

ESTIMATED ECONOMIC ACTIVITY FROM PRODUCING ONE ACRE OF NON-IRRIGATED, NO-TILLED CORN IN TENNESSEE

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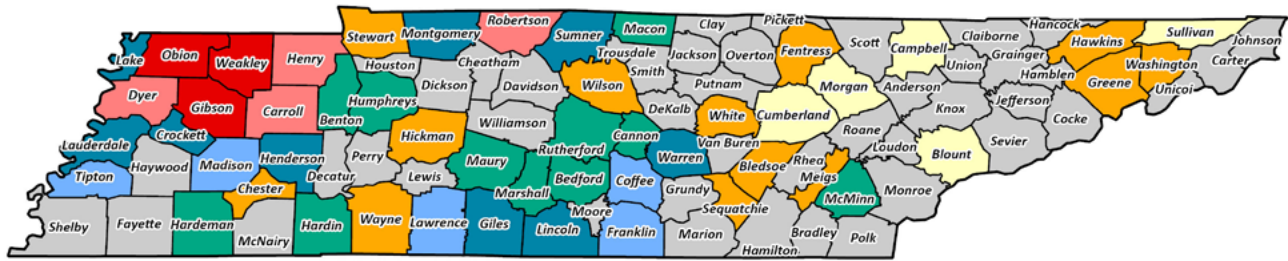
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KEY TAKEAWAYS

- The estimated economic impact for the backward linked supply chain for producing one acre of non-irrigated, no-tilled corn in Tennessee in 2024 is \$1,104 for economic activity, \$289 for labor income and \$612 for gross regional product.
- The output multiplier is 1.66. For each dollar spent growing one acre of non-irrigated, no-tilled corn in the state, an additional \$0.66 in economic activity is generated.
- The top five industries impacted based on total output economic activity are grain farming, support activities for agriculture and forestry, wholesale – other nondurable goods merchant wholesalers, commercial and industrial machinery and equipment repair and maintenance and non-depository credit intermediation and related activities.
- Nitrogen fertilizers purchases represent 13.1 percent of the direct spending, but the 2022 state IMPLAN model indicates that virtually all the fertilizer purchased are manufactured in other states (local purchase percentage of 1.7 percent), hence the sector has very little local impact.

BACKGROUND

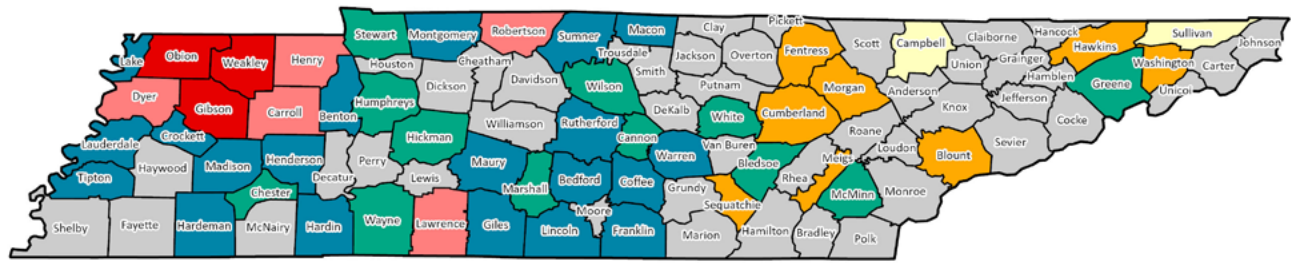
Corn is widely grown in Tennessee. County-level harvested corn acreage, production and yields for 2023 are shown in Figures 1, 2, and 3, respectively (USDA/NASS, 2024a). From 2013 to 2023, the average total planted acreage was 868,182 acres with harvested corn acreage for that same timeframe totaling 813,636 acres. Average production for that period was 132.9 million bushels with yields averaging 163.1 bushels per acre. Compared to other states in 2023, Tennessee ranked 17th for harvested acreages, 15th in corn production and 20th in yields (USDA/NASS, 2024a & 2024b).



Tennessee Harvested Corn, 2023
(Acres)



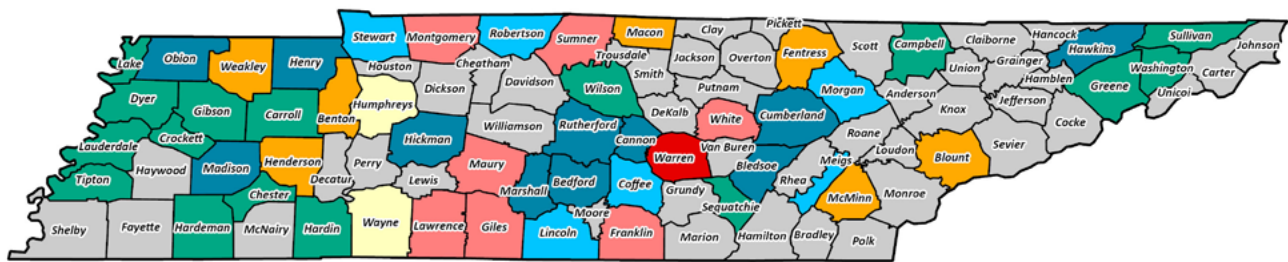
Figure 1. County-Level Corn Harvested Acres in Tennessee, 2023
Source: USDA/NASS, 2024a



Tennessee Corn Production, 2023
(Bushels)



Figure 2. County-Level Corn Production in Tennessee, 2023
Source: USDA/NASS, 2024a



Tennessee Corn Yields, 2023
(bu/acre)



Figure 3. County-Level Corn Yields in Tennessee, 2023
Source: USDA/NASS, 2024a

For Tennessee’s corn producers in 2022, corn cash receipts at \$691.5 million ranked third behind soybeans (\$1,094.7 million) and broilers (\$972.6 million). Compared to other states for 2022, Tennessee ranked 19th in cash receipts from corn (USDA/ERS, 2024). Accounting for all corn farming for the state, and including multiplier effects, producing corn in 2022 contributed an estimated \$1.3 billion in economic activity. This economic activity was comprised of an estimated 10,920 individuals working part- or full-time in industries that support corn farming with a labor income of \$272.5 million (IMPLAN Group, LLC, 2022).¹

The purpose of this analysis is to estimate the economic impacts using Input-output analysis for planting one acre of corn based on the University of Tennessee’s most recent row-crop budgets (Smith and Bowling, 2024). In doing so, our analysis is similar to that conducted by Nadreau (2022), using the methodology developed by Willis and Holland (1997), where they converted enterprise budget data to input-output vectors for a Washington state potato study. The study investigated the current state of potato production and the role the crop’s value chain plays in that state’s economy. Willis and Holland (1997)

¹Calculations based on IMPLAN’s 2022 direct value of production of \$690.1 million, which includes on-farm consumption and is net of inventory changes. IMPLAN’s grain farming corresponds to NAICS codes 111130, 111140, 111150, 111191 and 111199—establishments primarily engaged in raising small grains (wheat), corn and sorghum (US Census Bureau, 2024).

developed a six-step procedure for converting farm enterprise budget data into input-output (IO) accounts using grass seed as an example. They stressed the importance of margining² once the enterprise budgets were developed and transformed into a set of IO accounts, the need for margining to turn purchaser prices into producer prices, and, for those industries marginated, assignment to industries responsible for margining.

Since Tennessee's field corn is primarily grown via no-till systems, the row crop budget evaluated is for a non-irrigated system of this type (McClure, 2009). It is important to note that substantial variation in production practices, management decisions and cost structures exist for corn production across the state of Tennessee. High yielding regions will have different cost structures than low yielding regions. Crop budgets reflect an average cost structure across the state and are developed to assist producers in developing budgets that are reflective of their individual circumstances. IMPLAN's Cloud platform using 2022 data is used to generate the estimated economic impacts for this analysis. Budget expenditures are assigned to one or more of IMPLAN's 546 industries, which are based on the North American Industry Classification System (NAICS). The budget expenditures by corn producers for goods and services, land, labor, capital equipment and other materials enhance Tennessee's economy. In addition to IMPLAN describing a regional economy (e.g., Tennessee), it can be used for predictive purposes by providing multiplier-based estimates.

Model output includes descriptive metrics of the economy such as total industry output (a measure of economic activity), labor income and total value added. Total industry output (TIO) is defined as the value of production by industry per year.³ Labor income (LI) is defined as employee compensation (pay plus the value of certain benefits) and proprietor (owner-operator) income. Total value added (TVA) or gross regional product is defined as all income to workers paid by employers; self-employed income; interests, rents, royalties, dividends and profit payments; and excise and sales taxes collect by business from individuals. It is equivalent to a state's gross regional product (GRP), which is analogous to gross domestic product for the entire U.S.

TENNESSEE NON-IRRIGATED, NO-TILLED ENTERPRISE BUDGET FOR CORN

The estimated variable and fixed costs for non-irrigated, no-tilled corn are detailed in Table 1. Assumptions used to determine prices and quantities are footnoted at the end of the table. Variable and fixed costs are estimated at \$539.08 per acre and \$285.89 per acre, respectively. Total variable and fixed costs sum to \$824.96 per acre. Not surprisingly, seed, fertilizer and chemicals comprise the largest portion of the variable costs. The reader should note that this example does not include expenses for machinery rental, any custom work performed, grain drying and insurance other than crop insurance (see variable cost).

²"Margins allow for purchases from retail and wholesale industries to be appropriately allocated among the retailer, wholesaler, transporters, and produce of the good in question, thereby correctly attributing the appropriate portion of the good's sale price among all actors involved in bringing the good to the customer" (IMPLAN, 2023). By doing so, transactions flow directly from producer to consumer with transportation as trade treated as pass through industries (Miller and Blair, 2022).

³While employment is usually reported, the impact of one acre on employment is quite small so it is not reported in this analysis.

Table 1. Corn, No-Tilled, Non-Irrigated Enterprise Budget Expenditures for Tennessee, 2024*

Category	Unit	Quantity	Price	Total (\$/acre)
Variable Costs				
Seed ¹	Thousand	32	\$3.60	\$115.20
Fertilizer & Lime ²	Acre	1	\$213.86	\$213.86
Chemicals ³	Acre	1	\$71.92	\$71.92
Crop Scout or Consultant	Acre	1	\$10.00	\$10.00
Repair & Maintenance ⁴	Acre	1	\$45.98	\$45.98
Fuel, Oil & Filter ⁴	Acre	1	\$25.76	\$25.76
Operator Labor ⁴	Acre	1	\$13.98	\$13.98
Crop Insurance ⁵	Acre	1	\$20.40	\$20.40
Operating Interest ⁶	%	\$517.09	8.50%	\$21.98
				Total Variable Expenses: \$539.07
Fixed Costs				
Capital Recovery ⁴	Acre	1	\$127.89	\$127.89
General Overhead	Acre	1	\$20.00	\$20.00
Cash Rent ⁷	Acre	1	\$113.00	\$113.00
Management Labor	Acre	1	\$25.00	\$25.00
				Total Fixed Expenses: \$285.89
				Total Variable & Fixed Expenses: \$824.96

*This example does not account for expenses associated with machinery rental, custom work, grain drying and insurance other than crop insurance.

¹Corn seed costs assumes a bag of seed costs \$288 and contains 80,000 seeds (\$3.60/thousand seeds). Seeding rate of 32,000 seeds/acre. Seed treatment included in the price. Seed cost varies by variety.

²Lime assumed to be applied once every four years at a rate of 2 tons per acre (includes the cost of application). N, P, and K quantities and prices are shown in elemental pounds.

³Assumes a normal (e.g., corn and soybean) crop rotation with minimal weed infestation. A continuous monocrop system may require additional expenses for chemicals and/or land preparation.

⁴Machinery expenses will vary dramatically by operation, financial resources and land base. The machinery cost estimates are an estimate of costs of ownership and operation for specified pieces of machinery available to a "representative" row-crop farm in Tennessee.

⁵Crop insurance is an estimate and will vary by policy, county and coverage election. The estimate provided is the average premium paid per insured acre for each commodity in Tennessee for the previous production year, as reported by USDA's Risk Management Agency's Summary of Business Report.

⁶Operating interest is assumed to be charged on half of all variable expenses.

⁷Cash rental rates are the 2023 USDA-NASS reported cash rental rates for cropland in Tennessee (Smith & Bowling, 2024).

ASSIGNING CORN ENTERPRISE BUDGET EXPENDITURES TO IMPLAN SECTORS

The enterprise budget cost categories, along with the IMPLAN sectors assigned and their general description, plus the NAICS description indicating the reason that IMPLAN sector was chosen, are detailed in Table 2. Budget expenditures for corn seed, fertilizer, lime, chemicals and fuel were margined. The IMPLAN sectors used for margining are indicated in italics under the NAICS description. Approximately 80 percent of the budget expenditure for each particular cost category that was margined was distributed to the various assigned IMPLAN sectors in italics. The costs for applying the inputs, 20 percent, were assigned to IMPLAN sector 19 (Support Activities for Agriculture & Forestry). As an example, for chemicals the budget expenditure (Table 1) was \$71.92 per acre. For that value, 20 percent (\$14.38) was allocated to sector 19, whereas 80 percent (\$57.53) was margined and distributed across IMPLAN sectors 170 (pesticides and other agricultural chemicals) and 400 (wholesale services – other nondurable goods merchant wholesalers). A small share of the cost categories margined were assigned to various transportation sectors (e.g., air, rail, truck, water and pipeline).

Fuel is assumed to be wholesale and delivered by a trucker. Operator labor was assigned to IMPLAN sector 19, which

accounts for agricultural production or harvesting crews, crew leaders and farm labor contractors. Labor for management was assigned to proprietary income, as well as cash rent. Operating interest was assigned to IMPLAN sector 439 (non-depository credit intermediation and related activities). This sector accounts for lending, making loans or extending credit for agriculture. General overhead was assigned to IMPLAN sector 456 (accounting, tax preparation, bookkeeping and payroll services). Capital recovery for machinery (e.g., depreciation) was assigned to other property income, part of total value added, and was not included as part of the multiplier shock component of the model. The remaining expenditures (e.g., crop scout or consultant, repair and maintenance of equipment, and crop insurance) are detailed in Table 2.

Table 2. Non-Irrigated, No-Tilled Corn Expenditures for Tennessee Mapped to IMPLAN Sector

Cost Categories	Sector	Sector Description	NAICS Description
Corn Seed*	2	Grain Farming	Corn farming, field and seed production (<i>grains (sector 2)</i>)
Fertilizer*	19 (20%) & 400 (80%)	Support Activities for Agriculture/Forestry; Wholesale – Other Nondurable Goods Merchant Wholesalers	Fertilizer application for crops; Fertilizer & fertilizer materials merchant wholesalers (<i>nitrogen fertilizer (sector 167) and wholesale services – other nondurable goods merchant wholesalers (sector 400)</i>)
Lime*	19 (20%) & 400 (80%)	Support Activities for Agriculture/Forestry; Wholesale – Other Nondurable Goods Merchant Wholesalers	Spreading lime for crops; Lime, agricultural, merchant wholesalers (<i>lime (sector 208) and wholesale services – other durable goods merchandise merchant wholesalers (sector 396)</i>)
Chemicals*	19 (20%) & 400 (80%)	Support Activities for Agriculture/Forestry; Wholesale – Other Nondurable Goods Merchant Wholesalers	Crop dusting & spraying; Herbicides merchant wholesalers (<i>pesticides and other agricultural chemicals (sector 170) and wholesale services – other nondurable goods merchant wholesalers (sector 400)</i>)
Crop Scout or Consultant	19	Support Activities for Agriculture/Forestry	Entomological, pest and weed control for agriculture
Repair & Maintenance	515	Commercial & Industrial Machinery & Equipment Repair & Maintenance	Agricultural machinery & equipment repair & maintenance services
Fuel, Oil & Filter*	399	Wholesale – Petroleum & Petroleum Products	Fuel oil truck jobber (<i>refined petroleum products (sector 154) and wholesale services – petroleum and petroleum products (sector 399)</i>)
Operator Labor	19	Support Activities for Agriculture/Forestry	Agriculture production or harvesting crews; Crew leaders, farm labor; Farm labor contractors
Crop Insurance	444	Insurance Carriers, except Direct Life	Crop insurance carrier, direct
Operating Interest	439	Non-depository Credit Intermediation & Related Activities	Agricultural credit institutions, making loans or extending credit; Agricultural lending
Capital Recovery (Depreciation)	439	Other Property Income	Gross Regional Product component
General Overhead	456	Accounting, Tax Preparation, Bookkeeping, & Payroll Services	Agricultural credit institutions, making loans or extending credit; Agricultural lending
Cash Rent	GRP	Proprietary Income	Labor income & gross regional product component
Management Labor	GRP	Proprietary Income	Labor income & gross regional product component

*For margined expenditure categories (e.g., corn seed, fertilizer, lime, chemicals and fuel oil), a small share of the costs were assigned to various transportation sectors (e.g., air, rail, water, truck and pipeline).

IMPLAN SHOCK VECTOR FOR NON-IRRIGATED, NO-TILLED CORN

Based on the per acre expenditure information in Table 1 and their assigned IMPLAN sectors from Table 2, a rollup of the IMPLAN shock vector is shown in Table 3. The table displays the various transportation sectors in the shock vector (see footnote 2 discussing the importance for including transportation when margining). IMPLAN's local purchase percentage (LPP) option is used in this analysis, which affects the direct impact value applied to the multipliers. Instead of a 100 percent direct expenditure value for each respective expenditure budget category applied to the multiplier the model is set to the social accounting matrix value, or regional purchase coefficient (RPC), which is normally less than that.⁴ The direct per acre expenditures sum to \$824.96.

Table 3. IMPLAN Shock Vector for Non-Irrigated, No-Tilled Corn Expenditures by Assigned IMPLAN Sector (2024\$)

Sector	Description	Expenditure (\$/acre)	Expenditure Category %	Local Purchase Percentage %
2	Grain Farming	\$100.27	12.2%	100.0
19	Support Activities for Agriculture/Forestry	\$81.13	9.8%	100.0
154	Refined Petroleum Products	\$21.09	2.6%	27.7
167	Nitrogen fertilizer	\$108.05	13.1%	1.7
170	Pesticides & Other Agricultural Chemicals	\$40.01	4.9%	67.4
208	Lime	\$9.50	1.2%	65.3
396	Wholesale Services – Other Durable Goods Merchandise Merchant Wholesalers	\$1.15	0.1%	82.1
399	Wholesale – Petroleum & Petroleum Products	\$4.18	0.5%	86.4
400	Wholesale – Other Nondurable Goods Merchant Wholesalers	\$61.98	7.5%	83.2
414	Air Transportation Services	\$0.66	0.1%	37.1
415	Rail Transportation services	\$10.39	1.3%	72.5
416	Water Transportation services	\$3.57	0.4%	88.4
417	Truck Transportation services	\$8.58	1.0%	99.3
419	Pipeline Transportation services	\$0.15	0.02%	46.1
439	Non-depository Credit Intermediation & Related Activities	\$21.98	2.7%	88.5
444	Insurance Carriers, except Direct Life	\$20.40	2.5%	64.9
456	Accounting, Tax Preparation, Bookkeeping, & Payroll Services	\$20.00	2.4%	92.7
515	Commercial & Industrial Machinery & Equipment Repair & Maintenance	\$45.98	5.6%	94.9
LI	Proprietary Income	\$138.00	16.7%	
TVA	Other Property Type Income	\$127.89	15.5%	
	Total*	\$824.96	100.0%	

*Total may not add due to rounding.

The results are indicated in Table 4. The estimated economic impact for the backward linked supply chain for producing one acre of non-irrigated, no-tilled corn in Tennessee in 2024 is \$1,104 for economic activity, \$289 for labor income and \$612 for gross regional product. The output multiplier is 1.66. For each dollar spent growing one acre of non-irrigated, no-tilled corn in the state, an additional \$0.66 in economic activity is generated. The top five industries impacted based on total output economic activity are grain farming, support activities for agriculture and forestry, wholesale – other nondurable goods

⁴The RPC indicates what proportion of the local demand for that commodity is supplied by local production. An RPC of 0.50 for a given commodity means for each \$1 of local need, 50 percent will be purchased from local producers. For nitrogenous fertilizer in Table 3, the LPP or RPC is 1.7 percent. So, for every \$1 of local need only 1.7 percent will be purchased locally.

merchant wholesalers, commercial and industrial machinery and equipment repair and maintenance, and non-depository credit intermediation and related activities. The reader may be surprised that purchased inputs do not have a larger impact. Nitrogen fertilizers purchases represent 13.1 percent of the direct spending, but the 2022 state IMPLAN model indicates that virtually all the fertilizer purchased are manufactured in other states (local purchase percentage of 1.7 percent), hence the sector has very little local impact.

Table 4. Estimated Per Acre Economic Impact for Non-Irrigated, No-Tilled Corn in Tennessee (2024\$)

Category	Labor Income	Gross Regional Product	Total Industry Output
Direct ¹	\$145	\$361	\$664 ⁵
Indirect ²	\$51	\$84	\$162
Induced ³	\$93	\$167	\$278
Total⁴	\$289	\$612	\$1,104

¹Direct effects are those attributable to the actual enterprise budget expenditures in Tennessee.

²Indirect effects are those attributable to the input supplying businesses (e.g., expenditures on raw materials, supplies, and other operating expenses).

³Induced effects are created as the new income generated by the direct and indirect effects is spent and re-spent within the region.

⁴Total is the sum of the direct, indirect, and induced effects.

⁵Because of margining and using the model's LPP, the direct value will not total to \$824.96.

CONCLUSION

This analysis provides estimates regarding the economic impact of producing one acre of non-irrigated, no-tilled corn based on the University of Tennessee's Extension 2024 row crop budgets. For a direct impact of growing an acre of non-irrigated, no-tilled corn, \$825 the total estimated economic activity per acre is \$1,104 per acre, \$289 for labor income and \$612 for gross regional product. The top five industries impacted based on total output economic activity are grain farming, support activities for agriculture and forestry, wholesale – other nondurable goods merchant wholesalers, commercial and industrial machinery and equipment repair and maintenance, and non-depository credit intermediation and related activities. Some of the more common input purchases such as nitrogen fertilizers, pesticides and other agricultural chemicals and lime may not be manufactured entirely within state but outside the state's boundaries, influencing the magnitude of the economic activity for non-irrigated, no-tilled corn. The analysis also discusses the need for margining to turn purchaser prices from retail and wholesale industries into producer prices. For those industries margined, it is important to allocate the final sale price to the consumer to those industries responsible (e.g., retailer, wholesaler, transporter, etc.) in the supply chain.

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