Green Fields in Winter -

the Legacy of Alabama's Old Rotation Experiment (c. 1896)

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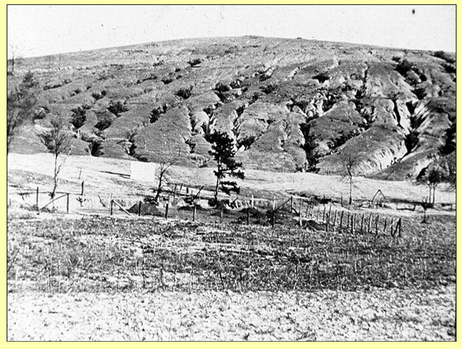
The Old Rotation experiment was placed on the National Register of Historical Places in 1988 as the oldest cotton study in the USA. Today, it is the oldest cotton study in the world and one of the world's oldest cover crop studies.

ABSTRACT

In the late 1800s, the Southern U.S. was producing most of the world's cotton on highly erodible soils with little or no lime or fertilizer inputs. Continuous cotton with no cover crops was taking a toll from the land and its farmers. Land Grant Universities and Experiment Stations were just getting started when Professor J.F. Duggar at Alabama Agricultural and Mechanical College (now Auburn University) established an experiment to test his theories that agriculture could thrive if farmers would ". . . keep their fields green in winter." Thus began Alabama's "Old Rotation" experiment (circa 1896) the oldest, continuous cotton experiment in the world and one of the first to demonstrate the soil quality improvements of using cover crops. It was listed on the National Register of Historical Places in 1988 and has continued to remain relevant by initiating conservation tillage, in-row subsoiling, irrigation, IPM and using data to support topics such as "sustainable agriculture", "soil health", and "nutrient use efficiency".

BACKGROUND



By the late 19th Century, continuous cotton production on highly erodible lands with no cover crops had taken a toll on most Southern cropland.

Professor J. F. Duggar at the Agricultural and Mechanical College of Alabama began an experiment in 1896 to test his theories that cover crops and crop rotations could sustain crop production on these soils. Today, Professor Duggar's experiment is known as the "Old Rotation". Photo shows Prof. Duggar standing in a mixture of crimson clover and hairy vetch in the Old Rotation around 1910.

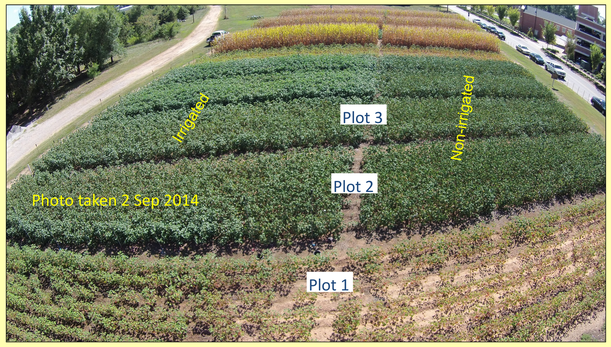


Image of "Old Rotation" from looking South from plot 1. Plots 1, 2 and 3 are exactly the same treatment except plots 2 and 3 are planted to a winter legume cover crop each fall. The left is irrigated and the right is not irrigated. The crop is cotton. Mature corn is on plots In the background.

METHODS

The original test consisted of 13, non-replicated treatments (plots) on 1-acre of land (photo above). Changes over time have now resulted in some treatment replications. Each plot is 6.5 m wide by 41.5 m long. In 2003, irrigation was installed on half of each plot. For the first 100 yr the experiment was managed using conventional tillage. Since 1997, it has been managed using conservation tillage using in-row subsoiling and planting into strips but no inversion or surface soil disturbance. Cultivars planted and pest management are those recommended for Alabama producers. Crop rotation, cover crops and N fertilization are the only variables. Soil at the site is a Pacolet fine sandy loam (Fine, kaolinitic, thermic Typic Kanhapludults).

Treatments

Cotton every year

- No N/no cover crop (plots 1 & 6)
- No N/+ winter legume cover crop (plots 2, 3, & 8)
- 134 kg N ha^{-1} / no cover crop (plot 13)

2-yr Cotton-Corn Rotation

- No N/ + winter legume cover crop (plots 4 & 7)
- +N fertilizer/ + winter legume cover crop (plots 5 & 9)*

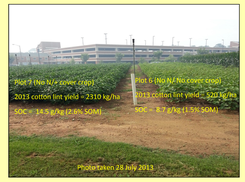
3-yr Rotation: cotton (legume cover)-corn (wheat)-soybean

- Fertilizer N on cotton, corn, and wheat (plots 10, 11 & 12)*

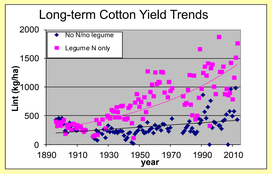
*Cotton plots get 134 kg N ha^{-1}; corn received 134 kg N ha^{-1} prior to 2007 and 202 kg N ha^{-1} since 2007.

Crimson clover (left) and/or hairy vetch has always been planted as a winter legume cover crop. Measured N fixation in the residue at full bloom ranges from 90 to 170 kg N ha^{-1} adequate for a cotton crop but not enough for high-yielding corn.

RESULTS



Plots 6 and 7 are identical except plot 7 is a 2-yr rotation with only legume N. Neither has ever received any direct N fertilization. In 2013, plot 7 produced more than 4 times the cotton (over 4 bales per acre) as plot 6. Differences are attributed to the cover crop, soil organic matter and improved soil quality, factors that have taken many years to develop.



Long-term cotton yield trends, 1896-2013, on plot 6 (no N/no legume) and plot 8 (No N + legume cover crop).

Mean crop yields and Soil Organic C on Old Rotation, 2003-2013

Treatment	Yield* Irrigated		Yield* Non-irrigated		Soil Organic C (0-10 cm)
Cotton lint (kg/ha)					---g C/kg---
No N/no cover crop	650	e	470	e	8.7
No N/+ cover crop	1220	d	1110	c	16.2
+ N/no cover crop	1530	b	1060	c	13.7
Rotation/no N + cover	1440	bc	1270	b	15.5
Rotation +N + cover	1750	a	1370	a	17.7
3-yr Rotation	1350	cd	850	d	17.0
11-YR MEAN	1260		1040		
Corn grain (kg/ha)					
Rotation no N +cover	5370	b	4270	b	15.5
Rotation +N +cover	11790	a	7120	a	17.7
3-yr Rotation	10540	a	6340	a	17.0
11-YR MEAN	9230		5230		
Wheat grain (kg/ha)					
3-yr Rotation	n/a		3510		17.0
Soybean following wheat (kg/ha)					
3-yr Rotation	3600		2510		17.0

*Values followed by the same letter or not significantly different at P<0.05.

Cover crops alone have almost doubled soil organic C; N from the legume accounts for cotton yields equivalent to about 134 kg N ha^{-1}.

Highest yields are produced from a combination of fertilizer N and winter legume cover crop. About 45 kg N ha^{-1} are removed where no N is applied and no legume is planted, about the same as 110 years ago. Irrigation has resulted in a positive yield response 6 yrs out of 11 for cotton, 10 out of 11 for corn, and 11 of 11 for soybean. Wheat is not irrigated.

SUMMARY

Renewed interest in cover crops, irrigation, sustainability and soil quality/soil health in the humid Southeast make the Old Rotation even more relevant to modern crop production than it was almost 120 years ago. The experiment has been using conservation tillage with increasing crop yields for 18 years makeing the experiment especially relevant to today's farmers and has proven a valuable resource for soil scientists and Extension specialists. Auburn University campus planners have protected the Old Rotation by designating the experiment and the adjacent 10 acres as protected agricultural lands.

The Old Rotation is maintained through a joint effort of the Auburn University Department of Crop, Soil and Environmental Sciences, the Alabama Agricultural Experiment Station and USDA Soil Dynamics Laboratory. It is supported by the Alabama Wheat and Feed Grains Committee, the Alabama Soybean Producers, and the Alabama Cotton Commission.