Distribution Agreement

Estimating the county-level effects of the Tennessee Valley Test Farm Program on U.S. agriculture (1935-1950)

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Abstract

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This study seeks to understand to the effects of the Tennessee Valley Authority Test Farm Program (1935-1950) on the race of farm operators, size and number of farms, and rates of farm ownership. We utilized historic population (Haines et al. 2018) and agricultural census data (Haines 2010) collected through IPUMS, and soil viability data from Schaetzl et al. (2012), combined with a new county-level data set on the timing of Test Farm Program Applications. The analysis is divided into two parts. First, OLS regression was used to identify the economic, demographic, and environmental factors that made counties more likely to have farms apply to the program. Then, we applied the difference-in-difference with two-way fixed effects and differential timing methodology from Calloway & Sant'Ana (2021) to estimate the average effects of treatment (ATT) from the entire time period, and for treatment during 5-year time periods on the number, size, and value of farms, along with the fraction of minority farms operators and the percentage of whole-ownership. Our findings suggest that counties with farmers who applied to the TFP were predominantly agrarian, with low crop, and livestock values, relatively unproductive soils, fewer acres of stable crops such as corn and wheat, lower property values, high rural populations, and slightly more small, wholly-owned farms. We also provide evidence to suggest that counties with farmers that first applied prior to 1940 experienced first-mover advantages through small, but statistically significant increases in property values and rates of whole farm ownership. The findings oppose the narrative in Selznick (1953) that the Test Farm Program preferred large, wealthy farms, and instead describes the program as being slightly beneficial for smallholder farmers looking to make a living off of and own their own land.

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1 Introduction

American agriculture changed significantly over the course of the 20th century. At the beginning of the century, more than 40 percent of the total U.S. workforce worked in agriculture. Just a century later, agricultural workforce participation fell to below 2 percent (Dimitri, Effland, & Conklin 2005). The number of farmers in America decreased from 6.8 million in 1935 to 2.7 million in 1969, and 1.9 million, or 30% of the peak, in 1990 (Huffman & Evenson 2001). The consolidation of farms and reduction in the agricultural workforce was coupled with rapid increases in aggregate US farm output, especially between 1935-1990 (Huffman & Evenson 2001). The average American farm size, which had experienced only moderate growth between 1890 and 1940, increased by 880% in the following 50 years partially because of farm specialization (Huffman & Evenson 2001). Overall, between 1936 and 2017, agricultural land use in the U.S. fell from 6.8 million acres to 2.1 million acres, while aggregate output had an annual growth rate of roughly 1.6% during a similar period (Alston & Pardey 2020). The underlying factor in the consolidation and efficiency of American farmland was the proliferation of synthetic fertilizers containing either Nitrogen (N) or Phosphorus (P). From 1850-1950, N-fertilizer use in the United States exploded, and areas of highest use migrated from the Southeast, near the government-owned chemical factories in Muscle Shoals, Alabama, to the Midwest after 1940 (Cao, Lu, & Yu 2018). The development of highly concentrated, effective fertilizers at an affordable price allowed farms to see higher yields while requiring fewer labor hours in the field: a turning point in the era of agricultural productivity scholars deem "The Green Revolution."

However, not all farmers were afforded the same opportunity to benefit from new fertilizer technologies. In fact, the mid-20th century was a period of turmoil for minority farmers, and especially Black farmers, in America. Recently, Francis et al. (2022) found that $326 billion was a conservative estimate for the total value of Black-owned land lost in the late 20th century due to discriminatory USDA policies (Francis, Hamilton, Mitchell, Rosenberg, & Stucki 2022). While this represents an enormous loss of inter-generational wealth, the study contextualizes it as only 3.3% of the estimated racial wealth gap in America. In their meta-analysis of the literature regarding Black farmer land loss, Gilbert, Sharp, & Felin (2002) found that between 1920 and 1997 land owned by Black farmers decreased from 16 million acres to less than two million acres while the number of Black farmers decreased from just under one million to fewer than 20,000 (Gilbert, Sharp, & Felin 2002). On average, Black farmers also owned smaller operations, had less formal education, lower farm incomes, and were more likely to be poor than white farmers (Gilbert, Sharp, & Felin 2002). In 1987, Black farmers in North Carolina had average gross incomes and acreage less than half that of their white peers and were more likely to leave farming altogether (Schulman 1989). 20th century government programs targeting agriculture were also saddled with institutional segregation and discrimination, especially in the Jim Crow south. The statute of "separate but equal" applied to institutional resources such as Land-Grant colleges created through the Morrill Act of 1862, which allowed for separate universities for Black and white students until the Civil Rights Act of 1964 (Selznick 1953, Rose 2017). Through differences in resources, funding, and education quality, prospective Black farmers were barred from beneficial agricultural programs and networks later utilized by their white peers (Selznick 1953). There is data that suggest these disadvantages persist today. Another seminal study of the economics of discriminatory agriculture used aggregated U.S. census data to show that white farmers own 98% of all farmland in America and earn 98% of all farm-related income (Horst & Marion 2018).[1]

Effective N and P-fertilizers have played a central role in the evolution of farming and the modern food system. In the United States, fertilizers allowed plant nutrient consumption to rise from 2.6 million tons to 11 million tons between 1945-1965, spawning a 50% increase in yields per acre (Tennessee Valley Authority 1966).[2] For commodity crops such as cocoa, rice, and other grains, applying mineral fertilizers to farm fields has shown increased land productivity, agricultural income, and farmer welfare (Martey, Kuwornu, & Adjebeng-Danquah 2019, Danso-Abbeam Baiyegunhi 2019, Boahen 2022).[3]

The concurrent trends of farm consolidation, productivity, and Black farmer land loss in American agriculture all took place during the mid 20th century. While several studies

[1]Similar methods were also used to demonstrate that female farmers only operate 7% of all U.S. farmland, from which they earn only 3% of all farm-related income. This share of female farm operation has only increased by about 3% from 1920, indicating the extent of the entrenched white-male dominance in American agriculture (Horst & Marion 2018).

[2]This equates to roughly a 3.8 percentage point or 300% increase in per-capita fertilizer use over the time period (1945-1965) using population from United States Census Bureau. (n.d.).

[3]Chemical fertilizers must also be recognized for contributing to environmental degradation through soil nutrient depletion, chemical runoff, and greenhouse gas (GHG) emissions. Unfortunately, the economically optimal fertilizer application rate is often higher than the environmentally optimal rate, creating a system of incentives that encourages farmers to over-fertilize their fields to increase crop yields and profitability in the short-run (Kim & Dale 2008). Excess fertilizer is then ingested and discharged by livestock or runs off directly into waterways causing surface water eutrophication, or a deadly lack of oxygen in the water column (Zhang, Ma, Ji et al 2008). The double-edged sword of short-term gains with long-term negative environmental impacts is a prominent dilemma in the modern debate over the legitimacy of sustainable development and partially hinges upon the demand for and shortage of minerals for agricultural fertilizer (Vitousek et al, 1997).

separately consider the causes and effects of each of these issues, this paper seeks to answer whether the origin of the countryâs at-scale fertilizer distribution, the Tennessee Valley Authority's (TVA) Test Farm Program, gave unfair advantages to early adopting farmers who were predominantly white, landowning, and high income.

We start by applying OLS regression to economic, demographic, and agricultural census data from counties with and without farms that applied to the Test Farm Program to show that counties with applicants were more likely to have high proportions of small, unproductive, white-owned farms. Next we test the effects of treatment on farm size, value, and ownership using the difference-in-difference with two-way fixed effects and differential treatment timing Callaway & Sant'Ana (2021). This analysis showed small, first-mover advantages to counties with farms that applied prior to 1940 in the forms of higher rates of farm ownership. However, small decreases to the fraction of farms over 1000 acres and insignificant effects on the fraction of minority farm operators and the number of farms indicate that the TVA Test Farm Program likely did not significantly contribute to farm consolidation and whitewashing.

Next, we will provide more background into the design and implementation of the Test Farm Program before describing our the creation of our data set and methodological approach. From there, we will share the results of our tests on selection into treatment and average effects of treatment. Finally, we will discuss how our results compare to the historic accounts of the TVA, and then provide opportunities for further research on the topic.

2 Institutional Background

A lot of what is known about the planning, implementation, and governance of the Tennessee Valley Authority's Agricultural Programs can be attributed to a handful of seminal works on the topic (Selznick 1953, Schaffer 1984, Droze 1979, Wengert 1949). Because of the thoroughness, and corroboration of these studies, books, and narratives, the introduction to the TVA Test Farm Program as the basis of this research will rely heavily on their work.

The Tennessee River Valley is a 40,000-square-mile tract of land in the eastern part of the United States running from Virginia in the northeast to Mississippi in the southwest (Schaffer 1984) (Figure 1). During the Great Depression Era, living conditions in the valley were in many ways inferior to other areas that were also experiencing periods of economic turmoil. The average valley net farm income was roughly one-third the national average (Schaffer 1984). Farms were small, usually less than 70 acres, soils were poor from heavy winds and water erosion, and the population was characterized by low levels of education, few possessions, small houses, large families, and little access to electricity (Droze 1979). In 1933, as a response to the economic and agricultural collapse of the region, Congress created the Tennessee Valley Authority, an agency tasked with "the proper use, conservation and development of the natural resources of the Tennessee River basin and ... adjoining territory" (Schaffer 1984). While the TVA is mostly known for its role in increasing access to electricity through the expansion of hydroelectric power (Kitchens 2014), the agency also had a vision to improve agriculture in the region by increasing land productivity, farm management, and farmer incomes (Droze 1979). Among other programs targeted at improving American agriculture, the TVA launched an initiative to revitalize soil quality and reduce runoff and erosion by inventing, testing, and distributing mineral-based fertilizers (Selznick 1953).

The TVA originally started inventing and manufacturing fertilizers in 1933 when the Federal government gave it access to the chemical plants in Muscle Shoals, Alabama. Later, the Authority's need for distribution channels, a testing population, and on-the-ground relationships with farmers encouraged it to establish a relationship with the Land-Grant colleges in the Valley (Selznick 1953). Through this relationship, the TVA agricultural branch worked as a grant-in-aid foundation whereby county agents and administrators working at the grassroots of TVA programs would be state university employees, but their salaries and program expenses would be refunded by the TVA (Selznick 1953) (Figure 2). Additionally, the relationship between the TVA and the Land-Grant universities made the agency reliant on university expertise when deciding whether to initially produce N or P-based fertilizers. The university's recommendation of concentrated phosphate production was controversial, as it was claimed that poor farmers could not afford the recommended processes of crop rotation and legume planting and would therefore be better supported by inexpensive nitrogen fertilizers (Selznick 1953). Moreover, the leadership of the TVA Department of Agricultural Services, made up of five male members, exercised their beliefs in white racial superiority by excluding the 17 segregated Black Land-Grant agricultural colleges from TVA programs, and avoiding opportunities to increase the number of Black TVA employees at the county level (Selznick 1953). Given this history, it is plausible that the TVA leadership might also have discriminated against minority farmers through their Test Farm Program.

Established in 1935, the TVA Test Farm Program (TFP) was an initiative designed to assess the value and effect of new fertilizers and farming methods, and to demonstrate the advantages of adopting such measures to surrounding farmers (Wengert 1949). At its core, the TFP distributed new P-based fertilizers to farmers who applied to the program, with an understanding that in return for having the material and production costs of the fertilizers covered by the government, the farmers would keep detailed records of their methods and results (Wengert 1949). TFP farmers generally agreed to five-year terms, where they dedicated their entire use of their farm to the program, including potential reorganization, land-use changes, and access to TVA or extension service workers (Selznick 1953). The program was quite popular, especially in the Tennessee Valley Region. In 1942, roughly 4% of all farms in Tennessee were involved in the TFP, which was estimated to cost the government around $100 per farm (Selznick 1953). However, several confounding factors such as the principle-agent relationship between the TVA and the Land-Grant Universities, the TVA's concurrent initiative for rural electrification and on-farm forestry, and incomplete record keeping on both sides [4] of the relationship made establishing a causal relationship between TVA phosphate use and farm profitability almost impossible (Selznick 1953). Instead of the fertilizers themselves, the system of decentralized education and capital allocation utilized by the TVA and Land-Grant Universities to distribute the fertilizers to farmers may have been the most important and impactful part of the TFP.

At the county level, the work of the TFP was carried about by individuals called county agents who were employees of the Land-Grant Universities, but whose salaries were subsidized by the TVA (Selznick 1953). County agents worked for the extension service offices and were assigned TFP farms in their county to help monitor and educate about optimal farming practices (Selznick 1953) (Figure 3). They were also responsible for calling meetings where community members would select farms to be used in the TFP (Selznick 1953) (Figure 4). As the primary gatekeeper of extension-service aid, and the local face of the TVA and Land-Grant Universities, county agents adopted a de-facto role of political power at the grassroots level (Selznick 1953). While communities were theoretically responsible for promoting farms to the TFP, "It is 'his' [county agent's] program and 'his' association, and it is understood in practice that all contact with the farmers and the farm organizations which implement the program will be made through him" (Selznick 1953). This centralization of power amid the dual responsibility of ingratiating the extension service in the eyes of the local county while also testing and assessing the value of TVA fertilizers is the crux of the principal-agent problem embodied in the county agents. For example, the TVA understood that farms in the TFP were intended to be representative of the average size, soil, and type in the county, but accounts from TFP supervisors described county agents' tendencies to target large-scale farms because the extension services believed small-holder farmers were too "ignorant and inefficient and are not capable of conducting a demonstration for the benefit of their neigh-

[4] Box 44 from the Test Demonstration Farm records National Archives Identifier 4529761 did contain roughly 16,000 pages of computer printouts from a 1/20th survey of records kept by TVA TFP farmers in Tennessee from 1964-1965. While these records were beyond the scope of this study, the individual-level data the records contain on fertilizer type, volume of use, frequency of use, and crop types would be interesting for further research on the topic

bors" (Selznick 1953). While sampling mostly large-scale farmers skewed the TVA data on the effectiveness of their fertilizers to improve farmer livelihoods, it increased the likelihood that farmers using approved methods would show an economic return, and that the extension services would remain in good standing with the counties where they operated (Selznick 1953). Combined with TVA leadership's structural exclusion of Black Farmers and beliefs in white racial superiority, the county agents' bias toward large farm inclusion in the TFP acts as a starting point for this study's inquiry into the possibility of TVA discrimination against Black and smallholder farmers through the timing of and awareness of the TFP.

3 Data

The data for this study combines a new data set collected from the National Archives in Atlanta on the timing of county-level applications to the TVA TFP with demographic, agricultural, and economic data from the Agricultural Censuses 1920-1959 collected by Haines et al. (2018), and U.S. Censuses 1920-1960 collected by Haines (2010) found in ICPSR data sets. Additional variables for Soil Productivity Index calculated by Schaetzl et al. (2012) were provided by Leonard, Parker, & Anderson (2020) and a variable containing distances to land grant colleges was calculated using data from Lee (2020).

The data set from the National Archives was gathered in person from the National Archives Identifier 4529761, NRC-142-96-008, box 37 attributed to the TVA Agricultural Relations Correspondence: Test Demonstration Farms: Contracts, Agreements, Proposals, and Studies for Unit Test Demo Farms Program with Valley States, 1933-1947, and Out of Valley States Contracts, Agreements, and Correspondences with TVA-Fertilizer Use and Production Plans. The records utilized included 19 states and described the first dates that counties in each of those states had farms that applied to the TFP. The data is separated into three columns, with each county having either the date when the first application was received, the date when the first contract was approved, or the date the first phosphate was delivered was recorded. For each county in the data set, only one date is recorded, so it is unclear whether there is a meaningful distinction between the three columns, or it was simply up to the discretion of the original documenter as to which column the date was filed under. Care was taken to document which counties were recorded to have applied, and which were recorded to have been approved, however, this study counted either documentation as "Treated". An example of this distinction can be seen in Figure 5. In some cases, such as for 15 counties in Michigan in Figure 5, documentation of the contract approval date was inconsistent, requiring us to use our best judgment in the interpretation of these differing methodologies. Based on the repeated use of the ditto abbreviation, followed by matching check marks in the adjacent box, we made the assumption to use the last date, 12-10-40 as the date of contract approval for the remaining counties in the column. In the final data set, each county from the original records is documented with the date of entry into the program (either through application or approval), whether or not the county was in the Tennessee Valley Region, the year the first county from that state entered the TFP, and whether the county was recorded to have applied, been approved, or had phosphate delivered. The NARA data set also included a list of the first date several states received shipments of phosphate from the TFP. Figure 6 shows a map of when counties applied for the TFP along with states that were recorded as having received phosphate. For our study, this data set was restricted to only include states that contained counties that were recorded to have applied to the TFP. The final data set included information on 1602 counties, 593 treated and 1009 untreated. This data was then been appended to Agricultural Census data from the ICPSR 35206 data set by way of matching state and county codes.

The ICPSR data set used to produce our outcome variables contained several data sets from agricultural censuses between 1840-2012. In the formation of the data set for this study, ICPSR data was pulled from sets 0011, 0012, 0013, 0015, 0016, 0020, 0021, 0025, and 0027 to create a new data set with values from 1920, 1925, 1930, 1935, 1940, 1945, 1950, 1954, and 1959. The pattern of 5-year increments changed between 1950 and 1954 because, during this time period, the government changed the Agricultural census dates from being the same dates as the decennial census of the population to dates ending in 4 and 9. For each of these years, available county-level data was recorded for several variables, including the number of farms, farms with white operators, farms with non-white operators, full owners, and the number of farms in relative size classes measured by acre. Tables 1, 2, 3, and 4 provide the difference in means outputs for each outcome variable by the treated and untreated groups for 1920, 1930, 1940, and 1950.

The ICPSR data set used to produce our control variables contained several data sets from U.S. censuses between 1790-2002. In the formation of the data set for this study, ICPSR data was pulled from the 1930 Census Parts 26-28 and combined with 1930 Agriculture Census Data from book 0013 of the previous ICPSR data set. The base year 1930 was chosen because it was the most recent census taken before the TFP began in 1935. Table 5 provides the difference in means outputs for each control variable in this data set by the treated and untreated groups in 1929-1930.

To compute the variable for the log distance to the nearest land grant college, QGIS was used to calculate the minimum distance between centroids in the land grant county data from Lee (2021) and the county shapefile in University of Minnesota (2006) merged by FIP code. Because Lee (2021) uses modern county boundaries, there were 3 untreated counties without a matching FIP code, meaning regressions run using the Log Nearest LGC variable use 1599 observations instead of 1602 (Table2).

The variable containing Mean Soil Productivity Index was calculated by Schaetzl et al. (2012) and taken from, Leonard, Parker, & Anderson (2020). The index is an ordinal classification of soil quality ranging from 1-20, where higher scores equal superior quality. The classification is based on environmental factors such as soil type, precipitation, and nutrient contents, and is considered independent of human involvement.

The variables for acres of soy, cotton, and vegetables in 1929 had a total of 4 missing values in the ICPSR datasets for the 1602 counties in this study. The difference in Means tests on the 1598 counties with complete data showed no significant difference in soy, cotton, and vegetable acres from tests run when replacing missing values with 0, so missing value were replaced to preserve data for the four observations in other variables.

4 Methods

The quantitative methodology of our study consists of two components: identifying the effects of independent variables on selection into the treatment group, and then assessing the effects of treatment on relevant outcome variables when controlling for base-year economic and demographic factors.

4.1 Selection Into Treatment Model

We used OLS regression to estimate the effects of several economic, agricultural, and demographic variables on the likelihood of treatment for a given county. For control variables in the base year set (1929-1930), we ran an unconstrained regression of all available variables in the panel data set on the likelihood of treatment, and then four constrained models using only geographic, livestock, crop, or demographic regressors. The models were of the form:

$$Treatment_i = \alpha + \boldsymbol{X_i}\boldsymbol{\beta} + u_i \tag{1}$$

Where $Treatment_i$ is the probability of a county i being treated, X_i is the matrix of independent control variables used in the regression from county i, and u_i defines the unobserved error term for county i.

4.2 Treatment Effects

To identify the effects of applying for the TFP at different time periods on a variety of economic and agricultural variables, we utilized the quantitative methodology defined in Calloway & Sant'Ana (2021) that defines doubly robust cumulative average treatment effects across groups with differential treatment using "not-yet-treated" groups as controls. The model used in Calloway & Sant'Ana (2021) relies on a handful of key assumptions.

4.2.1 Assumption 1: Parallel Trends

Although we cannot know what the treated groups would have done had they not been treated, in order to identify a treatment effect we need to be able to demonstrate that trends seen after the treatment periods were not preexisting before treatment. Figures 7 and 8 show the time series line plots of the average values of each outcome variable we tested by treated and untreated groups over the period 1930-1950. In this case, the "Treated" group includes all counties that are treated in any year, while the "Untreated" group includes only counties that were never treated. While the magnitudes of the two groups differ across all variables, the similar trends, especially between 1930-1940 (when most treatment takes place) indicate a high likelihood that the parallel trends assumption is satisfied.

4.2.2 Assumption 2: Irreversible Treatment

To accurately define the effect of treatment over time it is important that treated groups cannot become untreated. Because our treatment is defined as when the first farm from a county is documented as having applied to the TFP, and there is no option to "unapply," the irreversible treatment assumption is satisfied.

4.2.3 Assumption 3: Limited Treatment Anticipation

The limited treatment anticipation assumption revolves around the idea that "eventually treated" groups could take part in "anticipatory behavior" to improve their outcomes if they were to have foresight into when treatment might take place (Calloway & Sant'Ana 2021). In our study, individual farmers act as treatment agents for their entire county, meaning most treated farmers would join the treatment groups without knowledge of their change in status. Since treatment reflects the actions of an individual within a county and confers no explicit advantage to the group as a whole, we can assume that farmers would have little incentive to monitor when other farmers in their county applied for the program and therefore satisfied the assumption of limited treatment anticipation.

4.2.4 Assumption 4: Random Sampling

The random sampling assumption implies the data was gathered from a sample that is representative of the larger population. The demographic and economic data used in our study were from the U.S. population and agricultural census, meaning it is the most representative national-level data set available for the time period. Therefore, we can consider the random sampling assumption satisfied.

4.2.5 Average Treatment of the Treatment (ATT) with Two-Way Fixed Effects (TWFE) Model

The equation from Calloway & Sant'Ana (2021) for estimating the Average Treatment Effect on the Treated (ATT) is:

$$ATT = \frac{1}{n_T} \sum_{i \in T} (Y_i(1) - Y_i(0)) \tag{2}$$

where n_T is the number of treated counties, $Y_i(1)$ is the outcome for county i if it is treated, and $Y_i(0)$ is the outcome for county i if it is not treated.

Because the ATT aggregates the effect of treatment over the entire time period, it does not explicitly weigh observations treated in earlier periods more than observations treated later on. Rather, the equation allows longer treatment periods to confer stronger treatment effects before averaging the effects of treatment. However, the lack of explicit weighting allows for the possibility of greater estimator bias in the ATT rather than grouped time estimators.

4.2.6 Cumulative Average Treatment Effect Across Groups Until Time t Model

The equation for Cumulative Average Treatment Effect (CATE) until time t in Calloway & Sant'Ana (2021)is given by:

$$\theta_c(t) = \sum_{g \in G} 1\{t \geq g\} P(G = g | G \leq t) ATT(g, t)$$

where $\theta_c(t)$ is the cumulative group-level outcome up to time t, G is the set of time groups, $1\{t \geq g\}$ is a function that equals 1 if $t \geq g$ and 0 if not, $P(G = g|G \leq t)$ is the probability that the group is treated before time t, and $ATT(g, t)$ is the average treatment effect for group g at time t.

This is essentially a weighted average of the ATT for time-bound groups, where groups treated earlier in the period are given more weight than groups treated right before time t. Using the *csdid* Stata package provided by Calloway & Sant'Ana (2021), we can change $\theta_c(t)$ to $\theta_{notyet}(t)$, making the control group include the not-yet treated observations, instead of only the never-treated observations.

5 Results

5.1 Selection Into Treatment

Table 6 shows the outcomes from OLS regressions of treatment over 5-year periods using either control variables from 1930 (odd columns) or contemporaneous controls (even columns). The statistical significance of the coefficients appears to diminish over time, as fewer control variables hold significance for determining treatment in 1945 than in 1930. In the earliest periods, counties with high property values, high amounts of minority farm operators, and farm ownership were less likely to have farms apply for the TFP. Over time, high property values and farm ownership percentages changed to having a positive impact on selection into treatment between 1940-1944, along with negative impacts from the frequency of overly large (500-999 acres) and overly small (0-9 acres) farms.

Table 8 shows the OLS regression outcomes of treatment on the full range of 1929-1930 control variables, and then linear models of categorized control variables. In these regressions, the treatment group consists of all counties that applied to the TFP at any point in our data set, and the untreated group consists of counties that never applied. The consistently significant coefficients relative to treatment are inclusion in the Tennessee Valley Region, the percent of land in farms, the mean soil productivity index, the value of all crops per square mile, acres of corn and wheat, and the rural population. While being in the TVA, having a greater percentage of land devoted to farms, and a high rural population made counties more likely to have farms apply for the TFP, aspects such as productive soil, high per-acre crop and cattle values, and more acres of corn and wheat made counties less likely to have farms apply. These trends provide support for the idea that farms from poorer, less agriculturally productive counties might have been more interested in the TFP as a means of economic viability, while higher-earning, more productive farmers might have been less inclined to take risks with their land.

5.2 Treatment Effects

Before describing the results of the aggregated average treated on the treated (ATT) models, it is worth mentioning that the event study regressions in Figures 9 and 10 that show the average effects of treatment at different time periods relative to treatment provide an additional check of whether the parallel trends assumption is likely to hold. Several variables such as the fraction of full-owned farms, fraction of farms over 1000 acres, and number of farms show relatively consistent pre-treatment effects, meaning deviations in these variables post-treatment is more likely to be due to the effects of treatment instead of preexisting trends .

Table 8 provides the aggregated average treated on the treated (ATT) coefficients found by using difference-in-differences with multiple time periods and two-way fixed effects methods from Callaway & Santa Ana (2021). The controls for this regression were the 1929-1930 control variables found in the unconstrained "Full Model" in Table 8. Overall, the effects of applying for the TFP are rather small, with an approximately 1.9 percentage point increase in the fraction of full farm ownership, a 1.4 percentage point increase in the fraction of farms of 10-99 acres, and less than 1 percentage point decrease in the fraction of farms over 500 acres in size.

When we consider Table 9 showing the grouped time ATT estimates from groups treated during 5-year periods, there is evidence of first mover advantages for farmers who applied to the TFP before 1940. Counties where the first farmers applied before 1940 saw a 2.89 percentage point increase in full farm ownership, and a very small increase (0.12 percentage point) in the value of land and buildings. These trends can be seen in Figure 11, which show the statistically significant positive effect on counties where farmers first applied to the TFP before 1940. On the other hand, treatment in any of the 5-year periods had a negative effect on the percentage of farms over 1000 acres (Figure 12). This negative effect increases from negligible in the earliest-moving counties to a loss of around 1 percentage point in counties where the first farmers applied after 1940. Figure 12 illustrates the negative effect of treatment on the fraction of 1000+ acre farms treated in all four time periods, and Figure 13 shows how the worst of the negative effects for the first movers occurred between 9-15 years after treatment.

6 Discussion

6.1 Effects on Agricultural Trends

This study sought to understand whether white, land-owning farmers benefited from the TVA Test Farm Program's discriminatory fertilizer distribution. Historic records from the time period indicate a system of misaligned incentives that could have increased the likelihood that county agents acting in service of the TVA via state land grant colleges preferentially informed and recruited large, white-owned farms for the TFP. However, our findings do not entirely support this historic narrative.

6.2 Effects on Demographic Trends

Our findings suggest that counties with farmers who applied to the TFP were predominantly characterized by having large portions of farmland, low crop, and livestock value, relatively unproductive soils, fewer acres of stable crops such as corn and wheat, lower property values, high rural populations, and slightly more small, wholly-owned farms. These attributes are consistent with the hypothesis that farmers operating in such counties would be interested in opportunities to make continued farming on their land economically viable, and therefore more likely to apply for an experimental program designed to increase yields and farm profits. On the other hand, farmers with productive, high-yield farms would be less likely to apply for the TFP, seemingly following the logic of “if it ain’t broke, don’t fix it.”

While the fraction of minority farm operators in a county showed little effect on whether farmers in a county applied for the TFP over the entire period (1934-1950), it did show significant time-group effects, especially among counties treated in the first five years of the program. During the years 1934-1939, counties with more farms, low property values, and fewer minority farm operators were more likely to apply for the program. Additionally, counties with higher percentages of farms of under 100 acres were also more likely to be treated. These first-mover trends provide evidence in support of the conclusion in (Selznick 1953) that the TFP initially preferred farms operated by white farmers, but also contradict the idea that the TFP was geared toward larger farms.

Considering the trends of farm consolidation, expansion, and whitewashing in the 20th century, we would then expect counties that applied for the TFP would experience decreases in the number of farms and minority farm operators, and increases in land values, farm size, and land ownership. Interestingly, our analysis shows that application to the TFP had little effect on the number of farms, the fraction of minority farm operators, and the value of farmland and building, positive impacts on the fraction of farms 10-99 acres and farm ownership, and negative impacts on the fraction of farms over 500 acres. These aggregate effects of treatment suggest that overall the TVA Test Farm Program did not contribute to farm consolidation and expansion, and possibly even fought these trends in favor of farm ownership for smallholder farmers.

When we consider the grouped-time fixed effects of treatment, counties with early-moving farmers did see very small increases in farmland and building values, with an almost 3 percentage point increase in whole farm ownership. In every time period, treatment had a tiny, but statistically significant negative effect on the fraction of farms over 1000 acres. Combined with our finding that counties treated before 1940 had lower fractions of minority farm operators, and whole farm ownership, the evidence suggests that the TFP may have given initial advantages to white, smallholder farmers through preferential selection and early-mover increases in land value and farm ownership, but the significance of operator race and benefits to treatment are eliminated after 1940.

6.3 Opportunities for Further Research

An important area of exploration that could be conducted with this data set is identifying how the existence, timing, and number of neighboring treated counties affect the likelihood and impacts of treatment. Such analysis would help contribute to our understanding of information sharing in agriculture discussed in Conley & Udry (2005) and Foster & Rosenweig (1995). Furthermore, it would be helpful to merge this data set with that used in Francis, Hamilton, Mitchell, Rosenberg, & Stucki (2022) in an attempt to estimate the value of farmland purchased by Black and smallholder farmers as a result of the TFP. This study would likely necessitate the geographic restriction of observations to states in the southeast that have historic data on Black farmland ownership and crop yields but would define explicit present-day effects of the TFP. Studying the history and impact of the Tennessee Valley Authority on American agriculture provides a window into the development of the modern agricultural system, and will hopefully help us design more effective policies for farmers in a changing world.

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8 Appendix

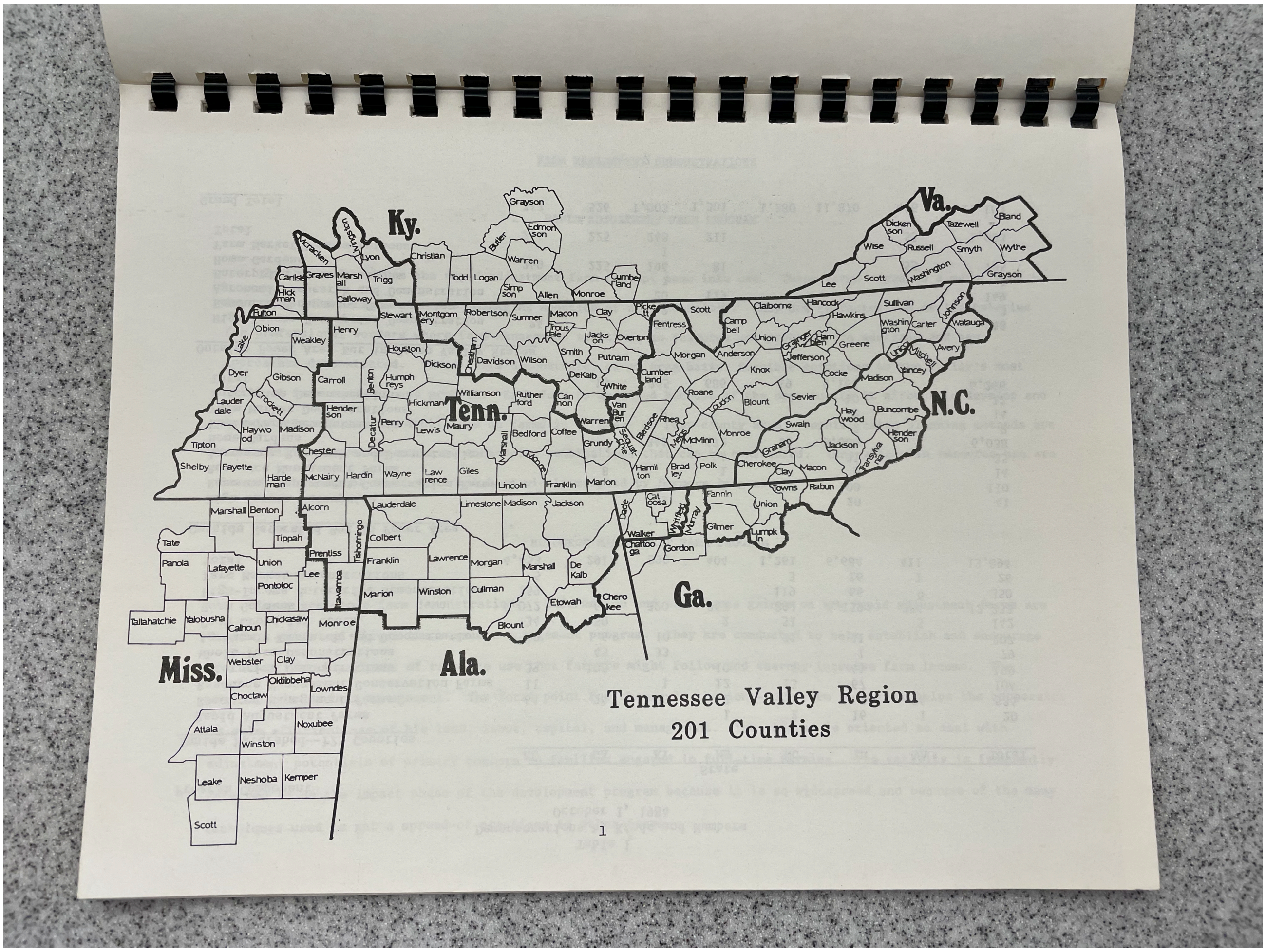
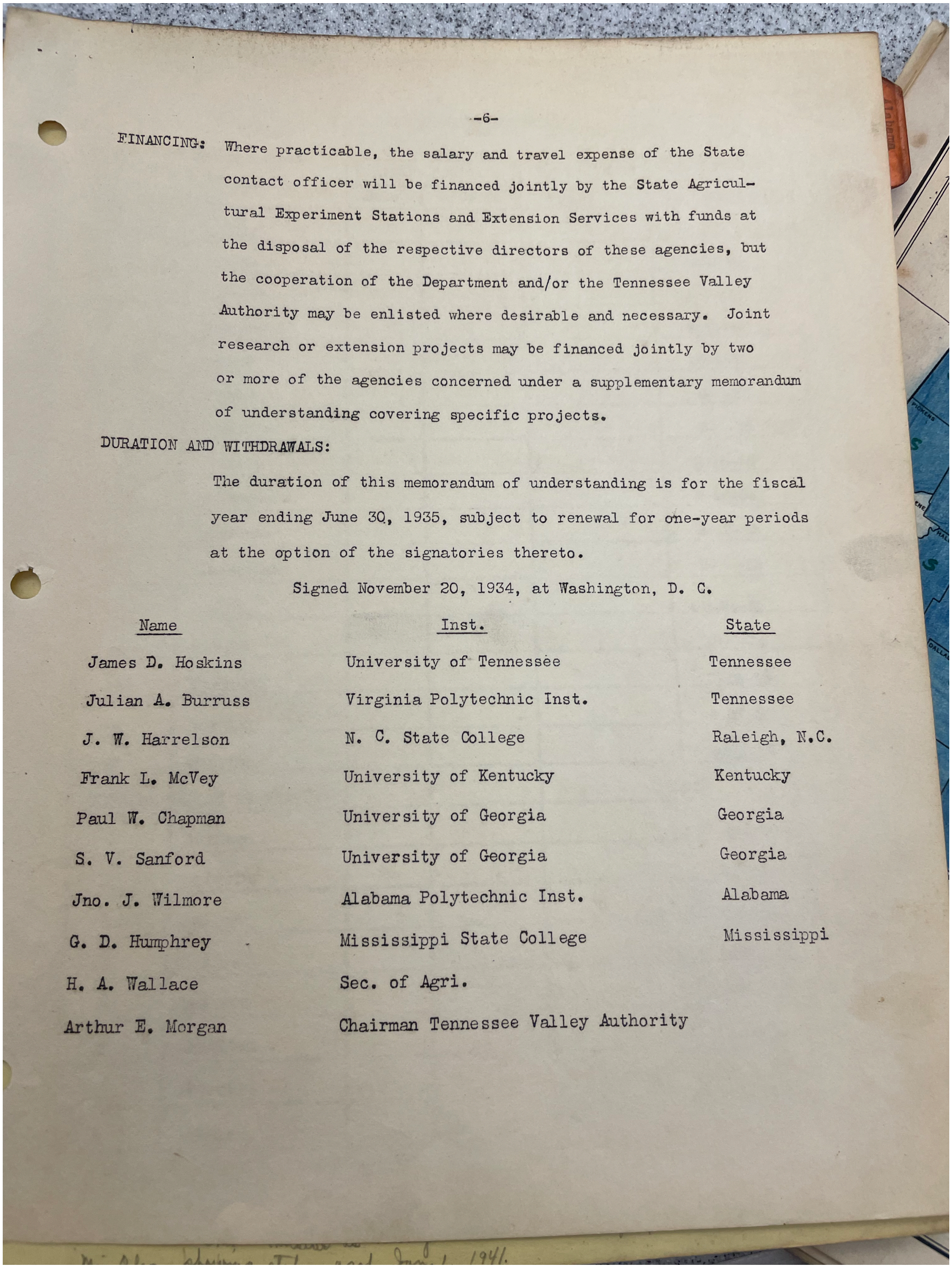


Figure 1: National Archives map of the Tennessee Valley Region (1940)



-6-

FINANCING: Where practicable, the salary and travel expense of the State contact officer will be financed jointly by the State Agricultural Experiment Stations and Extension Services with funds at the disposal of the respective directors of these agencies, but the cooperation of the Department and/or the Tennessee Valley Authority may be enlisted where desirable and necessary. Joint research or extension projects may be financed jointly by two or more of the agencies concerned under a supplementary memorandum of understanding covering specific projects.

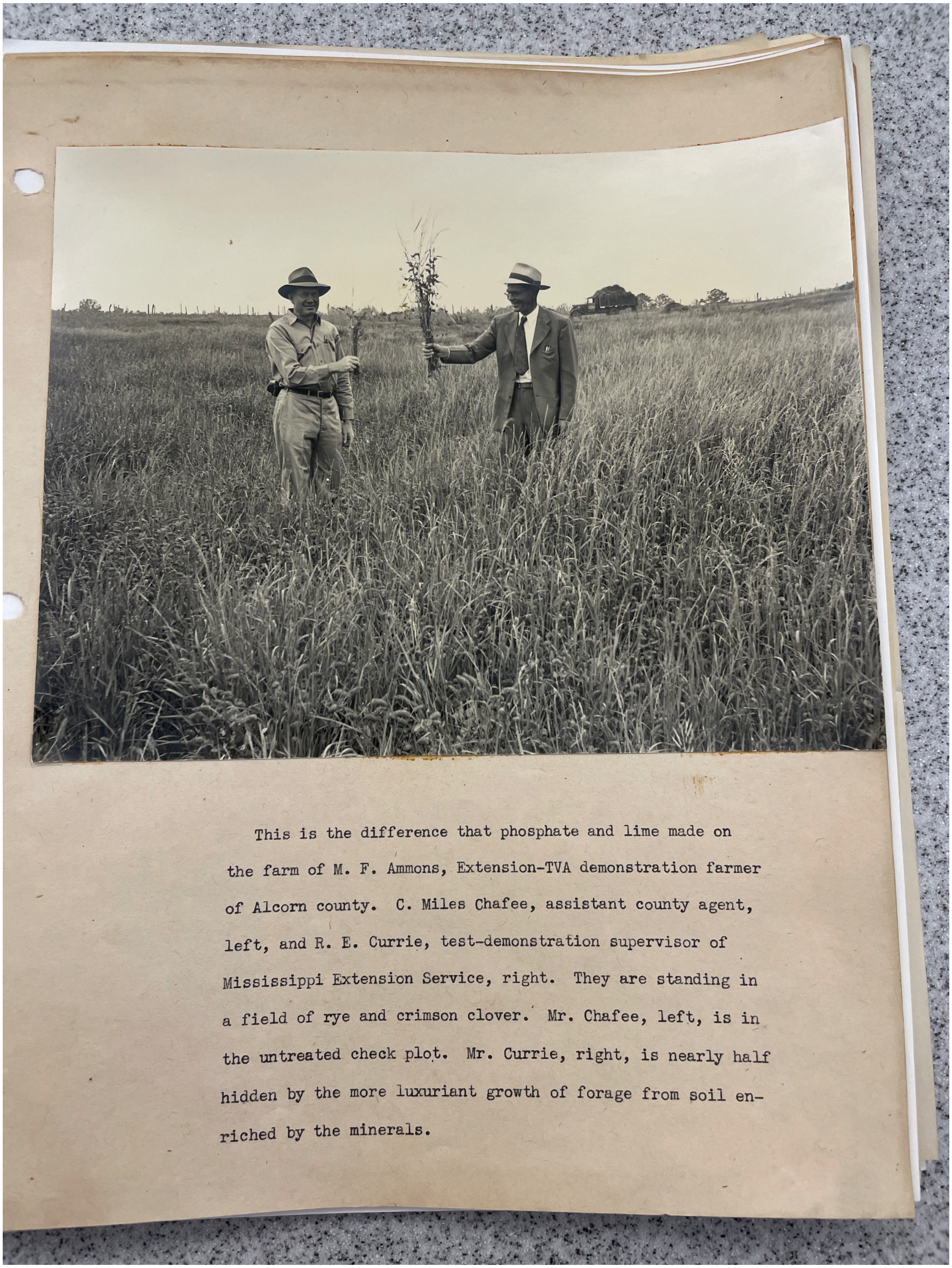
DURATION AND WITHDRAWALS:

The duration of this memorandum of understanding is for the fiscal year ending June 30, 1935, subject to renewal for one-year periods at the option of the signatories thereto.

Signed November 20, 1934, at Washington, D. C.

Name	Inst.	State
James D. Hoskins	University of Tennessee	Tennessee
Julian A. Burruss	Virginia Polytechnic Inst.	Tennessee
J. W. Harrelson	N. C. State College	Raleigh, N.C.
Frank L. McVey	University of Kentucky	Kentucky
Paul W. Chapman	University of Georgia	Georgia
S. V. Sanford	University of Georgia	Georgia
Jno. J. Wilmore	Alabama Polytechnic Inst.	Alabama
G. D. Humphrey	Mississippi State College	Mississippi
H. A. Wallace	Sec. of Agri.	
Arthur E. Morgan	Chairman Tennessee Valley Authority	

Figure 2: A page from the original contract between the TVA and state land grant colleges outlining county agent compensation (Nation Archives 1935)



This is the difference that phosphate and lime made on the farm of M. F. Ammons, Extension-TVA demonstration farmer of Alcorn county. C. Miles Chafee, assistant county agent, left, and R. E. Currie, test-demonstration supervisor of Mississippi Extension Service, right. They are standing in a field of rye and crimson clover. Mr. Chafee, left, is in the untreated check plot. Mr. Currie, right, is nearly half hidden by the more luxuriant growth of forage from soil enriched by the minerals.

Figure 3: Test demonstration farmer and county agent in Mississippi (Nation Archives 1940)

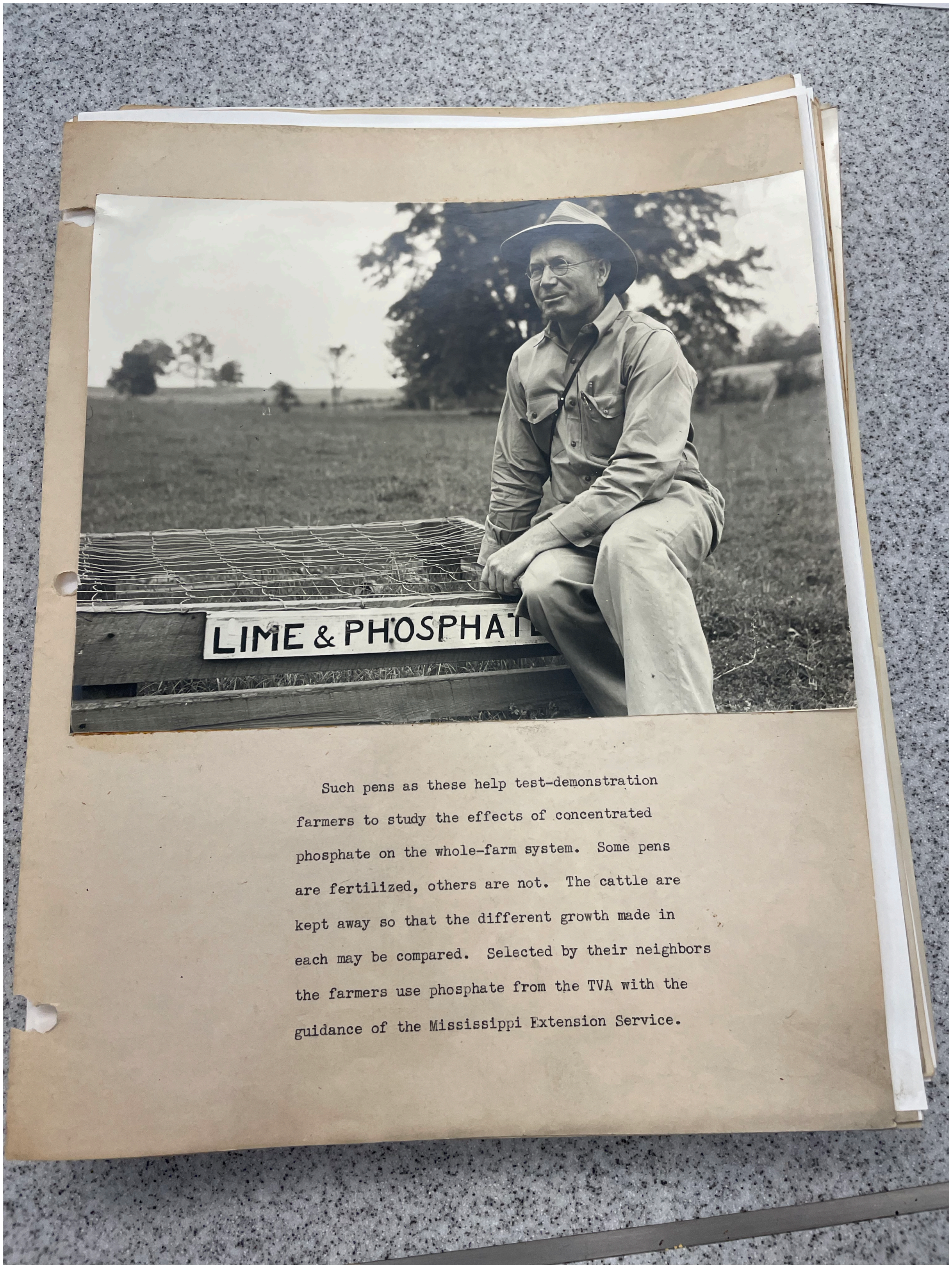
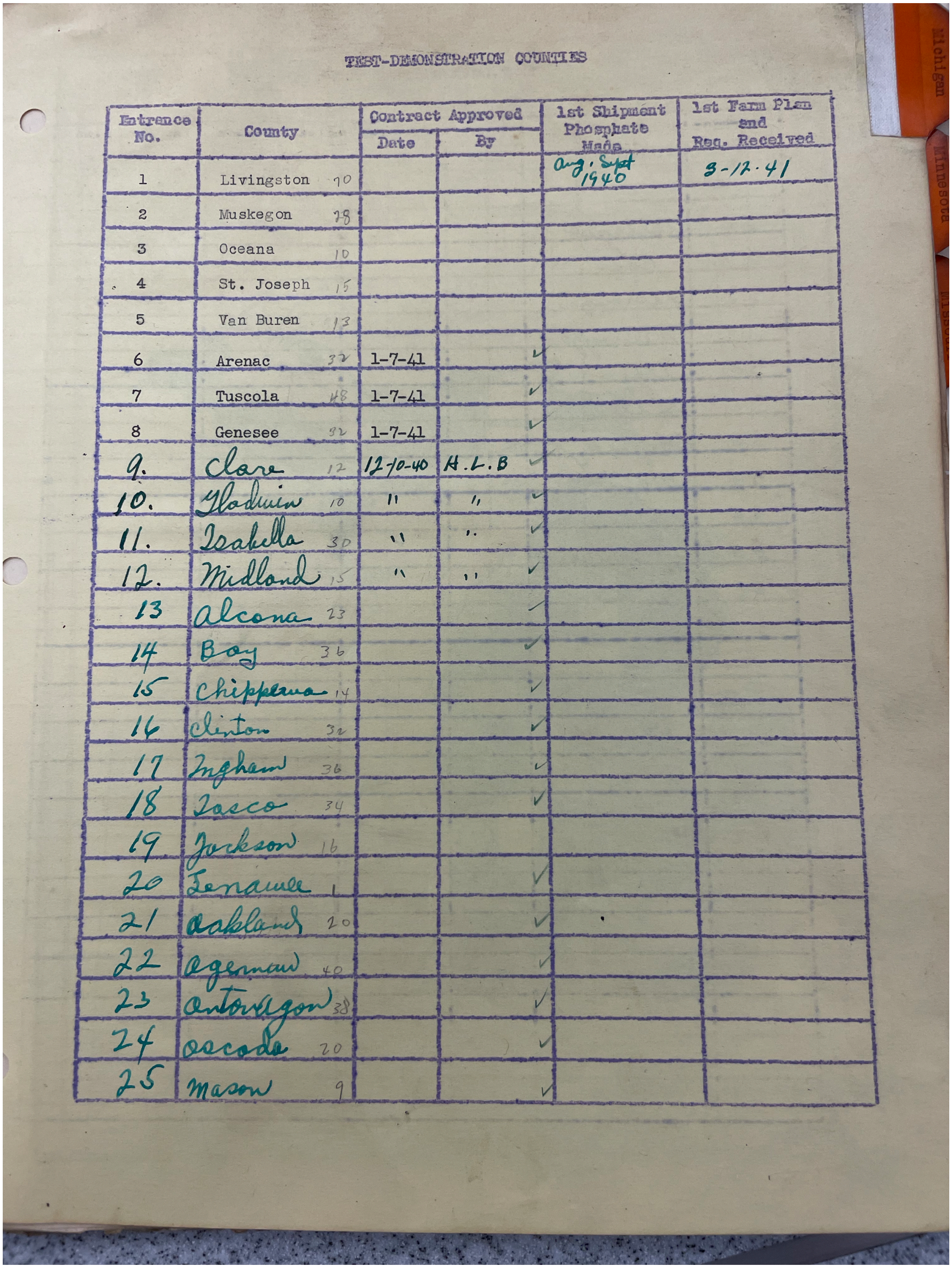


Figure 4: Mississippi test demonstration farmer selected by neighbors (Nation Archives 1940)



TEST-DEMONSTRATION COUNTIES

Entrance No.	County	Contract Approved		1st Shipment Phosphate Made	1st Farm Plan and Req. Received
		Date	By		
1	Livingston 10			Aug. Sept 1940	3-12-41
2	Muskegon 28				
3	Oceana 10				
4	St. Joseph 15				
5	Van Buren 13				
6	Arenac 32	1-7-41	✓		
7	Tuscola 48	1-7-41	✓		
8	Genesee 32	1-7-41	✓		
9.	Clare 12	12-10-40	H.L.B ✓		
10.	Gladwin 10	"	" ✓		
11.	Isabella 30	"	" ✓		
12.	Midland 15	"	" ✓		
13	Alcona 23		✓		
14	Bay 36		✓		
15	Chippewa 14		✓		
16	Clinton 32		✓		
17	Ingham 36		✓		
18	Iosco 34		✓		
19	Jackson 16				
20	Lenawee 1		✓		
21	Oakland 20		✓		
22	Ogemaw 40		✓		
23	Ontonagon 38		✓		
24	Oscoda 20		✓		
25	Mason 9		✓		

Figure 5: Example of county level documentation from Michigan. The columns were consistent across state documentors, but Michigan was the only state to use the system of "ditto" signs and check marks seen below.

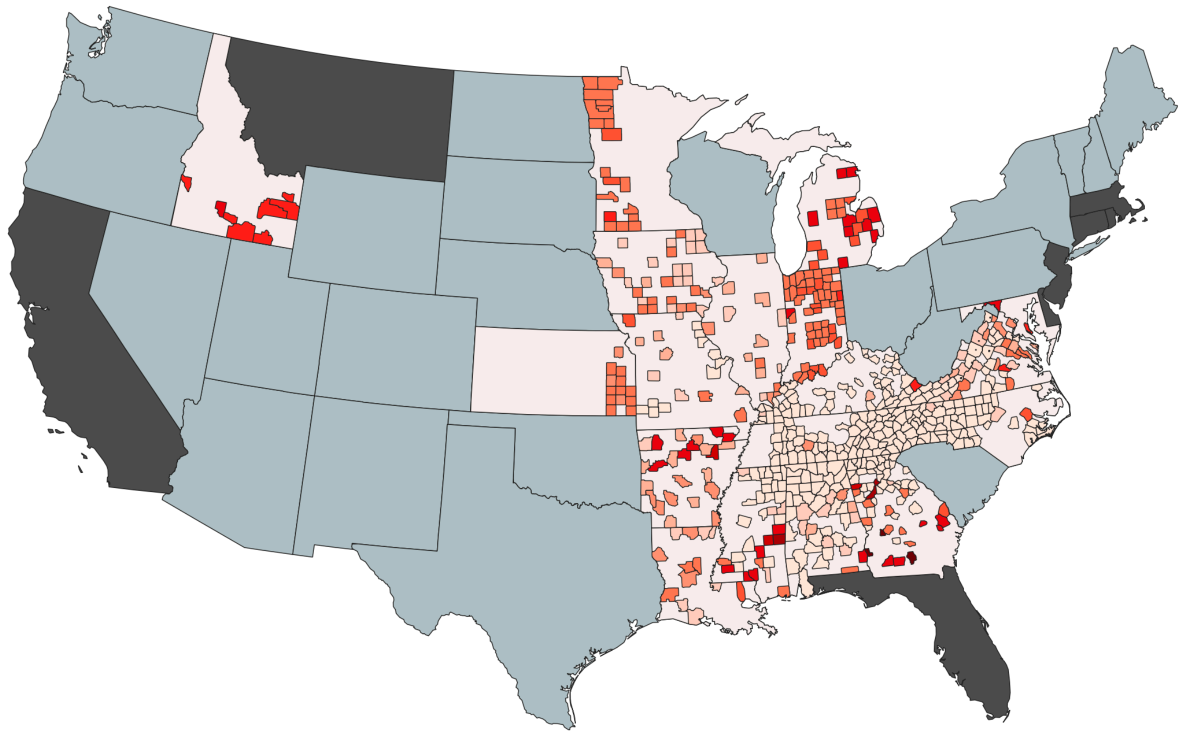


Figure 6: Map of Data Availability and TFP Applications (Treatment) Over Time (1935-1950). The white states indicate states that had data about farm applications at the county level. Lighter counties had their first farm apply for the TFP early than darker counties. The light grey states are states that had data about the year of first phosphate delivery at the state level. The dark grey states had no data.

Table 1: Difference in Means Tests for Outcome Variables (1920)

	(1) Treated mean/sd/b	(2) Untreated mean/sd/b	(3) Difference (2)-(1) mean/sd/b
Number of Farms (1920)	2549.15	2199.50	-349.65***
	(1180.10)	(1308.90)	
Fraction of Minority Farm Operators (1920)	0.14	0.15	0.01
	(0.21)	(0.24)	
Fraction of Farms Under Full-Ownership (1920)	0.61	0.60	-0.01
	(0.18)	(0.20)	
Value Farm Land and Buildings (Thousands) (1920)	18411.564	24811.518	6399.953***
	(22004.715)	(28601.518)	
Fraction of Farms 0-9 Acres (1920)	0.04	0.04	-0.01**
	(0.04)	(0.05)	
Fraction of Farms 10-99 Acres (1920)	0.59	0.51	-0.08***
	(0.18)	(0.24)	
Fraction of Farms 100-499 Acres (1920)	0.35	0.42	0.07***
	(0.18)	(0.23)	
Fraction of Farms 500-999 Acres (1920)	0.01	0.02	0.01***
	(0.01)	(0.05)	
Fraction of Farms over 1000 Acres (1920)	0.00	0.01	0.01***
	(0.00)	(0.03)	
Observations	593	1009	1602

Table 2: Difference in Means Tests for Outcome Variables (1930)

	(1) Treated mean/sd/b	(2) Untreated mean/sd/b	(3) Difference (2)-(1) mean/sd/b
Number of Farms (1930)	2455.68	2160.08	-295.60***
	(1234.19)	(1488.04)	
Fraction of Minority Farm Operators (1930)	0.14	0.15	0.01
	(0.21)	(0.23)	
Fraction of Farms Under Full-Ownership (1930)	0.47	0.45	-0.02**
	(0.16)	(0.19)	
Value Farm Land and Buildings (Thousands) (1930)	11934.911	15787.099	3852.188***
	(12200.981)	(16141.515)	
Fraction of Farms 0-9 Acres (1930)	0.05	0.05	-0.00*
	(0.04)	(0.05)	
Fraction of Farms 10-99 Acres (1930)	0.59	0.50	-0.09***
	(0.19)	(0.24)	
Fraction of Farms 100-499 Acres (1930)	0.34	0.41	0.07***
	(0.19)	(0.23)	
Fraction of Farms 500-999 Acres (1930)	0.01	0.03	0.02***
	(0.01)	(0.06)	
Fraction of Farms over 1000 Acres (1930)	0.00	0.01	0.01***
	(0.01)	(0.03)	
Observations	593	1009	1602

Table 3: Difference in Means Tests for Outcome Variables (1940)

	(1) Treated mean/sd/b	(2) Untreated mean/sd/b	(3) Difference (2)-(1) mean/sd/b
Number of Farms (1940)	2435.97	2084.47	-351.50***
	(1162.49)	(1337.33)	
Fraction of Minority Farm Operators (1940)	0.12	0.13	0.01
	(0.19)	(0.21)	
Fraction of Farms Under Full-Ownership (1940)	0.52	0.47	-0.04***
	(0.16)	(0.18)	
Value Farm Land and Buildings (Thousands) (1940)	9226.353	11407.079	2180.726***
	(8595.885)	(11347.640)	
Fraction of Farms 0-9 Acres (1940)	0.08	0.07	-0.01***
	(0.06)	(0.06)	
Fraction of Farms 10-99 Acres (1940)	0.65	0.56	-0.10***
	(0.21)	(0.28)	
Fraction of Farms 100-499 Acres (1940)	0.35	0.42	0.07***
	(0.18)	(0.21)	
Fraction of Farms 500-999 Acres (1940)	0.01	0.03	0.02***
	(0.02)	(0.06)	
Fraction of Farms over 1000 Acres (1940)	0.00	0.01	0.01***
	(0.01)	(0.05)	
Observations	593	1009	1602

Table 4: Difference in Means Tests for Outcome Variables (1950)

	(1) Treated mean/sd/b	(2) Untreated mean/sd/b	(3) Difference (2)-(1) mean/sd/b
Number of Farms (1950)	2218.08	1857.81	-360.28***
	(1112.84)	(1194.07)	
Fraction of Minority Farm Operators (1950)	0.11	0.12	0.01
	(0.18)	(0.20)	
Fraction of Farms Under Full-Ownership (1950)	0.61	0.54	-0.07***
	(0.16)	(0.19)	
Value Farm Land and Buildings (Thousands) (1950)	20022.702	24573.956	4551.254***
	(18062.747)	(24017.536)	
Fraction of Farms 0-9 Acres (1950)	0.09	0.08	-0.01***
	(0.05)	(0.06)	
Fraction of Farms 10-99 Acres (1950)	0.53	0.43	-0.10***
	(0.17)	(0.21)	
Fraction of Farms 100-499 Acres (1950)	0.35	0.43	0.07***
	(0.18)	(0.21)	
Fraction of Farms 500-999 Acres (1950)	0.02	0.04	0.02***
	(0.02)	(0.07)	
Fraction of Farms over 1000 Acres (1950)	0.01	0.02	0.02***
	(0.01)	(0.06)	
Observations	593	1009	1602

Table 5: Difference in Means Tests for 1929-1930 Control Variables

	(1) Treated mean/sd/b	(2) Untreated mean/sd/b	(3) Difference (2)-(1) mean/sd/b
Percent of Land in Farms (1930)	69.12	68.17	
	(19.99)	(25.90)	-1.01
Log Nearest LGC (Miles)	4.31	4.37	
	(0.64)	(0.68)	0.06
Mean Soil Productivity Index	7.67	9.37	
	(3.51)	(3.81)	1.70***
Total Population (1930)	27458.28	31712.34	
	(35707.27)	(143198.14)	4228.06
Male Population (1930)	13829.25	16089.57	
	(17726.11)	(72768.27)	2247.48
Rural Population (1930)	18451.09	16336.50	
	(10468.96)	(11254.58)	-2094.88***
Black Population (1930)	4563.57	4523.34	
	(10336.03)	(12606.68)	-17.90
Acres Operated by Tenant Farmers (1930)	82074.81	94763.78	
	(57936.78)	(71611.64)	12511.67***
Acres of Crop Failure (1930)	2500.08	3430.24	
	(3520.81)	(5017.59)	921.99***
Acres of Corn (1929)	34592.43	41436.53	
	(31704.58)	(42327.24)	6778.25***
Acres of Wheat (1929)	7269.15	18700.72	
	(12742.30)	(47218.51)	11376.28***
Acres of Soybeans (1929)	1596.53	1675.87	
	(3052.61)	(4017.13)	93.59
Acres of Cotton (1929)	13107.47	11594.10	
	(22570.26)	(27879.98)	-1531.67
Acres of Vegetables (1929)	545.93	746.70	
	(1193.57)	(1801.75)	216.87**
Value Livestock per Sq Mile	2786.09	3142.08	
	(2055.13)	(2423.69)	351.60**
Value Cattle per Sq Mile	1374.96	1594.91	
	(1146.06)	(1365.20)	216.50***
Value Chickens per Sq Mile	184.62	202.49	
	(133.45)	(158.50)	17.76*
Value All Crops per Sq Mile	4400.92	4899.60	
	(2406.78)	(3565.61)	507.74***
Observations	593	1006	1602

Table 6: Outcome Variable Regression Results on Selection 1930 vs Contemporaneous

	(1)	(2)	(3)	(4)	(5)	(6)
	Treated 1934-1939 Controls	Treated 1934-1939 Cont.	Treated 1940-1944 Controls	Treated 1940-1944 Cont.	Treated 1945-1950 Controls	Treated 1945-1950 Cont.
Val. Land + Build (log)	-0.0744***	-0.119***	0.0295*	0.0466**	-0.00295	-0.00325
	(0.0187)	(0.0192)	(0.0138)	(0.0143)	(0.00250)	(0.00269)
Number of Farms (100,000)	5.161***	7.675***	-1.102	-0.712	-0.153	-0.0529
	(1.200)	(1.187)	(0.885)	(0.962)	(0.160)	(0.182)
Frac. Minority Operator	-0.477***	-0.465***	0.00702	0.0975	0.0103	0.00266
	(0.0723)	(0.0704)	(0.0533)	(0.0608)	(0.00965)	(0.0105)
Frac. Whole-Owned Farm	-0.126	-0.260**	0.100	0.194**	-0.0218*	-0.0211
	(0.0789)	(0.0809)	(0.0582)	(0.0623)	(0.0105)	(0.0117)
Frac. Farms 0-9 Acr.	1.824*	2.187*	-0.377	-0.615***	0.161	0.0152
	(0.876)	(0.870)	(0.646)	(0.179)	(0.117)	(0.0507)
Frac. Farms 10-99 Acr.	1.721*	1.425	0.107	-0.416*	0.0520	0.0266
	(0.848)	(0.855)	(0.625)	(0.162)	(0.113)	(0.0470)
Frac. Farms 100-499 Acr.	1.252	1.178	0.158	-0.415*	0.0614	0.0211
	(0.834)	(0.840)	(0.615)	(0.185)	(0.111)	(0.0446)
Frac. Farms 500-999 Acr.	1.833	1.581	-0.301	-0.998**	0.0550	0.0149
	(1.264)	(1.305)	(0.932)	(0.326)	(0.169)	(0.0835)
_cons	-0.0732	0.729	-0.479	-0.243	0.00151	0.0449
	(0.893)	(0.896)	(0.659)	(0.264)	(0.119)	(0.0622)
N	1602	1602	1602	1602	1602	1602
adj. R^2	0.101	0.122	0.019	0.026	0.009	0.003

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: 1929-1930 Control Variables Regression: Selection into Treatment

	(1) Full Model	(2) Geographic	(3) Livestock	(4) Crops	(5) Demographic
In TVA	0.586***	0.617***			
	(0.0429)	(0.0426)			
Percent of Land in Farms	0.00427***	0.00251***			
	(0.000895)	(0.000581)			
Area in Square Miles (100000)	-2.087	-0.389			
	(2.893)	(2.628)			
Mean Soil Productivity Index	-0.0149**	-0.0248***			
	(0.00495)	(0.00357)			
Log Nearest LGC (Miles)	-0.00838	-0.0171			
	(0.0176)	(0.0171)			
Val Livestock Sq Mile (100000)	6.762*		5.117*		
	(2.677)		(2.473)		
Val Cattle Sq Mile (100000)	-9.940*		-10.68**		
	(3.948)		(3.803)		
Val Chickens Sq Mile (100000)	-18.14		4.388		
	(15.69)		(14.76)		
Val All Crops Sq Mile (100000)	-2.861***		-1.574**		
	(0.652)		(0.526)		
Acres of Corn (100000)	-0.172*			-0.176**	
	(0.0698)			(0.0675)	
Acres of Wheat (100000)	-0.146***			-0.200***	
	(0.0432)			(0.0426)	
Acres of Soybean (100000)	-0.277			0.121	
	(0.319)			(0.336)	
Acres of Cotton (100000)	-0.0294			-0.0755	
	(0.0746)			(0.0611)	
Acres of Vegetables (100000)	-1.487			-1.869*	
	(0.823)			(0.740)	
Acr of Tenant Farmers (100000)	0.0837			0.0829	
	(0.0461)			(0.0447)	
Acres of Crop Failure (100000)	-0.362			-0.480	
	(0.301)			(0.303)	
Total Population (100000)	-0.292				-2.474
	(2.625)				(2.892)
Male Population	0.133				-1.399
	(1.282)				(1.401)
Rural Population (100000)	0.561**				0.520***
	(0.176)				(0.157)
Black Population (100000)	0.0379				2.942
	(2.572)				(2.835)
White Population (100000)	-0.0854				3.174
	(2.637)				(2.905)
Amer-Born White Pop (100000)	0.427				0.0296
	(0.323)				(0.325)
Constant	0.262**	0.445***	0.443***	0.428***	0.290***
	(0.0993)	(0.0859)	(0.0234)	(0.0210)	(0.0230)
Observations	1599	1599	1602	1602	1602
Adjusted R^2	0.197	0.172	0.010	0.027	0.010

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Overall DiD Average Treatment Effects for Outcome Variables

	Num. Farms	Log ValueLB	Frac Minority	Frac FullOwner	Frac 0-9	Frac 10-99	Fraction100-499	Frac 500-999	Frac 1000
ATT	5.681	0.0527	0.00473	0.0186*	0.00929	0.0139*	-0.00429	-0.00163*	-0.00838**
	(37.50)	(0.0275)	(0.00581)	(0.00766)	(0.00608)	(0.00693)	(0.00462)	(0.000830)	(0.00313)
N	8010	8010	8010	8010	8010	8010	8010	8010	8010

Standard errors in parentheses

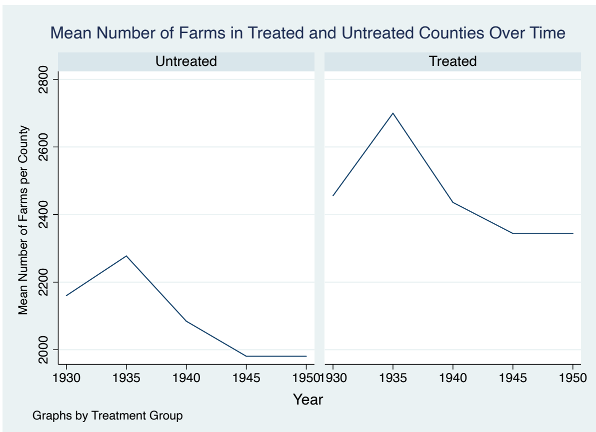
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Group Time DiD Average Treatment Effects for Outcome Variables in 5-Year Intervals

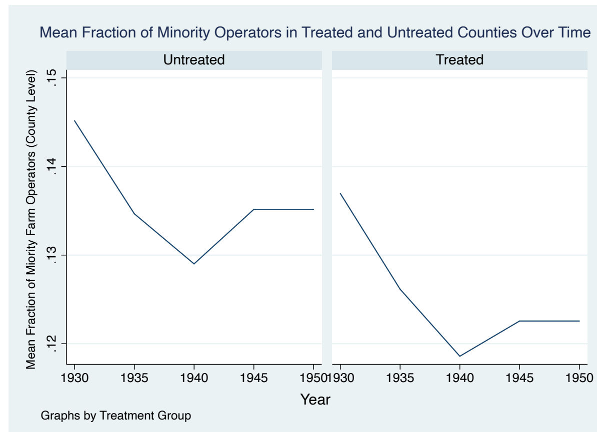
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NumberFarms	Log_ValueLB	FractionMinority	FractionFullOwner	Fraction0_9	Fraction10_99	Fraction100_499	Fraction500_999	Fraction1000
CAverage	16.42	0.0524*	0.00504	0.0141*	0.00859	0.0124*	-0.00538	-0.00135*	-0.00664**
	(32.33)	(0.0225)	(0.00475)	(0.00645)	(0.00507)	(0.00587)	(0.00378)	(0.000656)	(0.00244)
T1935	58.31	0.0411*	0.00700	-0.00517	0.00531	0.00522	-0.00961*	-0.000399	-0.000524**
	(43.43)	(0.0195)	(0.00424)	(0.00765)	(0.00557)	(0.00499)	(0.00448)	(0.000342)	(0.000167)
T1940	8.575	0.124**	-0.000152	0.0298***	0.0128*	0.0237	-0.00483	-0.000490	-0.00351*
	(41.74)	(0.0428)	(0.00279)	(0.00791)	(0.00582)	(0.0136)	(0.00315)	(0.000563)	(0.00148)
T1945	-1.636	0.0227	0.00651	0.0162	0.00818	0.0102	-0.00355	-0.00225*	-0.0109*
	(43.74)	(0.0387)	(0.00789)	(0.0103)	(0.00761)	(0.00684)	(0.00633)	(0.00111)	(0.00428)
T1950	0.440	0.0221	0.00681	0.0156	0.00808	0.0106	-0.00354	-0.00226*	-0.0116**
	(43.52)	(0.0385)	(0.00789)	(0.0103)	(0.00760)	(0.00683)	(0.00630)	(0.00111)	(0.00435)
N	8010	8010	8010	8010	8010	8010	8010	8010	8010

Standard errors in parentheses

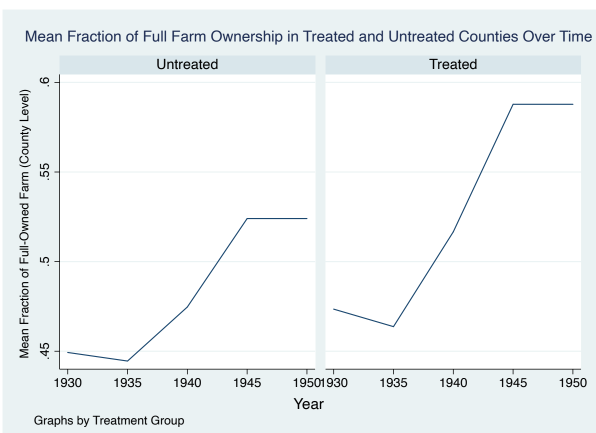
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



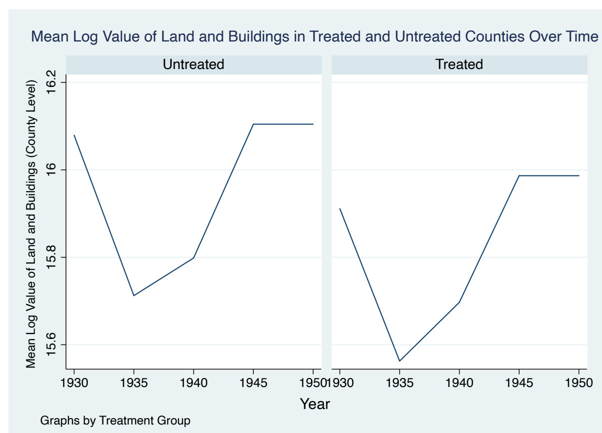
(a) Number of Farms



(b) Mean Fraction Minority Operator



(c) Mean Fraction Full Ownership



(d) Mean log Value Land and Buildings

Figure 7: Parallel Trends in Outcomes Variables Between Treated and Untreated Groups Over Time

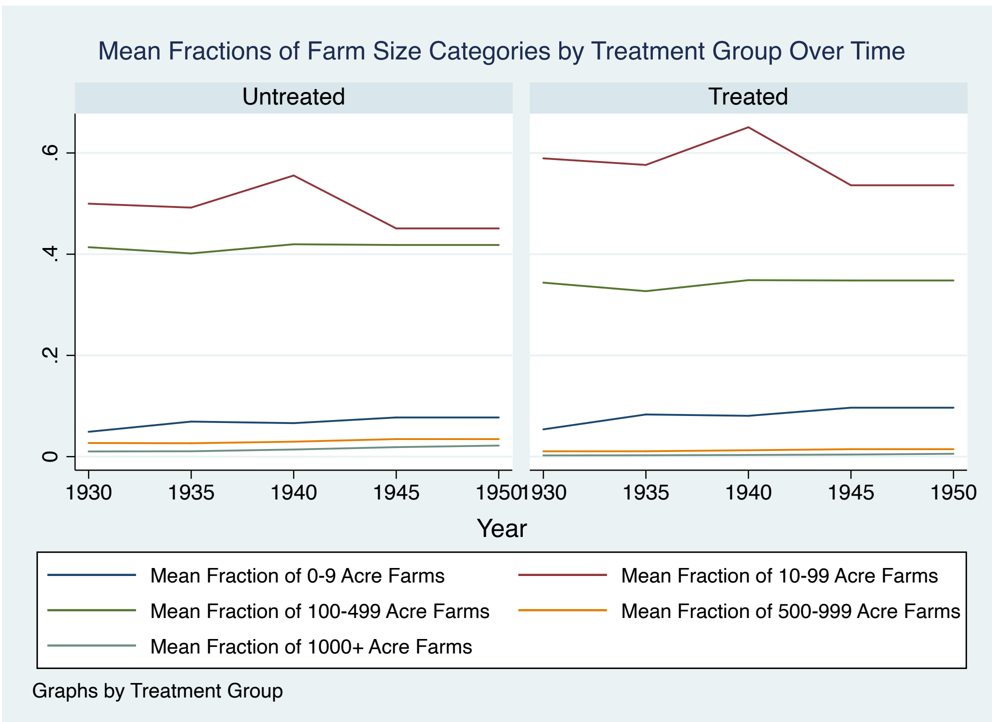
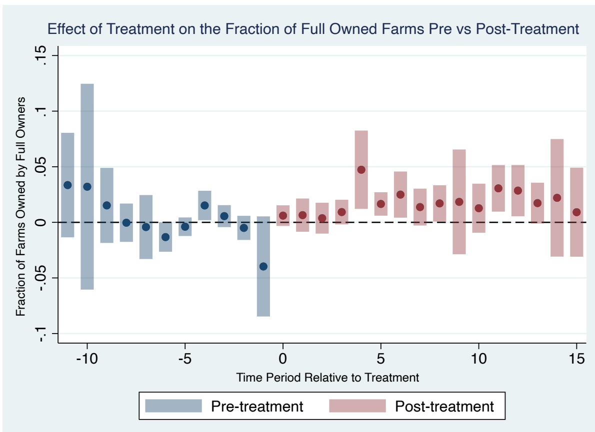
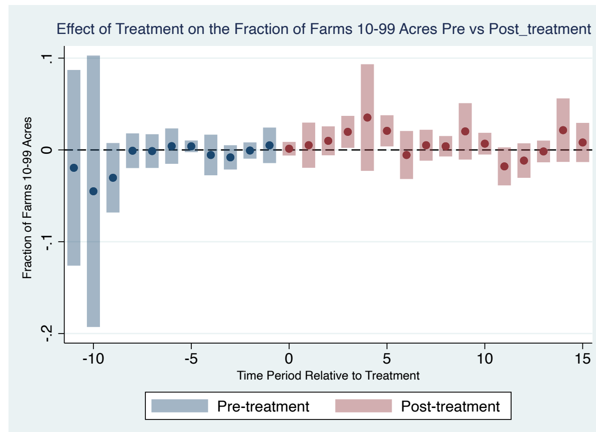


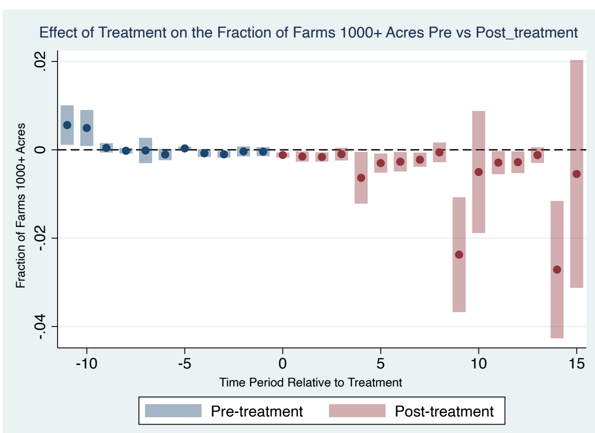
Figure 8: Parallel trends in farm size groups between treated and untreated groups over time



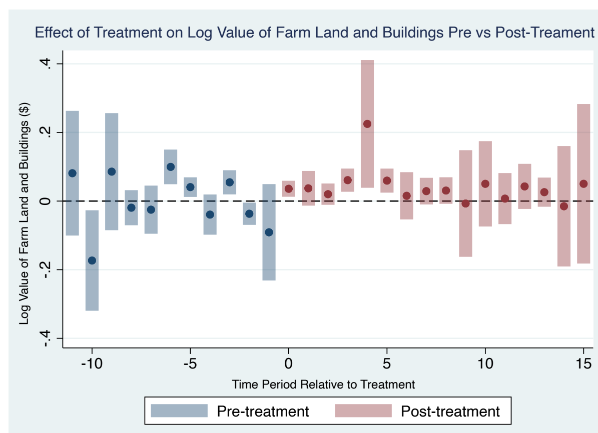
(a) Fraction Full-Owned Farms



(b) Fraction of Farms 10-99 Acres

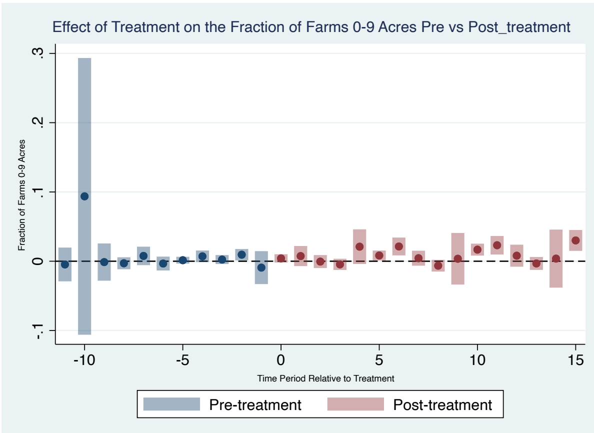


(c) Fraction of Farms 1000+ Acres

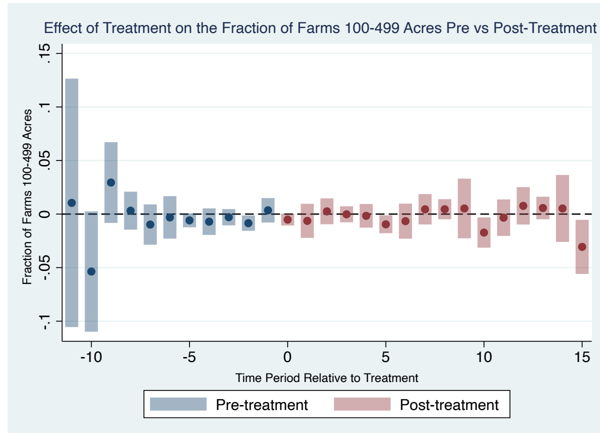


(d) Log Value of Farm Land and Buildings

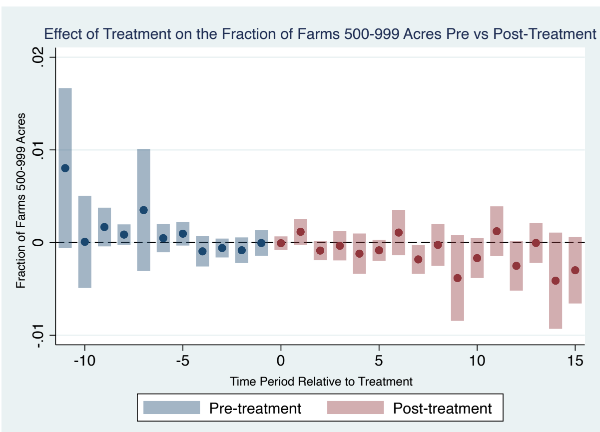
Figure 9: Effects of treatment relative to treatment period on statistically significant outcome variables



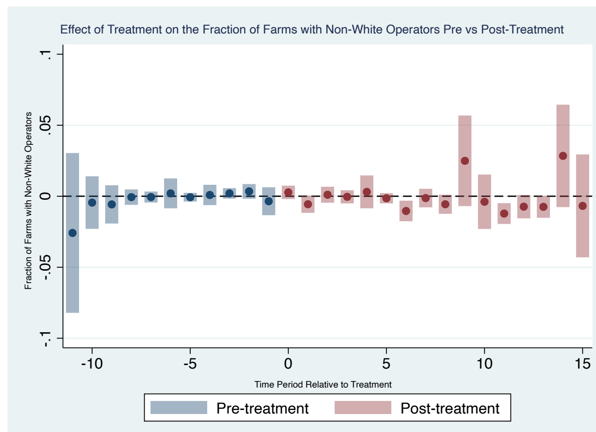
(a) Fraction of Farms 0-9 Acres



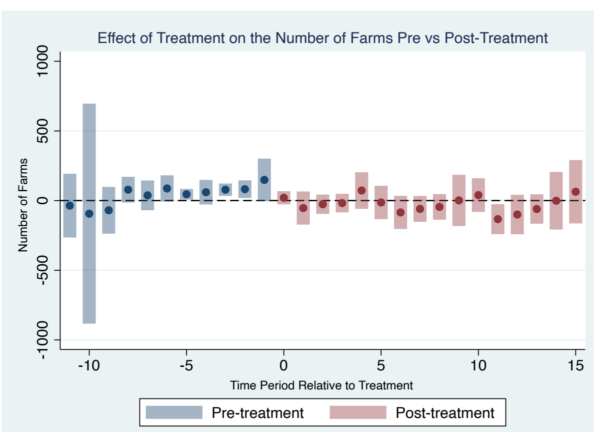
(b) Fraction of Farms 100-499 Acres



(c) Fraction of Farms 500-999 Acres

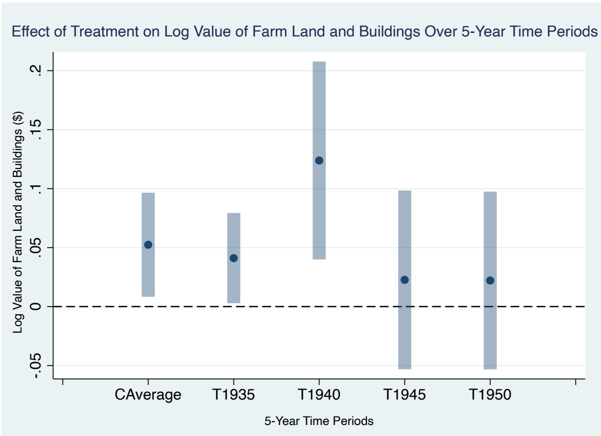


(d) Fraction of Farms with Non-White Operators

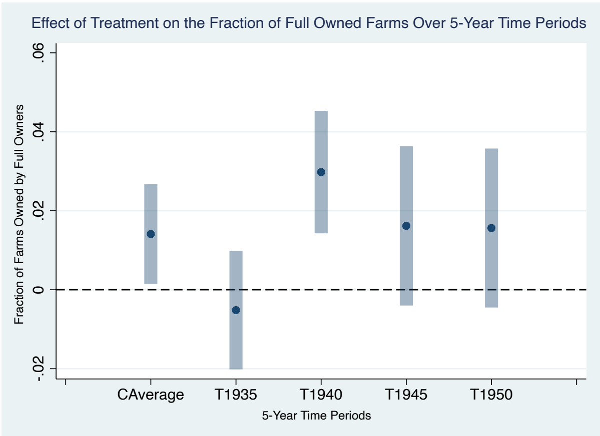


(e) Number of Farms

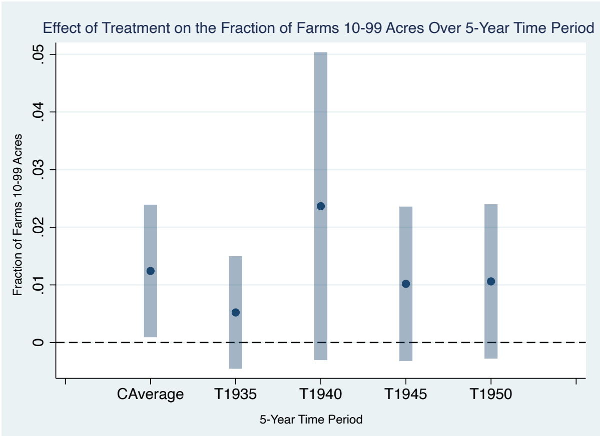
Figure 10: Effects of treatment relative to treatment period on non-statistically significant Outcome Variables



(a)



(b)



(c)

Figure 11: Treatment effects on Log Value of Farm Land and Building, the Fraction of Full-Owned Farms, and the Fraction of 10-99 Acre Farms for counties treated in 5-year groups of treatment timing.

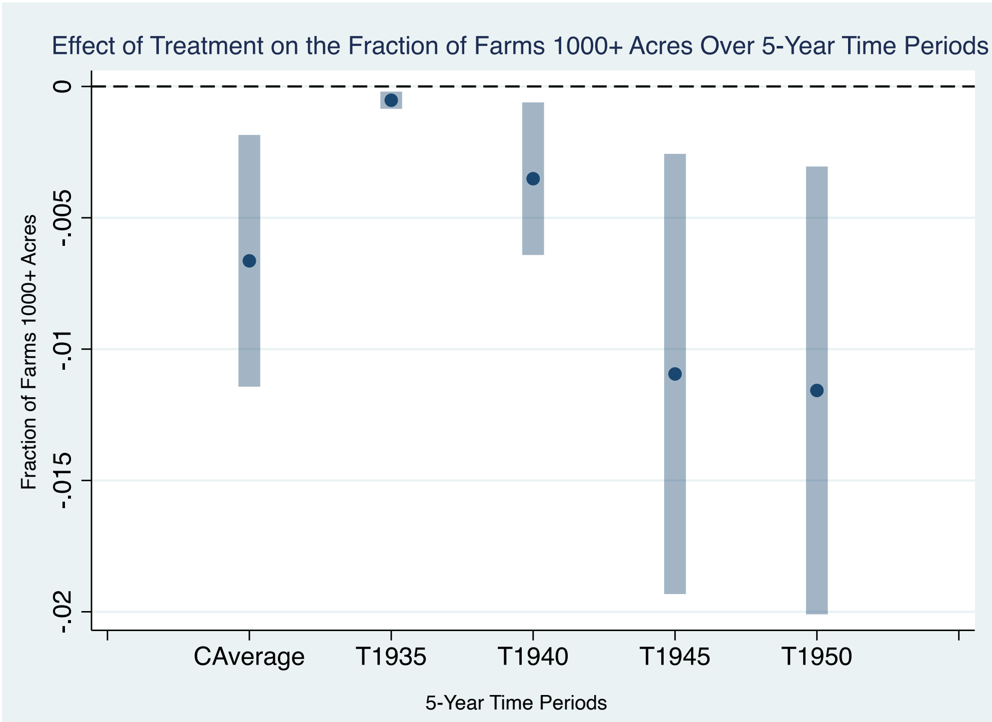


Figure 12: Treatment effects on the Fraction of 1000+ Acre Farms in 5-year groups of treatment

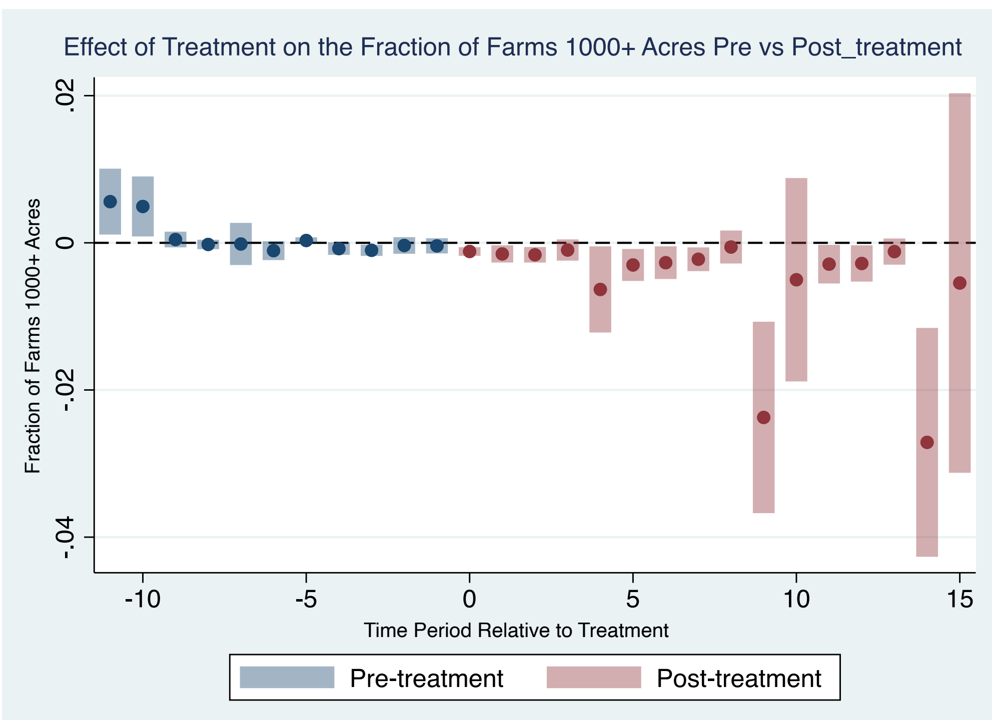
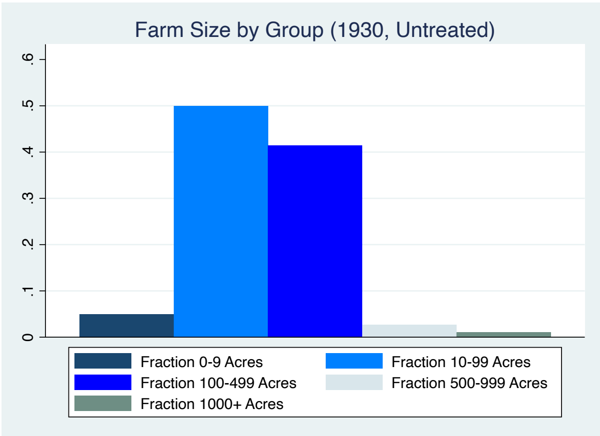
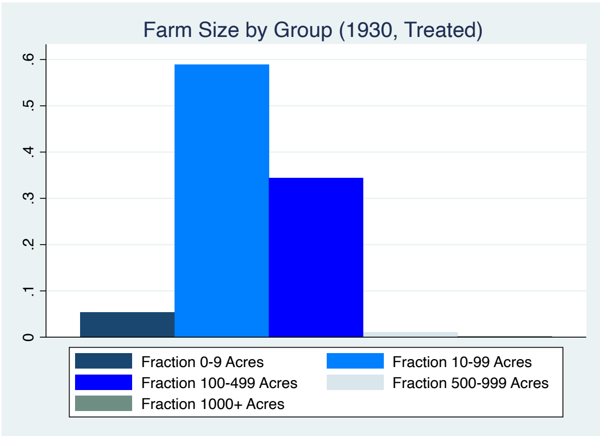


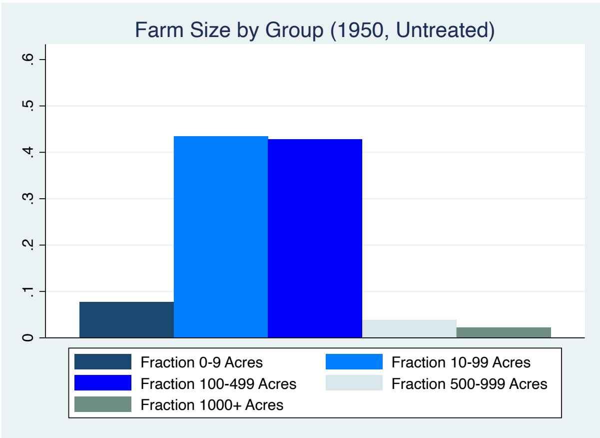
Figure 13: Treatment effect on the Fraction of 1000+ Acre Farms for pre and post-treatment periods



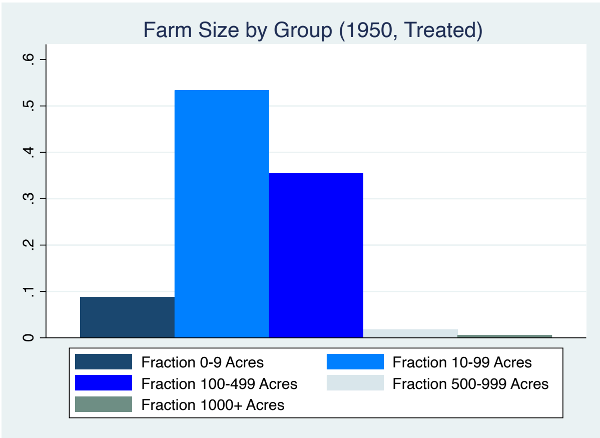
(a) 1930 Untreated



(b) 1930 Treated

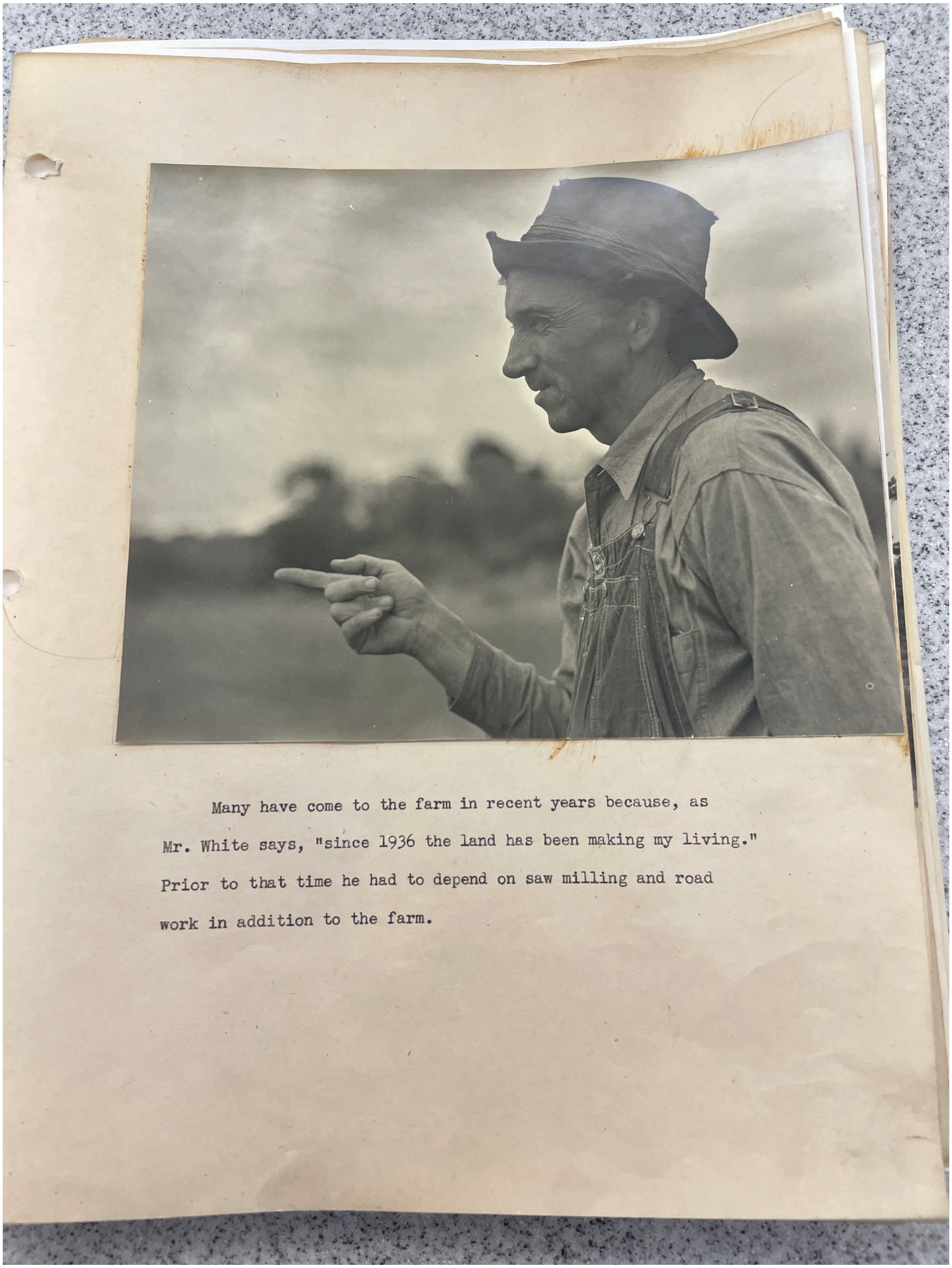


(c) 1950 Untreated



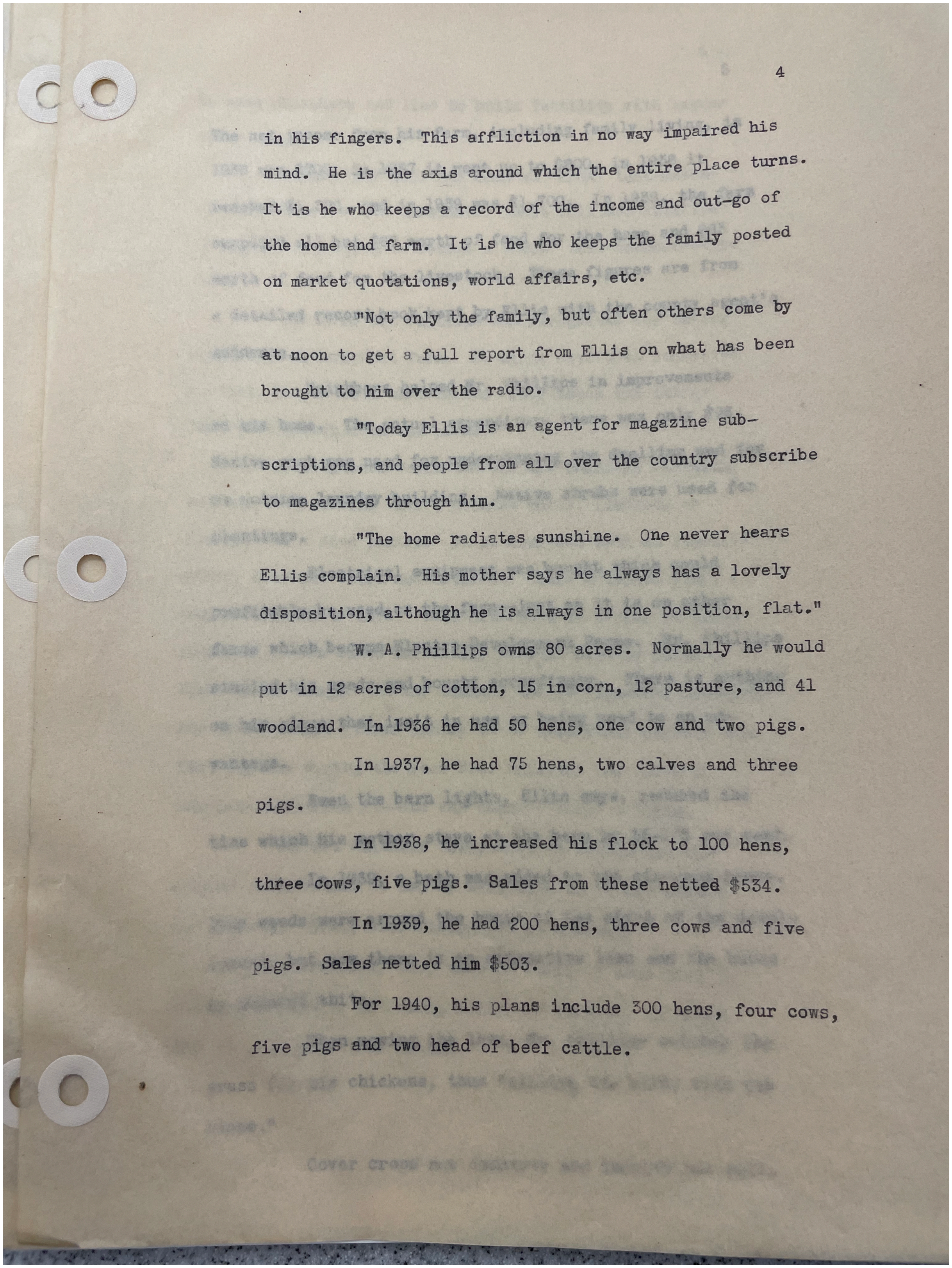
(d) 1950 Treated

Figure 14: Differences in farm size distribution in Treated and Untreated Counties, 1930 and 1950



Many have come to the farm in recent years because, as Mr. White says, "since 1936 the land has been making my living." Prior to that time he had to depend on saw milling and road work in addition to the farm.

Figure 15: Mississippi test farmer speaks about the need for off-farm income before the TFP (Nation Archives 1940)



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in his fingers. This affliction in no way impaired his mind. He is the axis around which the entire place turns. It is he who keeps a record of the income and out-go of the home and farm. It is he who keeps the family posted on market quotations, world affairs, etc.

"Not only the family, but often others come by at noon to get a full report from Ellis on what has been brought to him over the radio.

"Today Ellis is an agent for magazine subscriptions, and people from all over the country subscribe to magazines through him.

"The home radiates sunshine. One never hears Ellis complain. His mother says he always has a lovely disposition, although he is always in one position, flat."

W. A. Phillips owns 80 acres. Normally he would put in 12 acres of cotton, 15 in corn, 12 pasture, and 41 woodland. In 1936 he had 50 hens, one cow and two pigs.

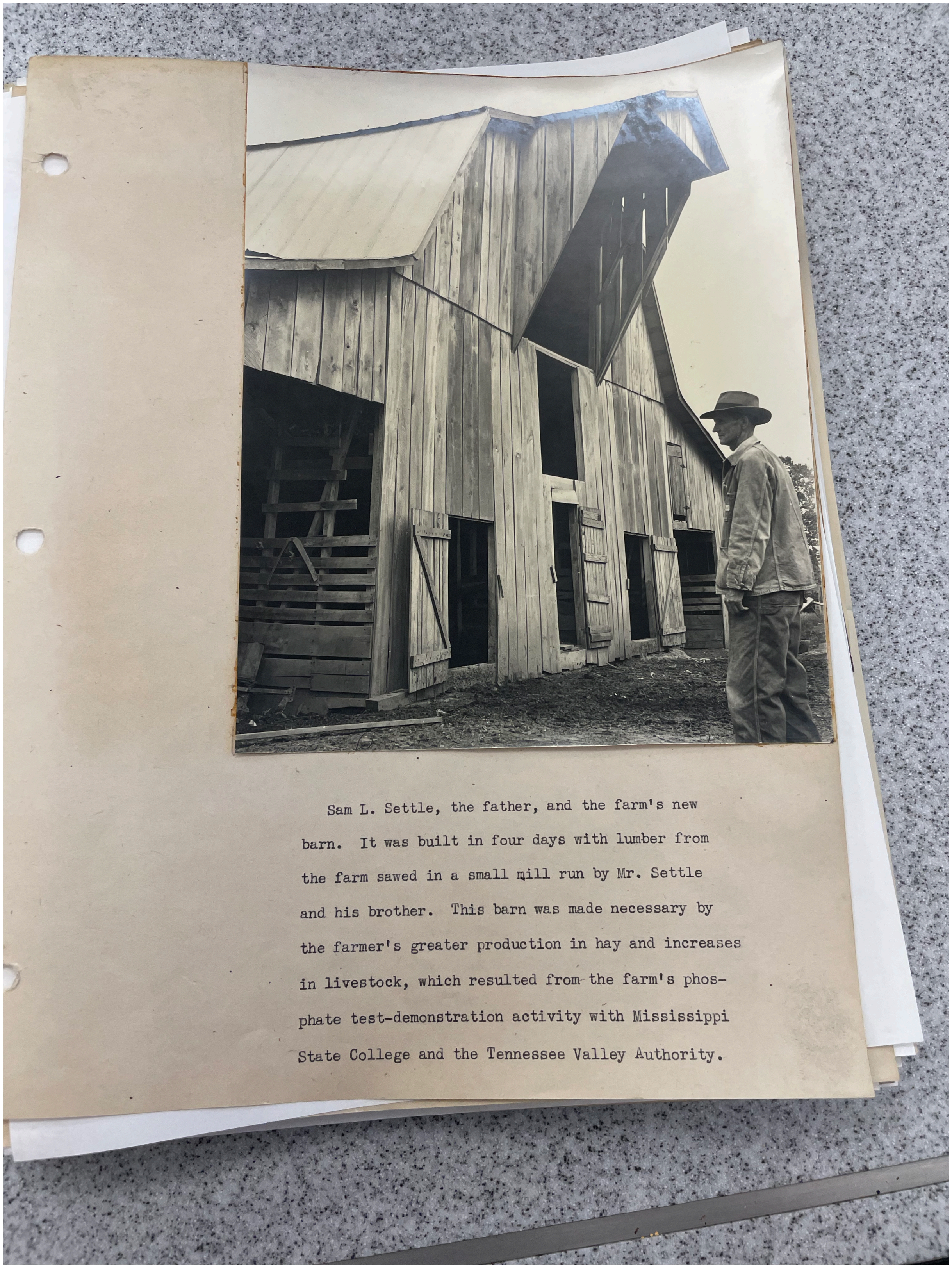
In 1937, he had 75 hens, two calves and three pigs.

In 1938, he increased his flock to 100 hens, three cows, five pigs. Sales from these netted $534.

In 1939, he had 200 hens, three cows and five pigs. Sales netted him $503.

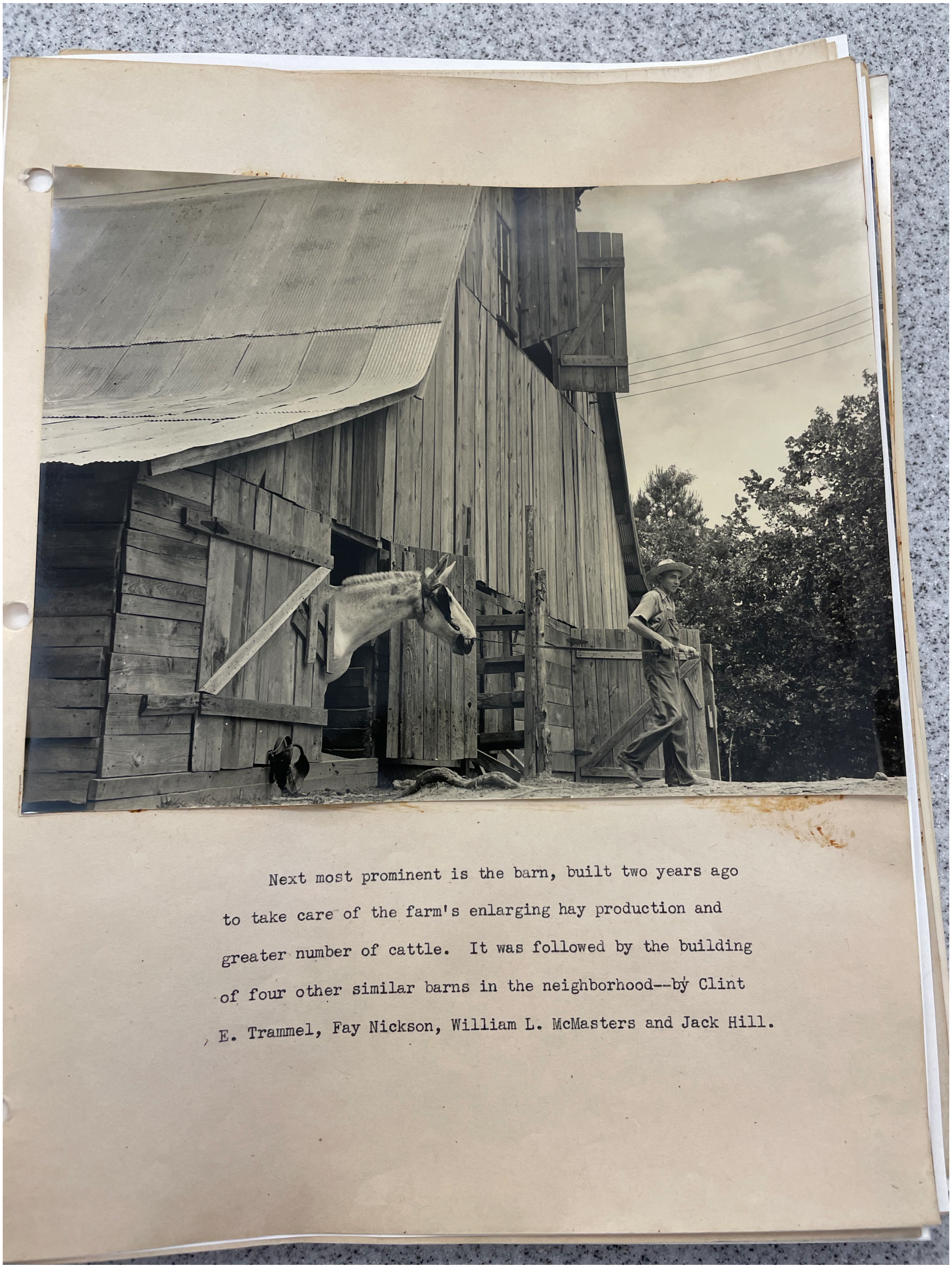
For 1940, his plans include 300 hens, four cows, five pigs and two head of beef cattle.

Figure 16: This excerpt is taken from a 1940 series of articles written by a farmer referred to as Mr. Phillips. The articles were published in series in the magazine "Commercial Appeal" about the Phillips family's experience in the TFP (Nation Archives 1940)



Sam L. Settle, the father, and the farm's new barn. It was built in four days with lumber from the farm sawed in a small mill run by Mr. Settle and his brother. This barn was made necessary by the farmer's greater production in hay and increases in livestock, which resulted from the farm's phosphate test-demonstration activity with Mississippi State College and the Tennessee Valley Authority.

Figure 17: The above picture and caption provides an example of increased yields from test fertilizers leading to improved farm infrastructure and value (Nation Archives 1940).



Next most prominent is the barn, built two years ago to take care of the farm's enlarging hay production and greater number of cattle. It was followed by the building of four other similar barns in the neighborhood--by Clint E. Trammel, Fay Nickson, William L. McMasters and Jack Hill.

Figure 18: Benefits from the TFP could spread throughout the community (Nation Archives 1940).