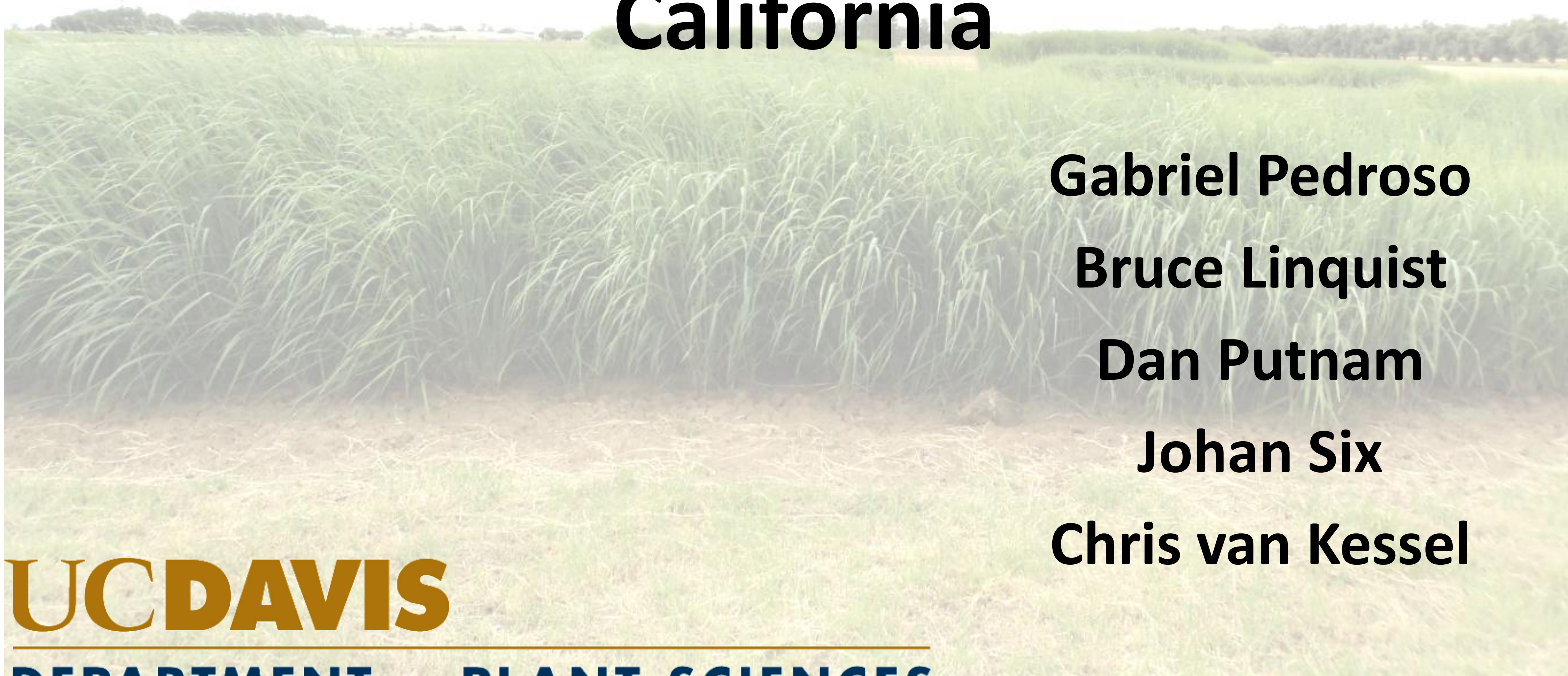
1st Brazilian BioEnergy Science and Technology Conference
Campos do Jordão - August - 14 to 18, 2011

Nitrogen and Water Use in Low and High-Input Irrigated Switchgrass (*Panicum virgatum*) Systems in California



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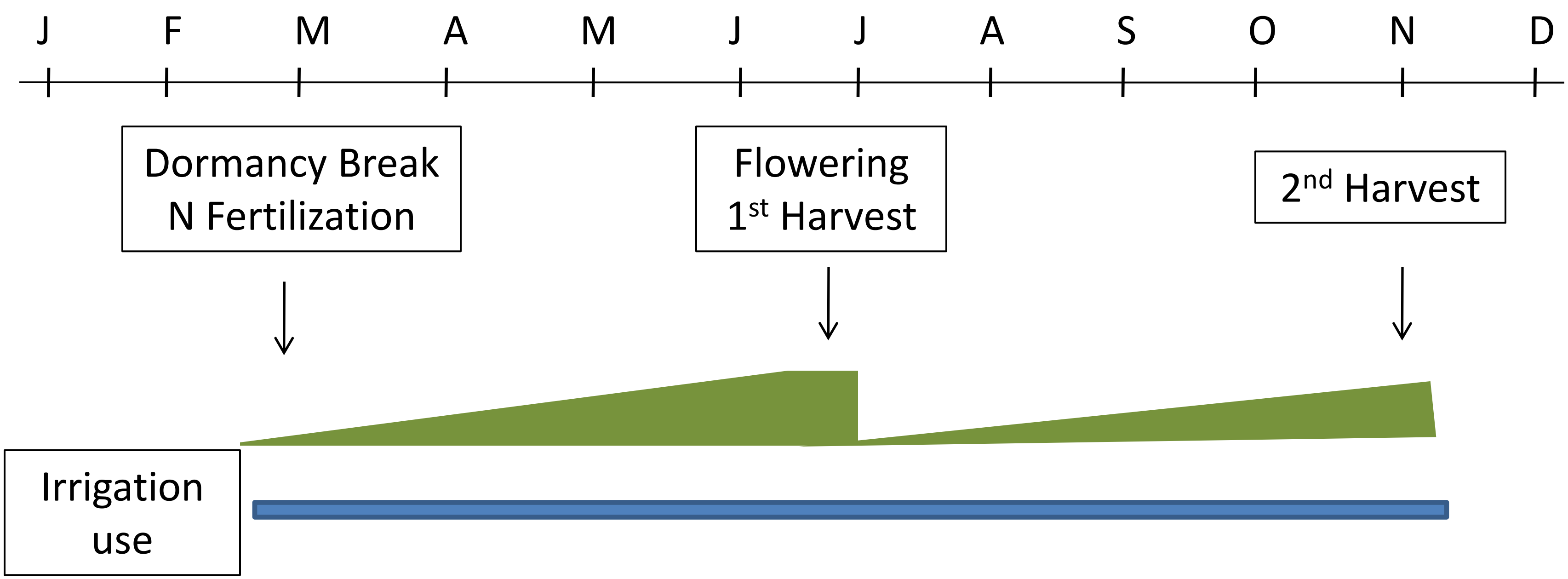
Background

- Switchgrass (*Panicum virgatum*) is a perennial C_4 grass native to the central north American prairie.
- Traditionally used as a pasture and forage, recently has received attention as a promising biofuel crop.
- Management as a biofuel crop differs from forage management.
- Reported yields under biofuel management range from 5.5 to 25 t ha^{-1}.
- Variable and conflicting response to N fertilization.
- Very little information about switchgrass production in irrigated regions and in Mediterranean climates.

Switchgrass in California

- Two-harvest system (July and October).
- Irrigation used throughout the entire growing season.
- Above ground (AG) biomass yields up to 30 t ha^{-1} yr^{-1}.
- Lowland ecotype varieties indicated to the Central Valley.



Switchgrass in California

Problems

- 1st Harvest (July):
  - 70% of the annual biomass.
  - High N removal (green plants).
- 2nd harvest (October):
  - 30% of the annual biomass.
  - Requires additional inputs (irrigation, fertilization, field operations).

- Switchgrass translocates N to belowground (BG) biomass in response to drought and during senescence. However, it has not been quantified.

Rationale

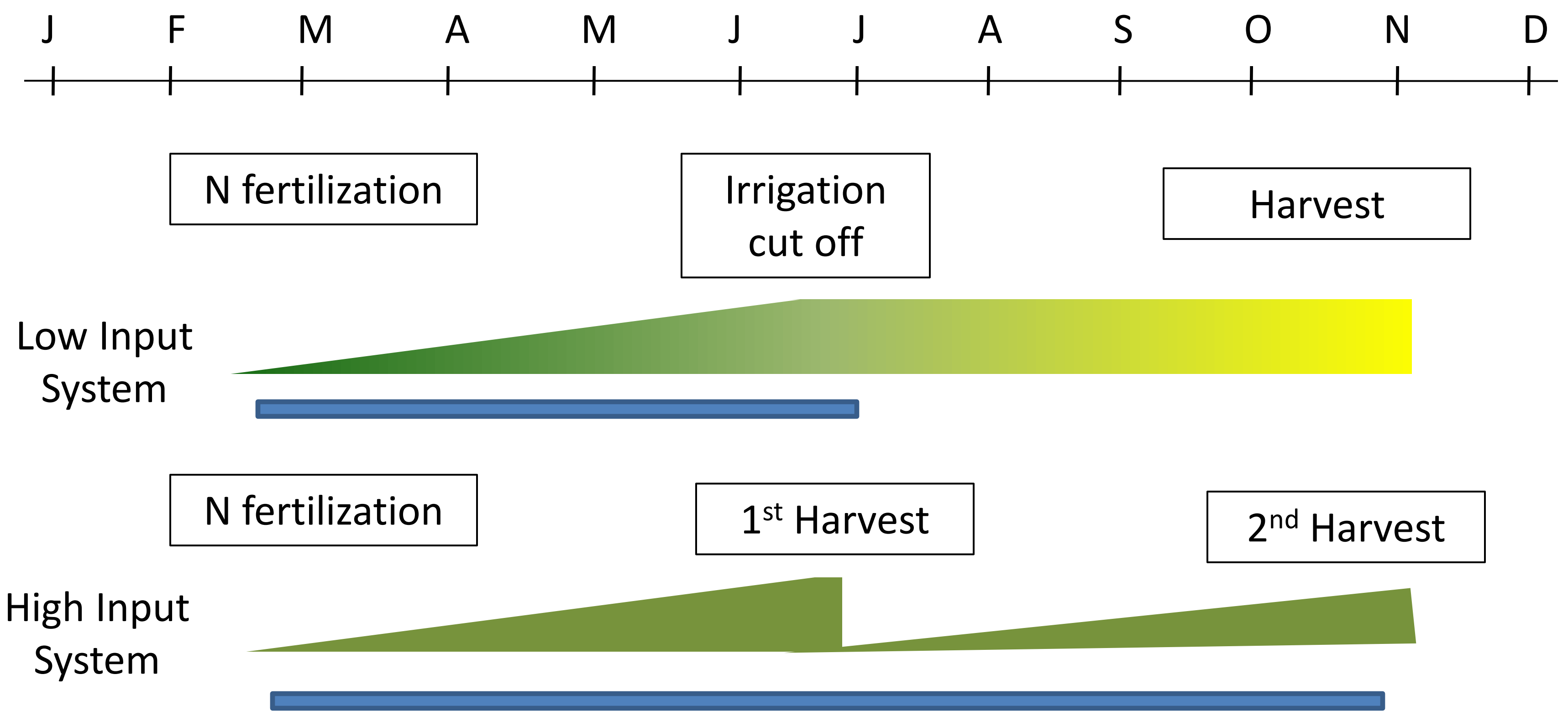
Single-harvest (Oct) system:

- High biomass production.
- Determinate growth, no biomass accumulation after flowering:
  - Irrigation could be cut off, leading to water savings.
- Uses the internal mechanism of N conservancy within the plant:
  - N translocation from AG to BG biomass during senescence.
  - Reduced N removal by harvest.
- Fewer field operations, lower energy input.

A single-harvest system would require lower-inputs than two-harvest systems.

Low and High Input System

- Low-input system: 1 harvest (Oct), irrigated until flowering (July).
- High-input system: 2 harvests (July and Oct), irrigated during the entire growing season.



Hypothesis and Objectives

Hypothesis	Low-input	High-input
Biomass yield	High	Higher
Irrigation use	Low	High
IUE (biomass/irrigation)	High	Low
N translocation during senescence	Yes	No
N removal	Low	High
NUE (biomass/N removed)	High	Low
N in below ground biomass	High	Low

Objectives:

a. Determine biomass production and irrigation use.

b. Determine yield response to N fertilization and NUE.

c. Determine fertilizer N recovery and losses in the plant-soil system with the use of ^{15}N enriched fertilizer.

d. Quantify N removal, N translocation during senescence to BG biomass and N carry-over to subsequent years through the use of ^{15}N enriched microplots.

Materials and Methods

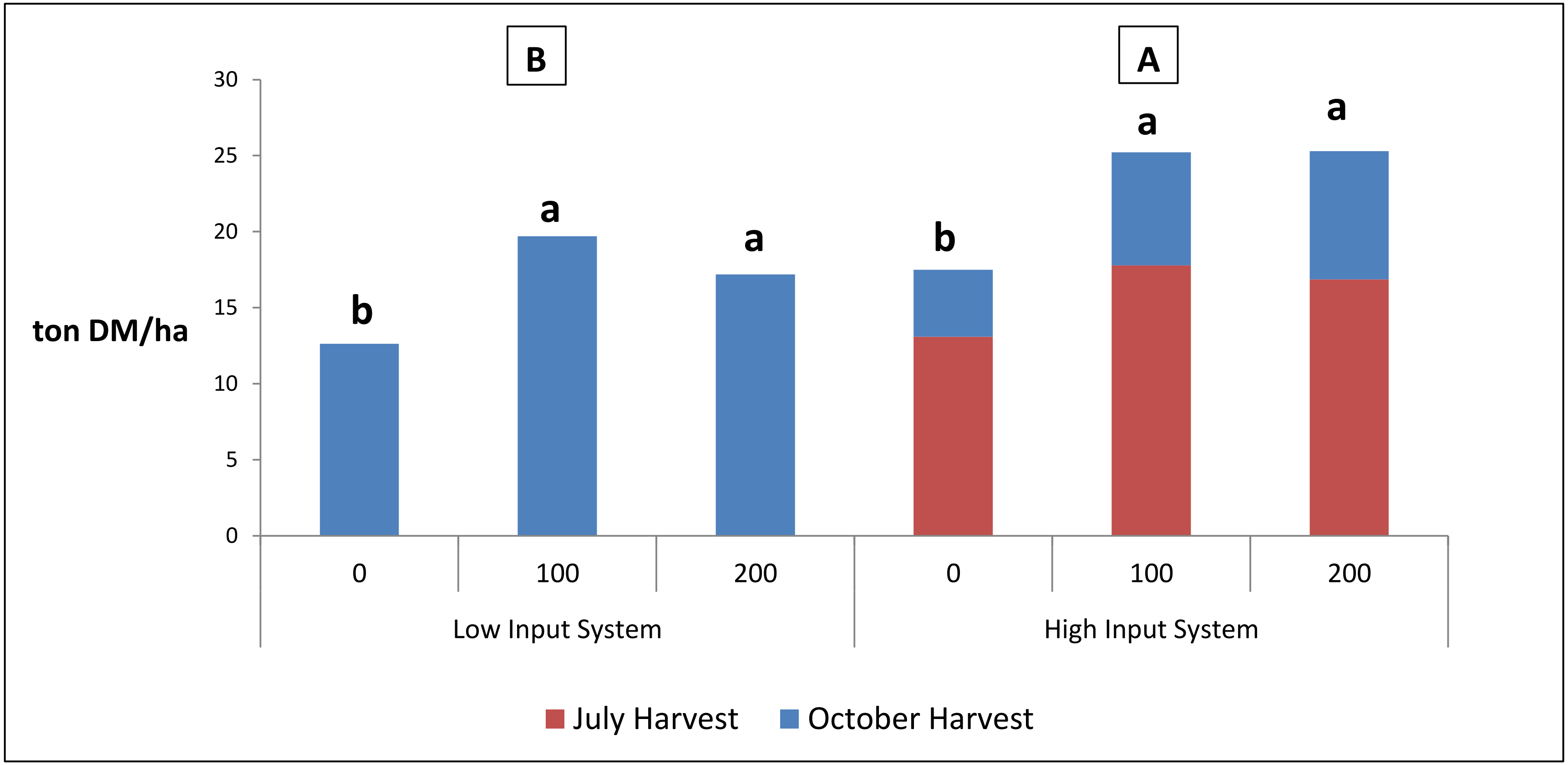
- Location: Davis, CA.
- Split-plot RCBD, 4 replications.
- Lowland ecotype variety ‘Alamo’.
- Main treatments: low and high input system.
- Sub-treatments: 0, 100 and 200 kg N ha^{-1} yr^{-1} surface applied in spring as ammonium sulfate.
- Irrigation according to evapotranspiration, 180 mm of water applied at each irrigation event.
- Sampling and measurements:
  - Above ground biomass, N concentration and water applied.

Materials and Methods

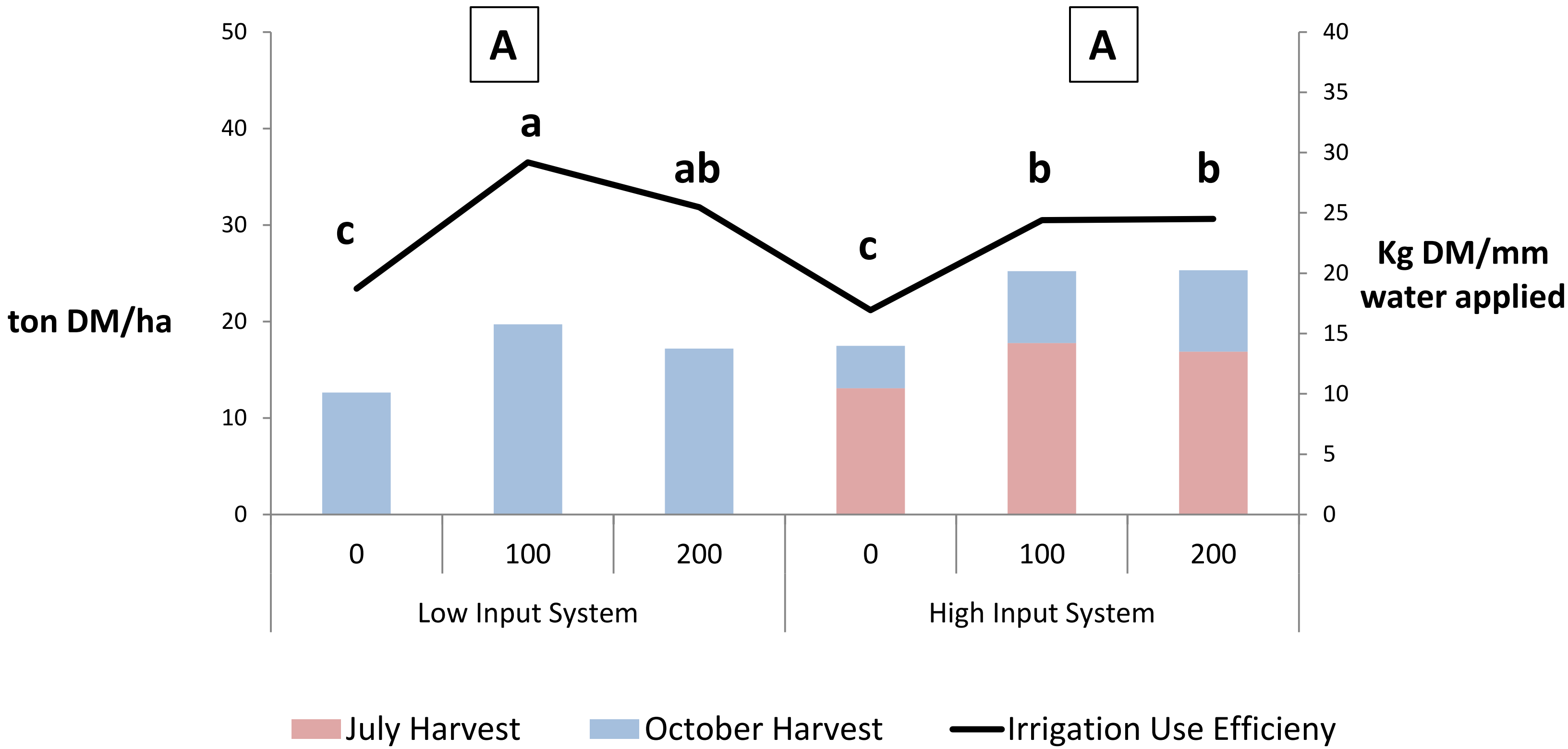
- ^{15}N microplots :
  - Only in the 100 kg N ha^{-1} yr^{-1}.
  - Single application of 10% ^{15}N enriched ammonium sulfate in spring of the first year. Fertilizer recovery measured at the end of the 1st, 2nd and 3rd growing seasons in plant and soil.

- ^{15}N fertilizer recovery:
  - Above ground and residues biomass.
  - Crown and roots biomass and soil, down to 3 m.

1^{st} Year Results
Biomass and Yield Response to N

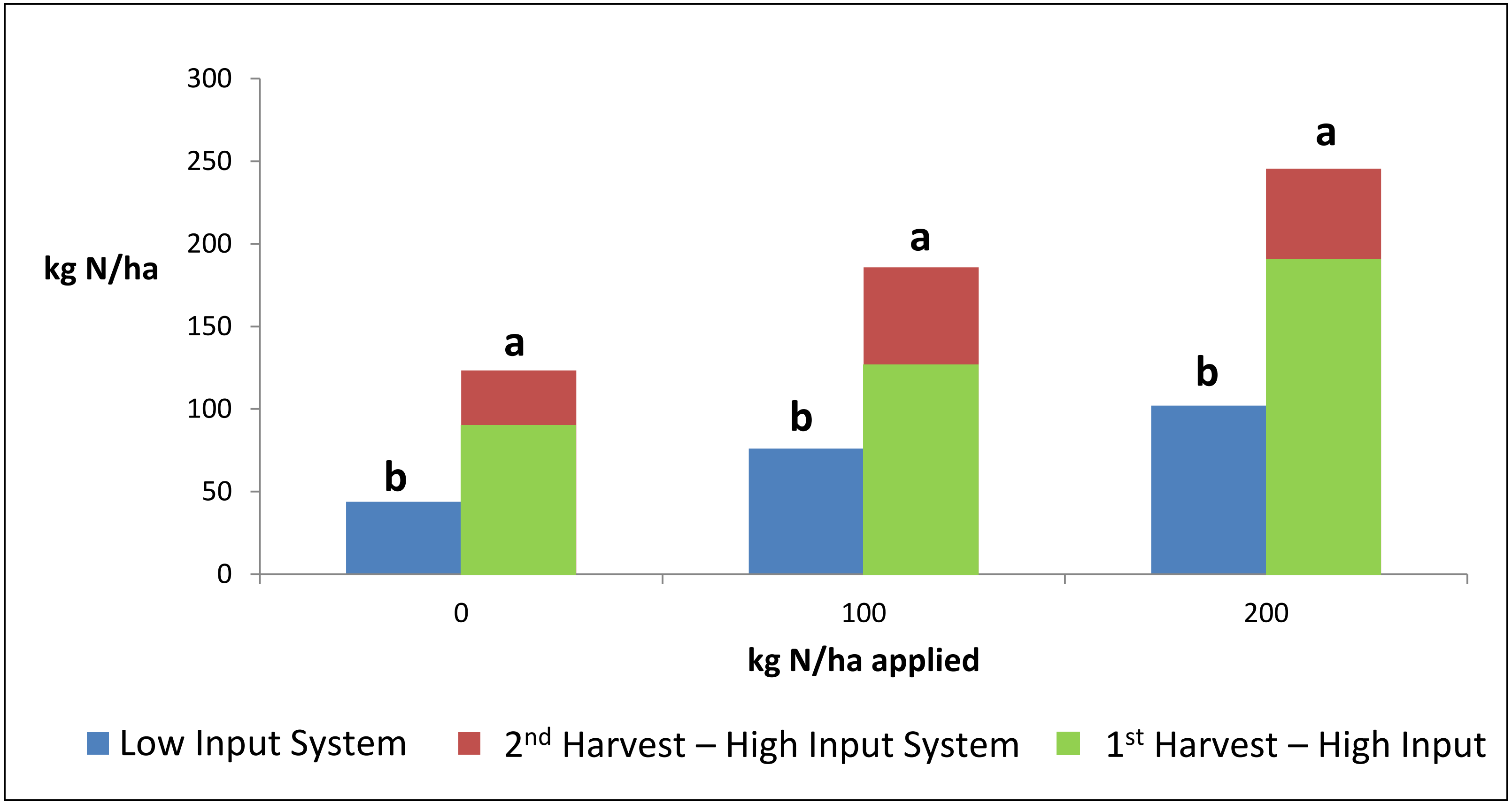


1st Year Results
Irrigation Use Efficiency



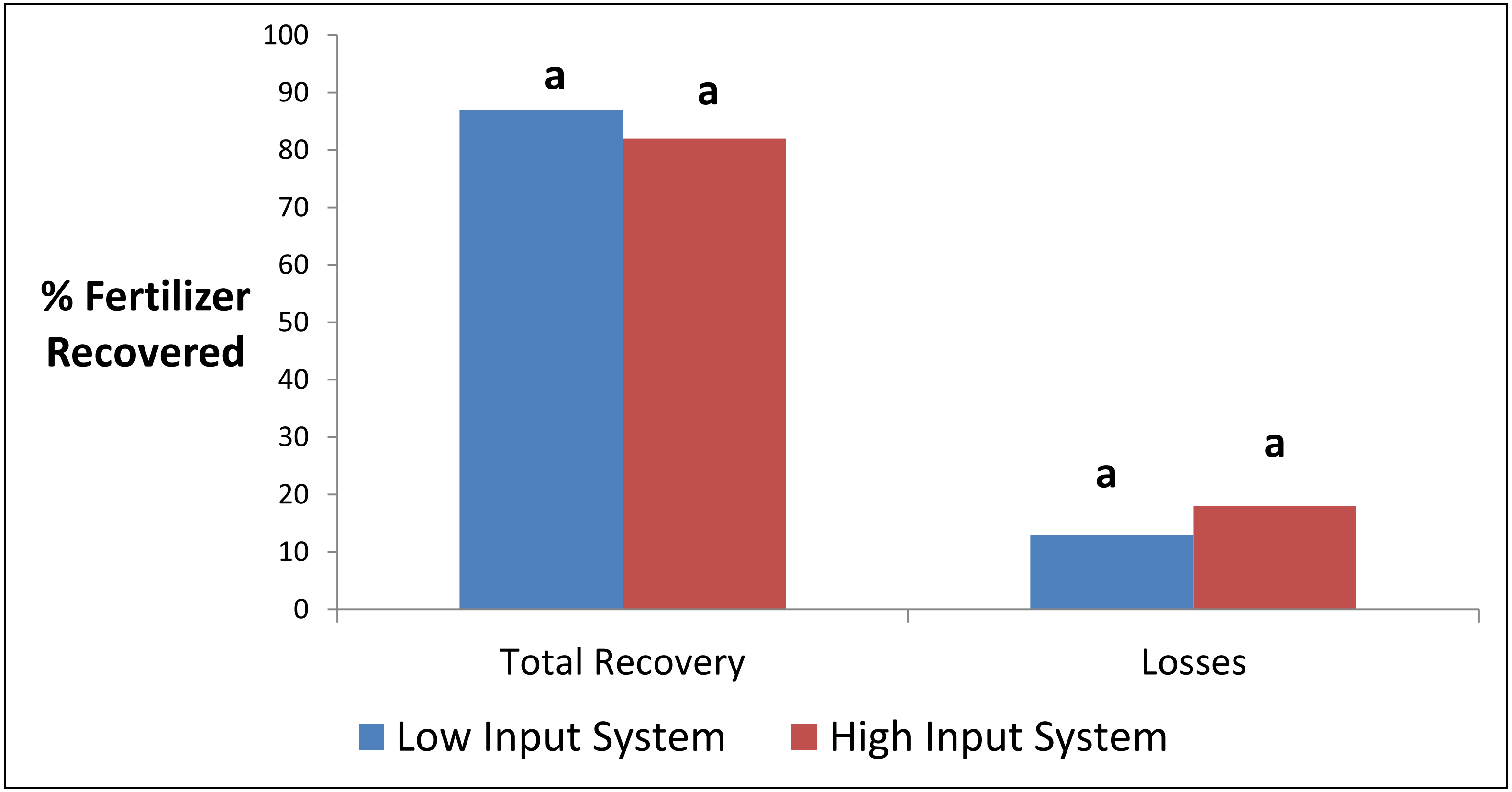
Water applied
Low Input: 650 mm yr^{-1}
High Input: 1050 mm yr^{-1}

1st Year Results
Crop N Removal

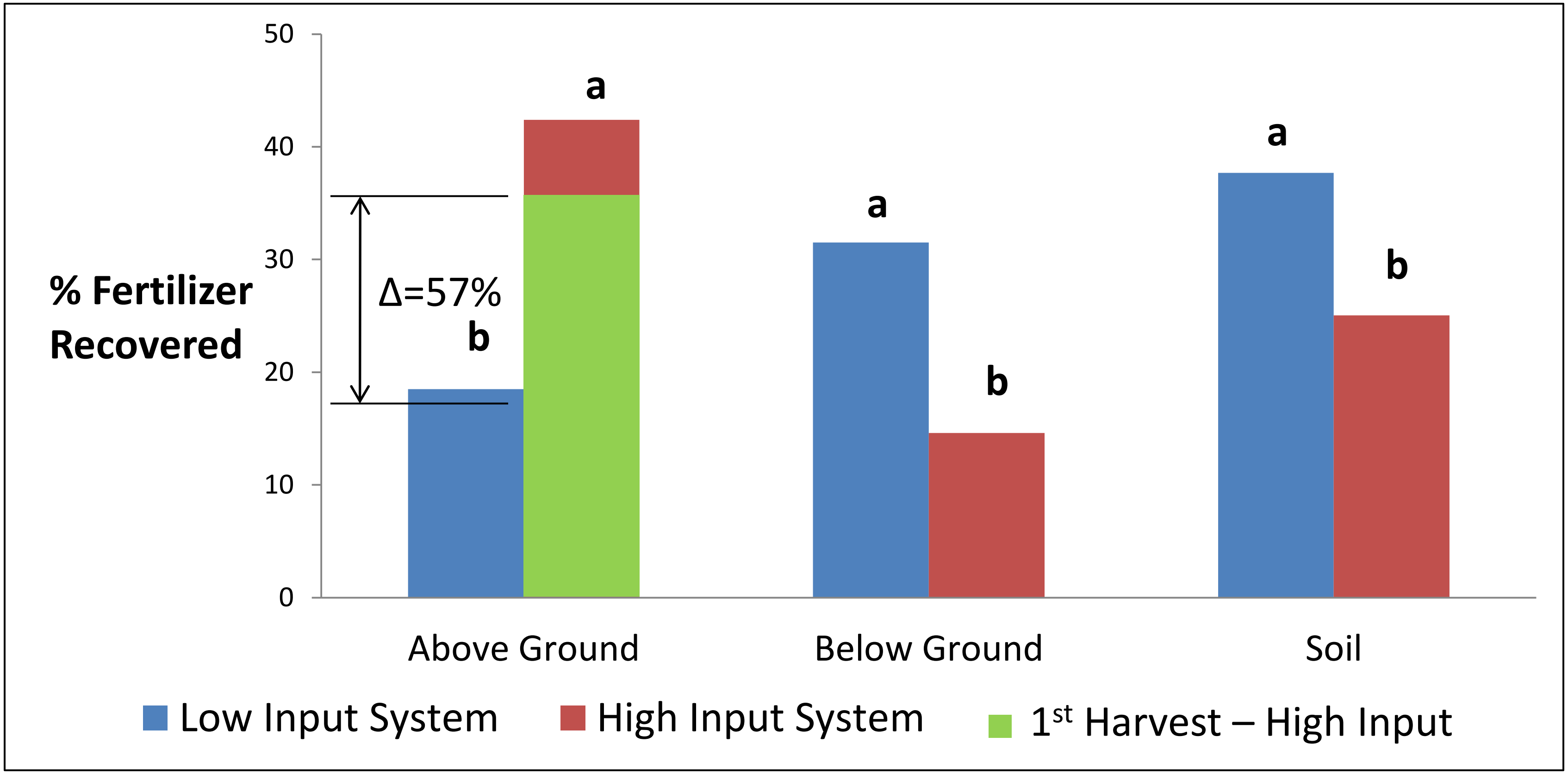


1st Year Results
Microplots - ^{15}N Fertilizer Recovery

Total fertilizer recovery (soil + plant).



1st Year Results
Microplots - ^{15}N Fertilizer Recovery



Key Points - % Change in High Input System

Summary		**% Change**
Biomass	t ha^{-1}	+ 28
Water use	mm yr^{-1}	+ 53
N removal	kg ha^{-1}	+ 143
Fertilizer N removal		+ 133
Fertilizer N in below ground biomass	% applied	-52
Fertilizer N in soil		-33

Questions

Funding: CAPES Foundation/Brazil, Chevron Corp.

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