The Feasibility of Cover Crops in Dryland Farming

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Colorado State University

The New Mexico Sustainable Agriculture Conference
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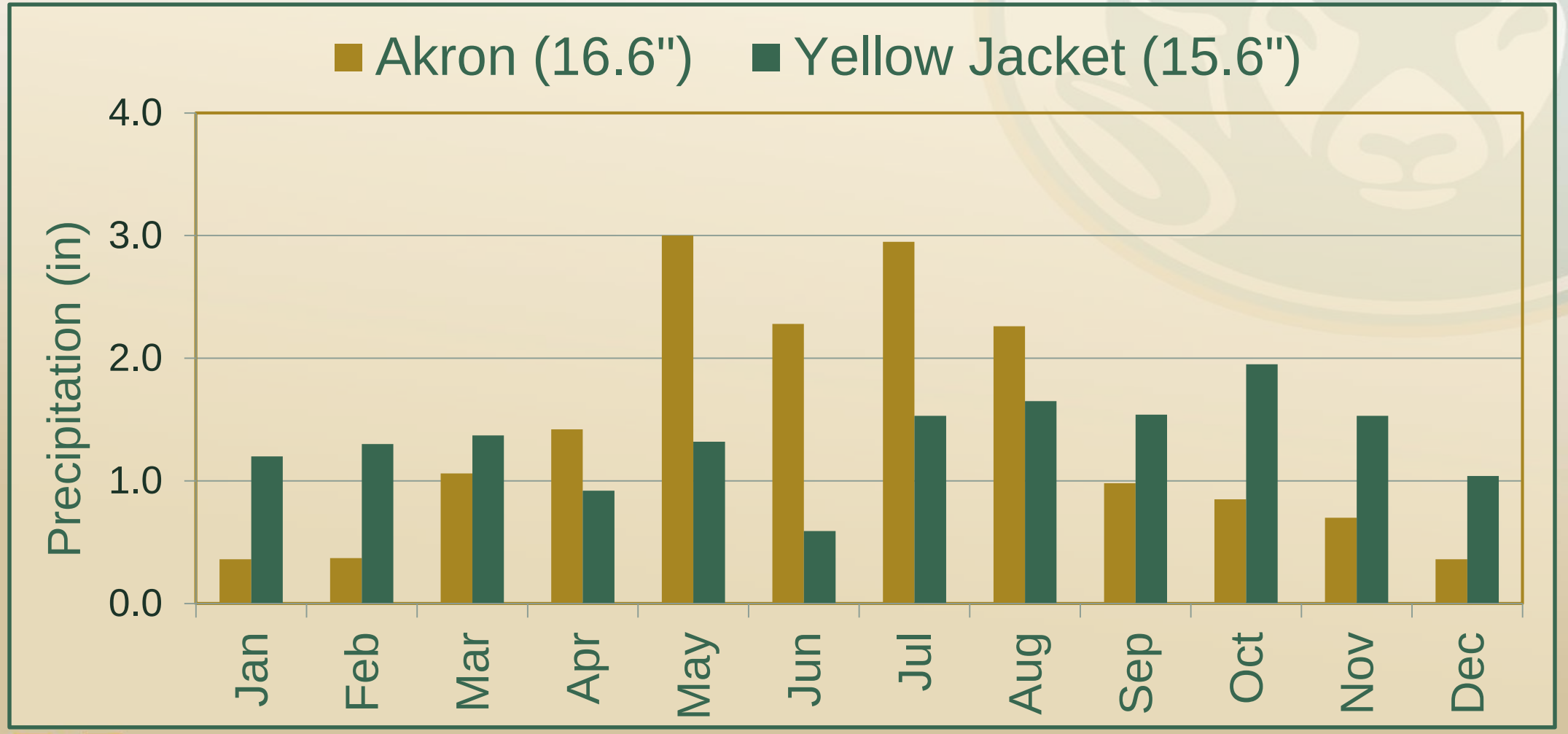
Colorado Plateau/4-Corners Region

- Unique environment
- High elevation
- Finite water resources
- Low & erratic precipitation
- Frequent droughts
- Distance from markets
- Rich cultural history
- Archeological & natural resources
- Resourceful people

Monthly Precipitation



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Low level of inputs

Dryland crop rotations

- Wheat-Fallow
- Wheat-Bean
- Wheat-Sun/Saff-Fallow

Soil management

- Conventional tillage
- Minimum tillage

2011-2013 average crop yield & profit

Crop Rotation	Average yield (lb/ac)	Estimated profit ($)
Winter Wheat-Fallow	739	$12.99
Winter Wheat-Sunflower-Fallow	862	$23.53
Winter Wheat-Safflower-Fallow	827	$18.78
Winter Wheat-Opp. Crop-Sunflower-Fallow	736	$9.75
Winter Wheat-Dry Bean-Sunflower-Fallow	777	$3.71
Winter Wheat-Dry Bean-Dry Bean-Fallow	643	($13.92)
Average	**758**	**$7.55**

Wheat yield in Dolores Co.

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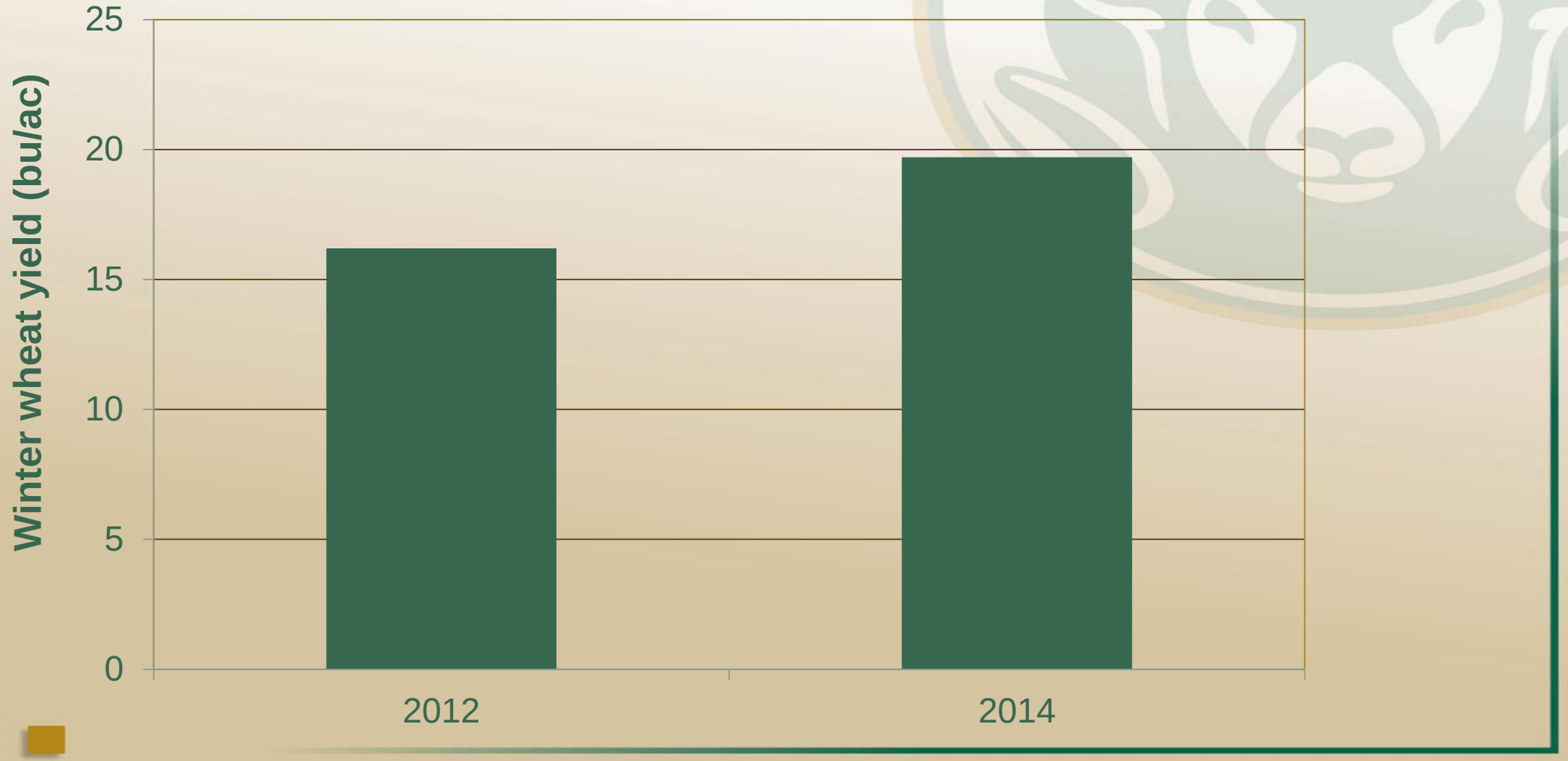

Dry bean yield in Dolores Co.

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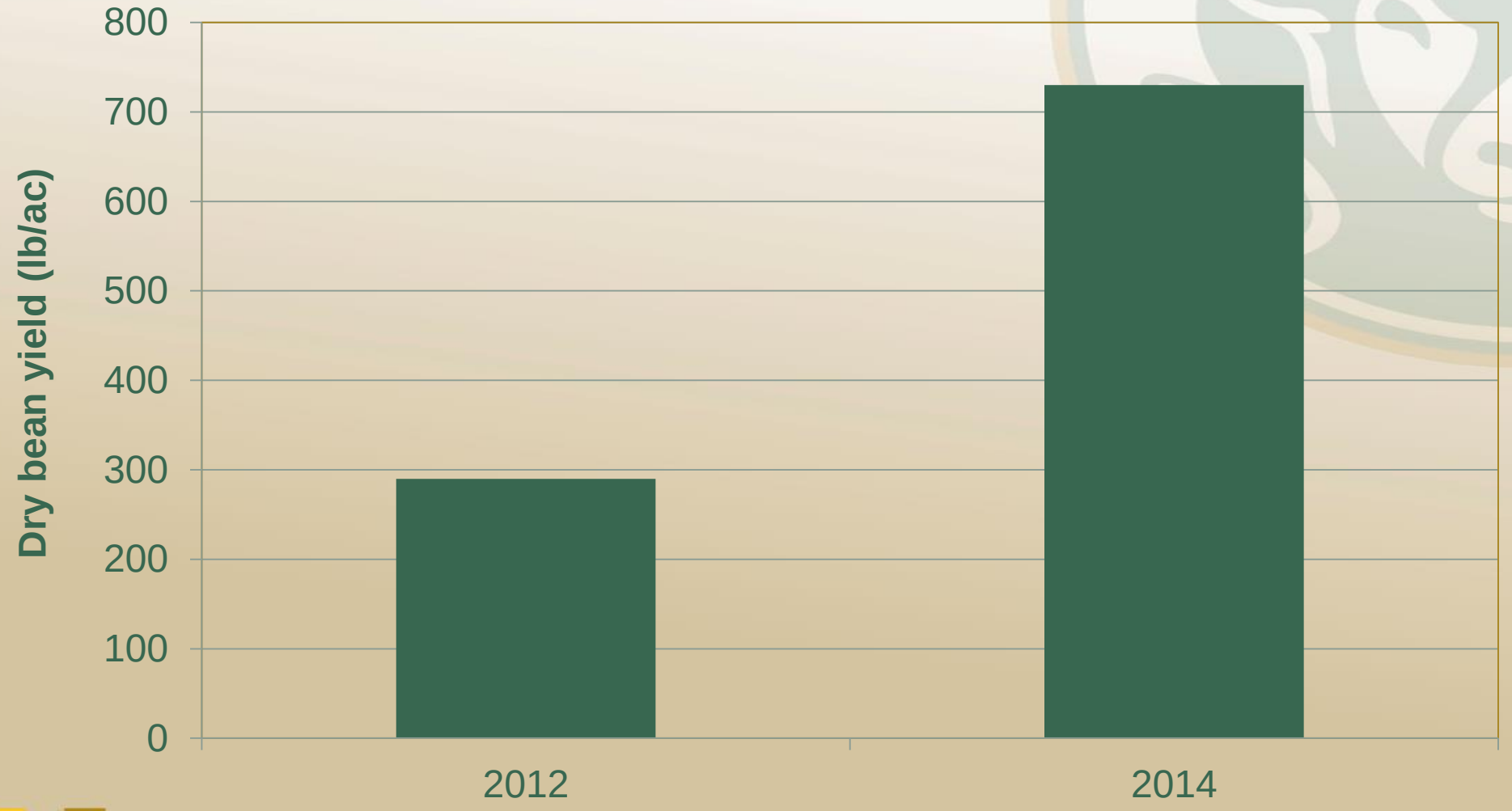

Challenges

- Short Growing season
- Low & variable precipitation/Droughts
- Soil erosion
- Low crop yields
- Distance from markets
- Transportation costs

Opportunities/Solutions

- Conserve soil & water
- Increase level of inputs
- Enhance resource use efficiency
- Grow high cash crops (e.g., organic)
- Diversify & intensify crop production
- Supplemental irrigation!
- Value-added products







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Sustainable ecosystems!

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✓ Permanent pasture + grazing

✓ No-Till/Conservation tillage

➢ Cover crops! Organic farming

- Improve soil health & quality
- Reduce soil erosion
- Suppress weeds

The Feasibility of Cover Crops in Dryland Cropping Systems in SW Colorado and SE Utah

Colorado State University

Abdel Berrada (PI)

WESTERN SARE
Sustainable Agriculture Research & Education

Colorado State University
College of Agricultural Sciences
Agricultural Experiment Station

Colorado State University
Extension

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

HIGH DESERT CONSERVATION DISTRICT

DOVE CREEK Conservation District

Western SARE Project SW15-008 GOAL

Determine if & *how* **cover crops** can enhance the **sustainability** of **dryland farming** in SW Colorado & SE Utah.

Cover Crop vs. Forage Crop Terminology (Holman et al., 2016)

- Cover crops are grown to provide agroecosystem "benefits" but not harvested.
- Forage crops are grown for "feed" that is either hayed or grazed.
- Forage crops can be managed for residue cover.

Objectives

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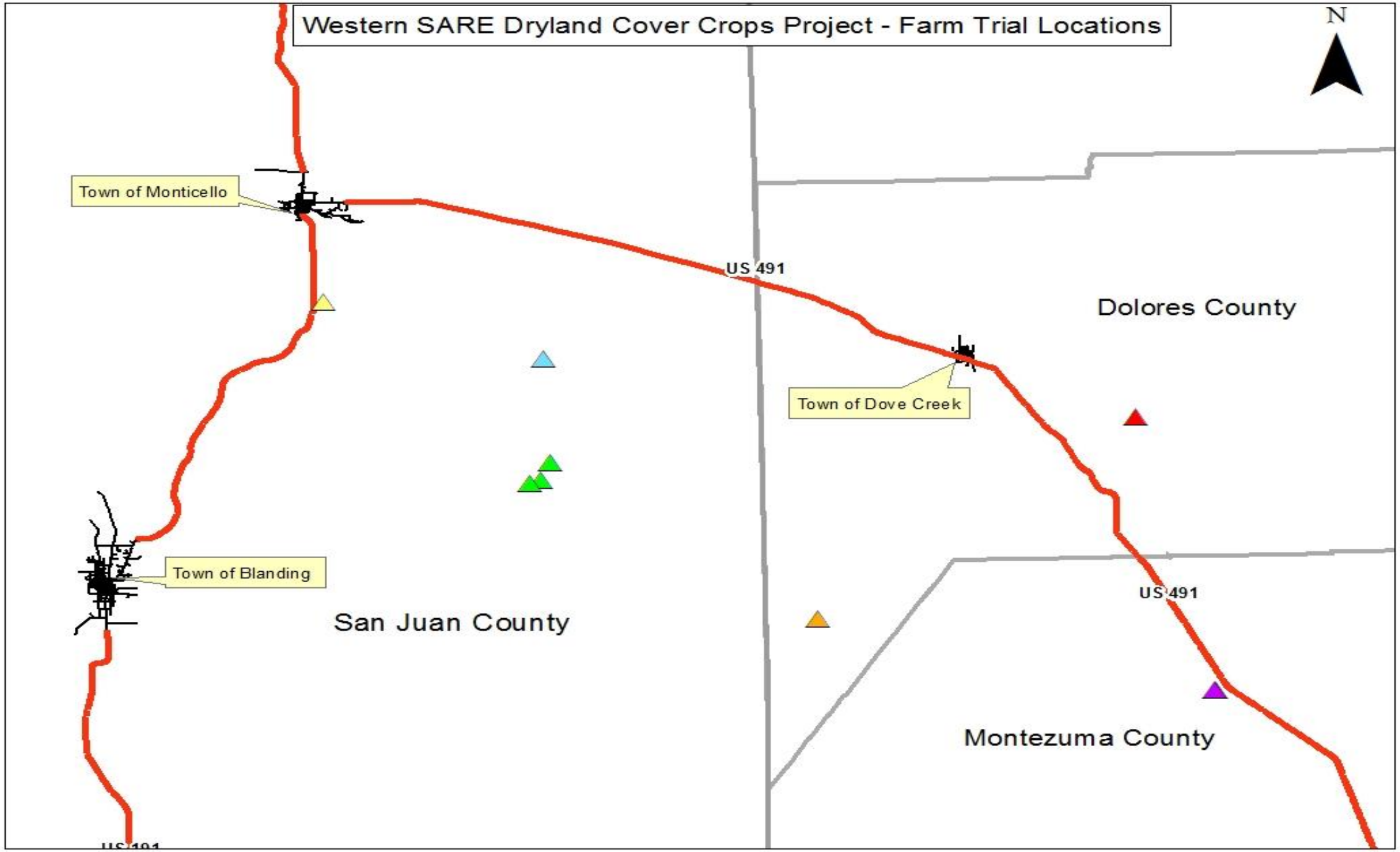
- ***Agronomic feasibility:*** quantify the effects of CCs on soil moisture, soil fertility & quality, weed control, and cash crop.
- ***Economic viability*:** determine which cover cropping strategies are profitable.
- ***Education & Outreach*:** share project findings & promote soil health.


Western SARE Dryland Cover Crops Project - Farm Trial Locations
N
Town of Monticello
US 491
Dolores County
Town of Dove Creek
Town of Blanding
San Juan County
US 491
Montezuma County

Materials & Methods

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- ✓ Three-yr. project started in Summer of 2015
- ✓ Total of ten field trials representing two crop rotations (W-F, W-SA-F) and three management practices (CT & NT, Conventional & Organic crop production)
- ✓ Nine summer/fall-planted cover crop mixes and six spring-planted cover crop mixes (CCM) have been tested on farmers' field and at the SWCRC.
- ✓ Number of species in the mix: 3 to 10

Cover Crops Selection Criteria

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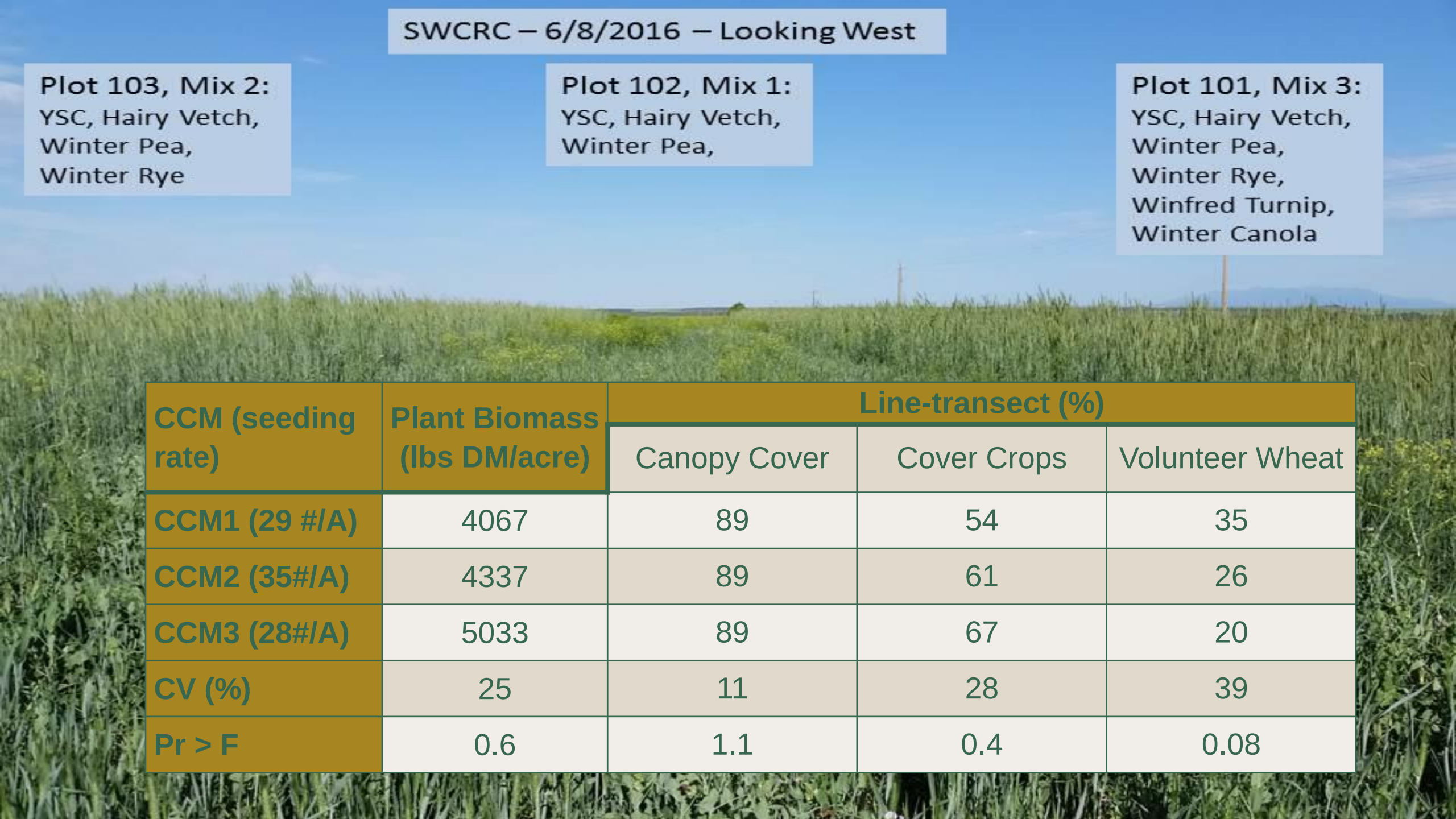
- ✓ **On-farm trials: Collaborating farmer & NRCS select the CCM, in coordination with CSU-SWCRC.**
  - ✓ **Objectives sought (N fix., biomass production, weed control, etc.)**
  - ✓ **Seed availability**
  - ✓ **Seed cost**
- ✓ **Tools: Green Cover Seeds SMARTMIX, local knowledge, experience**

- ✓ Soil water content & infiltration rate
- ✓ Traditional soil test analysis
- ✓ Haney soil health test
- ✓ Soil microbial community (PLFA)

PLANT MEASUREMENTS

- ✓ *Canopy & ground cover (line-transect method)*
- ✓ *Plant biomass*
- ✓ *Cash crop yield and quality*
- ✓ *OTHER: Costs & returns*



CCM (seeding rate)	Plant Biomass (lbs DM/acre)	Line-transect (%)		
		Canopy Cover	Cover Crops	Volunteer Wheat
CCM1 (29 #/A)	4067	89	54	35
CCM2 (35#/A)	4337	89	61	26
CCM3 (28#/A)	5033	89	67	20
CV (%)	25	11	28	39
Pr > F	0.6	1.1	0.4	0.08

BN – Oct. 29, 2015

Winter Peas-25%, Yellow sweet clover-5%, Berseem Clover-10%, Teff-5%, Sorghum-Sudangrass-10%, Proso Millet-10%, Nitro Radish-5%, Purple Top Turnip-5%, Sunflower-5%, Buckwheat-20% @ 20 lbs/ac

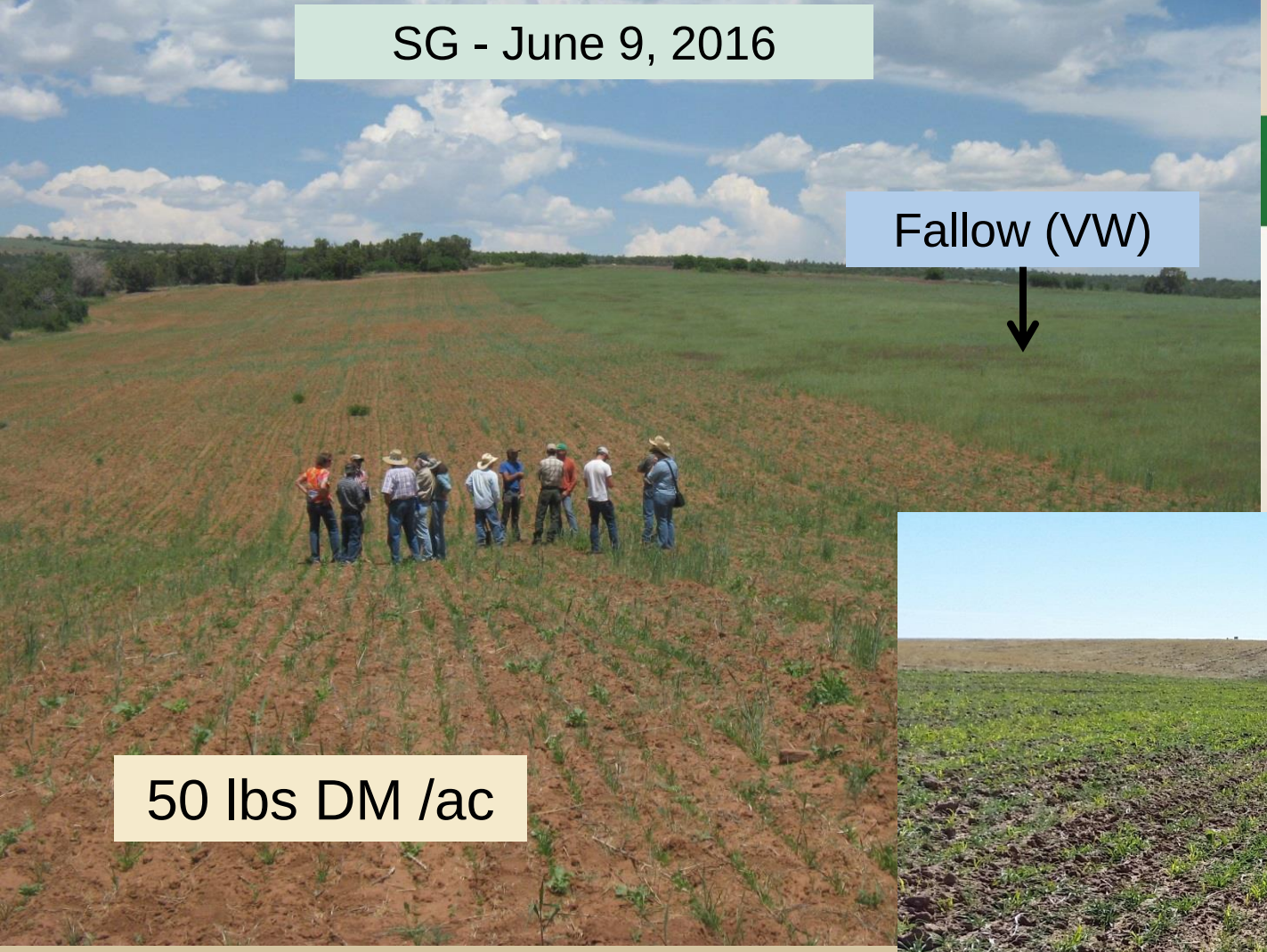
BN Sampling period	Plant DM (lbs/ac)	Canopy Cover (%)	Cover Crop Canopy (%)
Fall'15	966	44	44
Spring'16	1527	75	67

BSW – Early June 2016

Pea-26%, Oat-32%, Barley-32%, Rapeseed-3%, Safflower-3%, Flax-5% @ 15 lbs/ac

SG - June 9, 2016

Fallow (VW)



50 lbs DM /ac

Cover Crops: Balansa Clover, Crimson Clover, Ryegrass, Tillage Radish @ 15 lbs/ac

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Cover Crops: SSG, Barley, Dry Bean, Oat, Corn, Peas (2), Sunflower @ 34 lbs/ac

SG - October 14, 2016

230 lbs DM /ac

Soil & Yield Data @ SWCRC#1

Treatment	September 2016		July 2017	
	0-3 ft. Soil moisture (%, g/g)	NO_3-N (lbs/ac)	Wheat Yield (bu/ac)	Grain Protein (%)
CCM	12.5	36.3	44.8	12.2
Fallow	**17.8**	**62.3**	**61.4**	**13.2**
CV (%)	16.9	11.3	2.9	2.9
Pr > F	0.03	0.00	0.00	0.03

Soil (9/16) & Yield Data (7/17) @ SB

CCM vs. Fallow	BN % Soil moisture* (0-2 ft)	BESW % Soil moisture* (0-2 ft)	BN NO_3-N (lbs/ac)	BESW NO_3-N (lbs/ac)	BN Wheat (bu/ac)	BESW Wheat (bu/ac)
CCM	9.2	9.3	19.8	23.8	26.2	25.2
Fallow	14.0	12.8	36.6	42.0	32.4 NS	32.5

**by weight*

Plant Biomass @ SWCRC#2 on June 19, 2017

CCM planting date	Plant Biomass (lbs DM/ac)	Contribution (% of DM)			
		Cereals	Legumes	Brassicas	Volunteer wheat
August 2016	3438§	0	1.2	0	85
April 2017	713	50	40	2	6

§Significant at α=0.0001

Cover Crop Mixes at SWCRC#2 -- August 2016

CCM (lbs/ac)	Cover Crop Species (% by weight)
CCM1 (25)	Winter Pea (67%), Berseem Clover (4%), Yellow Sweet Clover (1%), Sorghum-Sudangrass (11%), Proso millet (8%), Teff (4%), Nitro Radish (2%), Purple Top Turnip (1%), Sunflower (2%)
CCM2 (33)	Winter Pea (85%), Flax (10%), Nitro Radish (3%), Rapeseed (1%), Impact Forage Collards (1%)
CCM3 (43)	Winter Pea (66%), Winter Triticale (31%), Rapeseed (2%), Purple Top Turnip (1%)
CCM4 (35)	Winter Pea (54%), Yellow Sweet Clover (4%), Winter Triticale (38%), Rapeseed (2%), Nitro Radish (2%)
CCM5 (38)	Winter Pea (50%), Hairy Vetch (8%), Winter Triticale (35%), Sorghum-Sudan (5%), Nitro Radish (2%)

Cover Crop Mixes at SWCRC#2 -- April 2017

CCM (lbs/ac)	Cover Crop Species (% by weight)
CCM6 (24)	Hairy vetch (14%), spring pea (62%), oat (16%), rapeseed (1%), flax (2%), safflower (4%)
CCM7 (10)	Balansa clover (40%), crimson clover (20%), annual ryegrass (30%), EcoTiller radish (10%)
CCM8 (22)	Crimson clover (2%), spring pea (67%), spring barley (25%), Nitro radish (7%)

Soil Data @ SWCRC#2 in September, 2017

Treatment	0-3 ft. Soil Moisture (%, g/g)	NO_3-N (lbs/ac)
Aug'16 CCM -- CT	11.0	11.0
Aug'16 CCM -- NT	11.8	14.2
April'17 CCM -- CT	14.6	17.5
April'17 CCM -- NT	14.3	17.8
CT Fallow	16.9	30.0
NT Fallow	16.6	31.3
CV (%)	14.8	10.9
Pr > F	0.00	0.00

Preliminary Conclusions

2 yrs of data [2015-2016 (17.5”), 2016-2017 (12.6”)]

3 trials with a complete crop rotation

Unique environment & No prior research data

More data: infiltration rates, PLFA, etc.

How Much Biomass to Increase SOM By 1%?

ASSUMPTIONS

0-3 inch soil depth - 1,000,000 lbs of soil

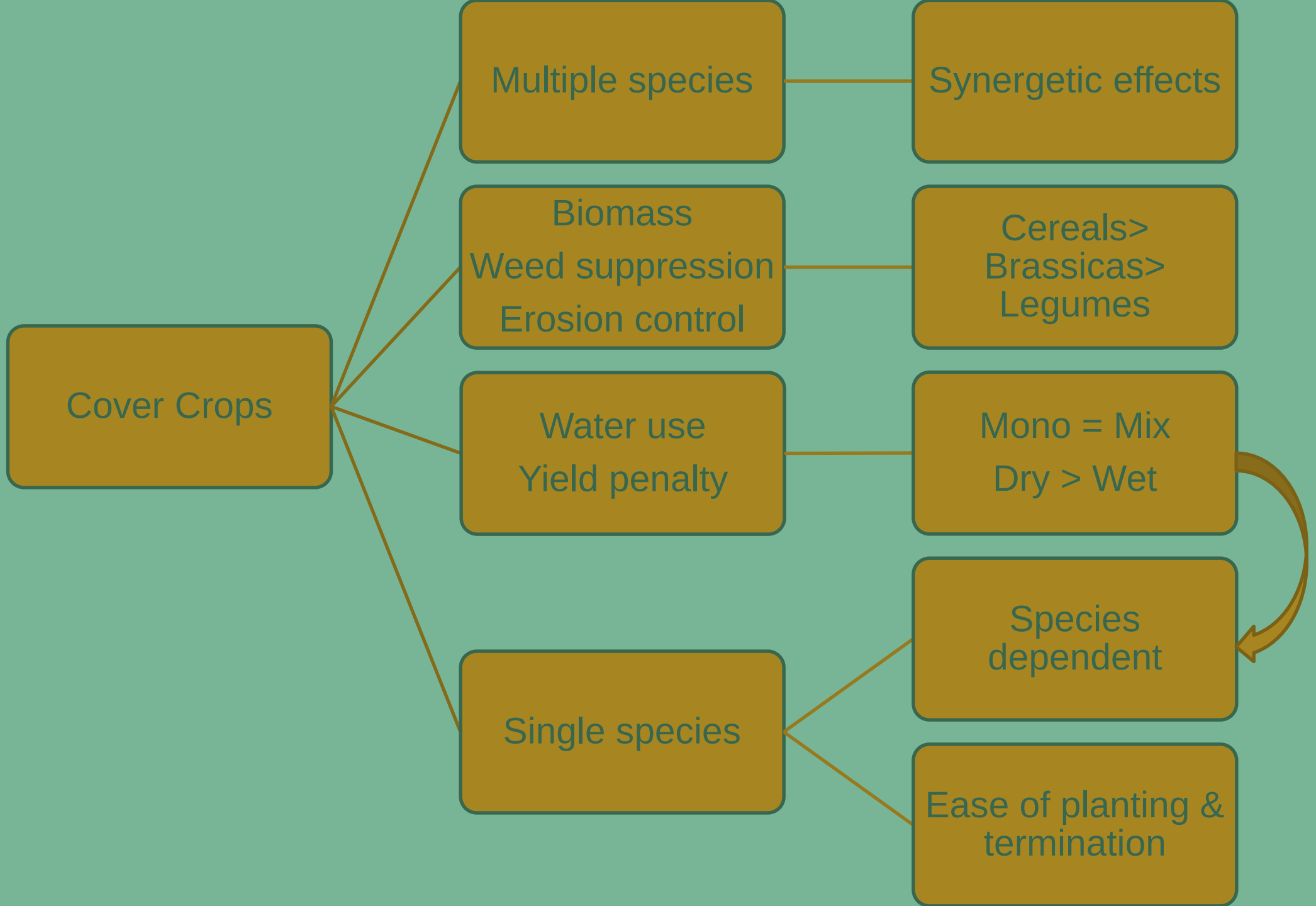
10% of residue becomes OM, rest is mineralized

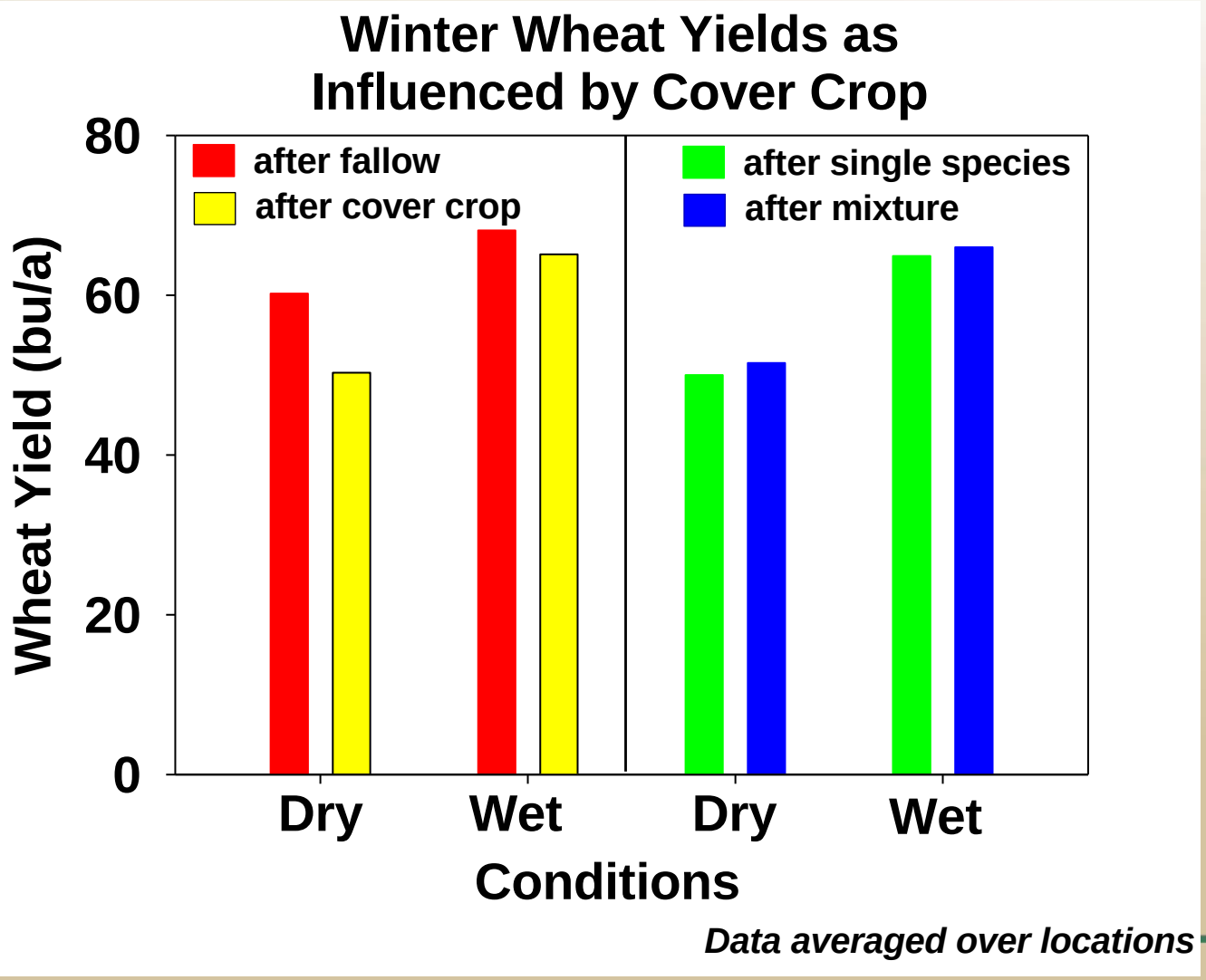
ANSWER

100,000 lbs or 50 tons of residue

- Too early to draw conclusions BUT the results to date are not in favor of cover crops in dryland farming in SW Colorado & SE Utah
  - Cover crops depleted soil moisture and N.
    - Apply N fertilizer?
  - Cover crops depressed wheat yield.
- Longer term: Increased SOM, infiltration, biological activity…
- Impacts on soil erosion & weed control (CC vs NT)

- Plant biomass: Fall planting > Spring planting
- Number of species in the mix
  - Species adaptation (pea, winter cereals, brassicas, SSG!)
  - Management (planting & termination dates, seeding depth & rate, legume seed inoculation, etc.)
  - Seed cost


Cover Crops
Multiple species
Synergetic effects
Biomass
Weed suppression
Erosion control
Cereals>
Brassicas>
Legumes
Water use
Yield penalty
Mono = Mix
Dry > Wet
Single species
Species
dependent
Ease of planting &
termination



- Cover crops study in the Central Great Plains
- John Holman et al, March 18, 2016, Four States Ag Expo, Cortez, CO.

Holman et al., 2016 (continued)

- Cover crops USE water
- Cover crops CAN be profitable IF hayed or grazed
  - Irrigation makes this easier to accomplish
- Reducing fallow increases RISK of crop failure in semi-arid dryland production

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DRYLAND COVER CROPS

Prospective Students

Welcome Collaboration Colorado Utah Resources Video

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