	5.1	13.2
3043D033-01	CHK	4.6	9.3	7.6	21.5	1.2	3.7	4.9	13.2
NM1713PAR	CHK	4.7	9.5	7.5	21.7	1.2	3.5	4.7	13.2
AFX196014	REC	5.1	9.0	7.7	21.8	1.1	3.1	4.3	13.0
AFX194013	REC	4.5	9.2	7.7	21.4	1.1	3.4	4.5	13.0
AFX196007	MNT	4.9	8.5	8.1	21.4	1.2	3.2	4.4	12.9
AFX194010	REC	4.8	8.5	7.7	21.0	1.3	3.4	4.8	12.9
AFX193002	MNT	4.6	8.9	7.8	21.2	1.1	3.3	4.5	12.8
AFX186041	CHK	4.6	8.7	8.1	21.5	1.1	3.1	4.2	12.8
AFX194006	MNT	4.4	9.0	7.7	21.1	1.2	3.4	4.5	12.8
CW 105023	CHK	4.2	9.1	7.1	20.4	1.2	3.4	4.7	12.5
CW 105006	CHK	4.3	8.8	7.6	20.6	1.1	3.3	4.4	12.5

Results

- No significant difference between groups for overall forage yield
- Forage yield for drought maintenance group was significantly higher than check entries at Rocky Ford, CO ($p = 0.04$)
- No significant difference in persistence between groups
- Significant genotype, location, year and harvest effects
- No significant GxE

Discussion

- Alfalfa has multiple mechanisms to endure severe water deficit
- Struggled to impose severe drought conditions at Rocky Ford, CO due to higher-than-average precipitation
- Low biomass yields in drought studies likely make it challenging to observe differences between groups
- Larger MET study could better identify drought tolerant germplasm
- Drought tolerant synthetics were able to outperform check entries at a single location – encouraging signs for a continued breeding effort
- 2 synthetics from this drought project were advanced
- A new SPN was established in 2023 with selections to be made in 2026

Acknowledgements

- **Suresh Bhamidimarri**
- **Steve Damon**, DLF USA