

Economic Issues Related to Long-Term Investment in Tree Fruits

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The concept of asset fixity—which Galbraith and Black (1938) defined as the “lumpiness” of salient production factors due to high fixed costs, making their temporary reduction or reorganization very expensive and unprofitable in the short run—in agriculture has interesting implications for perennial crops such as tree fruits. Johnson (1950) introduced the concept of asset fixity in agriculture, explaining that most farm machinery and land have low opportunity costs because they have few alternative uses outside of agriculture. Johnson (1958) later stated that the existence in agriculture of fixed resources with low opportunity costs leads to persistently low rate of returns. Further, Johnson and Quance (1972) later argued that fixed asset theory has implications for an overproduction trap, or the tendency in agriculture to maintain high aggregate production levels even when real prices are declining. However, Johnson and Pasour (1981) questioned the implications of the asset fixity theory, stating that it contrasts the concepts of choice-influencing cost and the rule of resource allocative efficiency, while admitting that asset fixity theory helps explain why the supply function is irreversible. Chambers and Vasavada (1983) applied statistical tests to prove the existence of asset fixity in U.S. agriculture and found no fixities involving agricultural capital, labor, or materials at the aggregate level, concluding that asset fixity should not be used uncritically as the basis for explaining supply irreversibilities. However, they recognized that data aggregation was a potential caveat to their study. Edwards (1985) disputed their findings, suggesting that the work by Chambers and Vasavada did not support the rejection of asset fixity applications to a single farm when comparing opportunity costs of capital with alternatives for acquisition and salvage. Nonetheless, Chambers and Vasavada (1985) replied that their 1983 findings were only applicable to the context discussed in their paper.

Farmers have tried to improve and increase their output volumes in response to increased demand, but in attempting to do so, they have gathered more fixed

assets than variable assets, making the production supply inelastic and negatively affecting farmers’ income. Vasavada and Chambers (1986), when studying the dramatic change in U.S. agriculture, argued that aggregate factors of production adjusted slowly to price changes. Labor and capital were the most difficult to adjust, and the shortest lag in adjustments was observed in the land and intermediate input markets. In an attempt to solve the difficult adjustment in labor markets, policy makers implemented wage-oriented policies; however, these policies were ineffective in reducing the level of labor utilization during production.

This article is a description of policies oriented to mitigate the consequences of asset fixity. In addition, this article includes a description of the investment needed for tree fruit production comparing such with annual row crops.

Box 1. Helpful Definitions and Terms regarding the Economics of Orchard Investments, Production, and Policy

asset fixity—The difficulty of adjusting agricultural inputs in the short run or the slow adjusting of such inputs in the long run.

assets—Equipment and infrastructure in an agricultural operation.

inputs—What is needed for agricultural production.

opportunity costs—The forgone revenues that could have been realized if the funds would have been invested in an alternative activity or if an input was sold or rented.

preproduction years—Years

Policies to Mitigate Asset Fixities: An Analysis of the Literature Review

This review summarizes contributions centered on policies to mitigate asset fixity. Vasavada and Chambers (1986) concluded that wage-oriented policies aiming to

mitigate asset fixity in agricultural labor were not appropriate. In relation to policies dealing with asset fixity in agricultural lands, Kuchler and Tegene (1993) concluded that such policies had a positive effect on landowners wealth but not on farmers wealth. Fixed farmland costs are expected to cause a rise in farmland prices, and all rents are owed to the owners of the fixed input. In absence of complete fixity, the rents derived from the changes in agricultural policies are expected to spread throughout the agricultural sector. Therefore, farmers need to substitute among inputs in response to policy changes for the input suppliers to benefit from the policy changes. Bonnen and Schweikhardt (1998) emphasized that one of the major problems in the agricultural sector is the fixity of assets and suggested that future policies for the commercial farm sector would be a collection of specific tax and commercial code features, commodity, and market regulations, with adaptations to regional differences in production and marketing choices. In the long run, policies in the long run would involve price supports, production controls, or direct income transfers, although they predicted that policies that were much less transparent would soon replace the above-mentioned suggestions. Richards and Green (2003) discussed “hysteresis”—the perpetuation of an economic phenomenon long after its initial cause has disappeared—to explain why producers continue to grow crops that have become uneconomical in perennial crop production. Producers of perennial crops, such as wine grapes, are often reluctant to switch to production of new crops because doing so entails high establishment costs. Lower establishment costs and more stable expected returns improve adoption. Policies can help enhance financial stability by enabling revenue insurance or the use of production contracts. Lambarraa, Stefanou, and Gil (2016) concluded that decision support training and tools for olive farmers can help mitigate technical inefficiency and its persistence in the presence of irreversible investment. The Common Agricultural Policy (CAP) of 2006, modified in 2007 and adjusted in 2009, introduces provisions that would guarantee a more secure environment for future investment.

In sum, the literature on policies oriented to mitigate asset fixity in agriculture concurs that the formulation and implementation of policies is complex. The research also concurs that policies should vary depending on the characteristics of the fragmented agricultural production and marketing sectors. Appropriate policy measures should include tax collection, price supports, and production control. Direct income transfer should be specific to production and marketing regions. In addition, allowance for crop and revenue insurances were found useful for mitigating the issue at hand.

Focusing on Tree Fruits

In the United States, tree fruits are categorized into citrus, noncitrus, and tree nuts. The agricultural sector is of economic importance to a number of rural

communities in the United States, generating annually, on average, over \$25 billion in farm cash receipts. Interestingly, tree fruits and nuts are produced on less than 2% of agricultural lands; however, the farm cash receipts account for 7% of total receipts for all agricultural commodities and around 13% for all agricultural crops (Department of Agriculture, 2020). Besides being important to local rural communities across the United States; the tree fruit and nut industry supports a nationwide supply chain infrastructure of market intermediaries including packers, processors, brokers, and shippers. Also, export markets are important for this sector; about 20% of all domestic production is exported.

Peterson (1992) observed that as developing nations increase their gross domestic production, they import more tree fruits improving the quality of life of their citizens. Gallardo and Sauer (2018) indicate that the specialty crop sector, including tree fruits, have witnessed productivity increases stemming from technological innovations including improvements in seed, fertilizers, and pest management. However, the development and adoption of labor-saving technologies has been lagging compared to most annual crops, making tree fruits increasingly dependent on manual labor. Tree fruit crops, different from annual row crops, require intensive crop management. Hence, the value added and the general production costs for specialty crops are higher compared to other crops.

Tree Fruit Production Costs Overview

The establishment of a tree fruit operation is a considerable investment and can be expected to pay off only after a number of years—for tree fruit, the production lifecycle is at least 15 years. The first years are considered establishment years, when the tree has not reached its full maturation and hence not yet in full production or full bearing. Only after four to five years is the tree in full fruit production. Yields across full production years are also highly variable, which induces uncertainty about yield levels and revenues (Gallardo and Garming, 2017).

In general, tree fruit production costs include both cash and noncash costs. Cash costs comprise direct or variable costs—such as expenses for seeds or trees, fertilizers, plant protection, wages for seasonal and permanent labor—and overhead costs—such as fuel, energy, water, farm office space, advisory fees, and insurance as well as the costs for renting land and capital. Noncash costs refer to depreciation and opportunity costs. Opportunity costs are the forgone revenues that could have been realized if the funds had been invested in an alternative activity or if an input had been sold or rented. Examples of opportunity costs are unpaid family and operator labor, preowned machinery, and preowned land (Gallardo and Garming, 2017).

Another way to measure tree fruit production costs include variable versus fixed costs. Variable costs vary depending on the expected yield per unit of production. They include all production costs or field activities, the inputs for every activity, and labor associated with each. For example, winter pruning, flower thinning, green fruit thinning, and the application of fertilizers, pesticides, and plant growth regulators, among others. Fixed costs would not vary with the expected yield per unit of production. These costs will generally be calculated for the whole farm enterprise and be allocated for the unit of production, such as depreciation rates, cost of opportunity interest rates, and management costs (Gallardo and Garming, 2017).

To calculate the profit accrued by the tree fruit operation, first, the gross revenue is calculated. This is the total yield multiplied by the market price. When assessing the profitability of a tree fruit enterprise, it is common to use gross profit (gross income minus direct costs and seasonal labor costs), accounting profit (gross income minus cash costs and depreciation), and profit (gross income minus total cost of production) (Gallardo and Garming, 2017). Tree fruit operations do not always have profits above zero. Due to varying yield levels as well as output prices, full cost recovery is not achieved in all years. To analyze the short-term economic situation of the agricultural operation, only direct costs and seasonal labor costs should be considered. To analyze the longer-term economic situation, cash costs and imputed costs (that is, total cost of production) should be included. Note that for tree fruit production, variable

costs might not be variable in the strict sense; once the orchard is established, a farmer could consider the establishment costs as fixed costs and would continue to produce even if the production results in negative profits (Gallardo and Garming, 2017).

Examples of Tree Fruit Production Costs

Table 1 compares total costs (cash plus noncash) of five tree fruit crops grown in the United States: almonds, walnuts, Honeycrisp apples, sweet cherries, and plums (Duncan et al., 2019; Hasey et al., 2018; Gallardo and Galinato, 2020; Grant et al., 2019; Day et al., 2019). Establishment costs vary across the tree fruits presented, being more expensive for trees planted at higher tree densities (number of trees per surface area). Trees density varies by crop (Table 1); from 64 trees/acre for walnut to 1,452 trees/acre for Honeycrisp apple. A high-density plantation means there are more trees per surface area compared to medium or low density. For example, a high density could refer, depending on the specific production context, to more than 1,400 trees per acre such as Honeycrisp apples; and a low density, to less than 500 trees, such as almonds, walnuts, sweet cherries, and plums in Table 1. High tree density implies, compared to low-density plantings, that additional investment is needed to plant a larger number of trees with dwarf rootstocks and orchard infrastructure. Dwarf rootstocks produce trees with smaller trunks than regular rootstocks. A small trunk will not offer a strong enough support for the tree canopy, requiring a trellis system—additional infrastructure, such

Table 1. Costs and Revenues for Selected Tree Fruit Crops Grown in the United States

	Unit	Almonds ^a	Walnuts ^b	Apples Honeycrisp ^c	Sweet Cherries ^d	Plums ^e
Tree density	Trees/acre	130	64	1,452	134	202
Costs						
Establishment—year 1	\$/acre	8,584	8,262	24,672	6,040	7,436
Preproduction—year 2	\$/acre	2,830	2,861	9,344	3,238	2,237
Preproduction—year 3	\$/acre	-	2,907	-	3,352	-
Production—year 3	\$/lb	9.51	-	1.69	-	0.66
Production—year 4	\$/lb	6.39	6.89	1.20	3.77	0.60
Production—year 5	\$/lb	3.44	2.96	1.06	3.51	0.53
Production—year 6	\$/lb	-	1.63	1.06	-	-
Production—year 7	\$/lb	-	1.05	-	-	-
Gross revenues—full production year	\$/lb	2.50	1.00	1.07	2.06	0.57
Profits—full production year	\$/lb	-0.94	-0.05	0.02	-1.45	-0.05

^aDuncan et al. (2019).

^bHasey et al. (2018).

^cGallardo and Galinato (2020).

^dGrant et al. (2019).

^eDay et al. (2019).

as poles and wires, to support the canopy. Related to asset fixity, investment in a trellis system is irreversible and difficult to adapt to other crops. Preproduction years refers to the previously mentioned establishment years, that is, those years in which the trees do not yet produce fruit. The cost variation across crops (Table 1) is mostly due to differences in tree density across crops. Compare Honeycrisp apples, with establishment costs of \$24,672/acre and tree density at 1,452 trees/acre, with the other crops, with establishment costs ranging from \$6,040/acre to \$8,584/acre and tree densities from 64 trees/acre to 202 trees/acre. Similarly, compare preproduction costs in year 2 (Table 1): Honeycrisp apples at \$9,344/acre with the other crops ranging from \$2,237/acre to \$2,861/acre. Note that not all crops report preproduction costs in year 3 in Table 1. For example, costs are reported for walnuts and sweet cherries but not for almonds, Honeycrisp apples, and plums. This indicates that not all trees produce fruit in the same year. Tree precocity is related to rootstock type and refers to the year in which the trees start producing fruit.

Dwarf rootstocks are more conducive to precocious trees (that is, trees that would produce fruit in higher volumes sooner) than regular rootstocks. Depending on the precocity of the tree variety and rootstock, trees start producing fruit in the third or fourth year. For example, Honeycrisp apples, almonds, and plums start producing fruit in the third year. Walnuts and sweet cherries produce fruit in the fourth year. Trees will not produce to their fullest until the fifth or sixth year. For example, almonds, sweet cherries, and plums achieve full production in the fifth year, Honeycrisp apples in the sixth year, and walnuts in the seventh year. The longer the tree takes to produce fruit and the longer it takes to achieve full production, the more years are needed to recover the investment. To facilitate comparison across crops, the \$/lb costs in Table 1 were calculated by dividing the costs presented in each study in \$/acre (Duncan et al., 2019; Hasey et al., 2018; Gallardo and

Galinato, 2020; Grant et al., 2019; Day et al., 2019) by the yields converted to lb/acre.

Table 1 also presents gross revenues and profits (gross income minus total cost of production) for the above-mentioned tree fruits. The revenues and profits correspond to the year when the tree achieved full production and are presented in \$/lb. Similar to the cost in production years, the \$/lb revenues were calculated by dividing the revenues presented in each study (Duncan et al., 2019; Hasey et al., 2018; Gallardo and Galinato, 2020; Grant et al., 2019; Day et al., 2019) by the yield realized in a full production year and expressed in pounds.

Unlike Honeycrisp apples, plums, almonds, walnuts, and sweet cherries do not exhibit profits. The profits accrued by crops presented in Table 1 range from -\$1.45/lb to \$0.02/lb. This difference is mainly driven by market prices. Honeycrisp apples face higher costs compared to other apple varieties but enjoy a market price premium, enough to cover the higher costs incurred (Gallardo and Galinato, 2020). The above-zero profits will not apply to all apple varieties but only dessert-quality apples, which exhibit the texture and flavor profile preferred by U.S. consumers and usually exhibit a price premium (Gallardo et al., 2018). For the other crops, the information in Table 1 show evidence of hysteresis, as producers keep producing even if profits are negative. One can observe evidence of the reluctance to switch production to more profitable varieties or crops. Also, this is a cautionary note for producers contemplating investing in tree fruits. Information on profits in Table 1 signals that investment should consider varieties whose market prices would ensure a positive profit stream in the long run.

Table 2 presents production costs in two categories (land and nonland costs) for five selected annual row crops: corn, soybean, spring wheat, canola, and alfalfa (Lattz and Zwilling, 2019; Schnitkey, 2020; University of Minnesota Extension, 2020; Johnson, 2020; Texas A&M AgriLife Extension, 2020). Costs per pound range from

Table 2: Costs and Revenues for Selected Annual Row Crops Grown in the United States

Annual Row	Unit	Corn ^a	Soybeans	Wheat ^b	Canola ^c	Alfalfa ^d
Costs						
Land costs	\$/lb	0.02	0.11	0.03	0.05	0.03
Non-land costs	\$/lb	0.06	0.06	0.07	0.12	0.06
Total costs	\$/lb	0.08	0.17	0.10	0.17	0.09
Gross revenues	\$/lb	0.06	0.14	0.10	0.13	0.12
Profits	\$/lb	-0.02	-0.03	0	-0.04	0.03

^aLattz and Zwilling (2019), Schnitkey (2020).

^bUniversity of Minnesota Extension (2020).

^cJohnson (2020).

^dTexas A&M AgriLife Extension (2020).

\$0.10/lb for wheat to \$0.17/lb for canola and soybeans. Gross returns and profits are also presented in Table 2. Similar to tree fruits, one observes profits not above zero for corn, soybeans, and canola. A zero profit is observed for spring wheat and an above-zero profit is observed for alfalfa. Results in this table suggest the overproduction trap noted by Johnson and Quance (1972) (that is, the tendency in agriculture to maintain high aggregate production levels even when real prices are declining).

Information in Tables 1 and 2 enables us to discern differences in cost structures between annual crops and tree fruits. For the annual crops, costs are divided into land costs, nonland costs, and total costs; for tree fruits, the establishment cost alone includes an amount dedicated to land, and the rest is divided between labor and capital. The production year costs include costs accrued to labor, materials, energy, and miscellaneous. In the years of full production, however, the cost entailed in growing tree fruits is minimal compared to that needed during production/maintenance years. Moreover, this information demonstrates that the investment in tree fruits is larger by far than the investment in annual row crops. The uncertainty surrounding tree fruits is also larger, as there is no production until year three or year four, depending on the tree crop—and within the crop, the variety—and the rootstock type. Per pound gross revenues are higher for tree fruits compared to those for annual row crops, hence the perception that tree fruits

are highly valuable crops. Given the magnitude of the initial investment, the time to recover the investment, and the increased uncertainty, one can conclude that the low opportunity costs for the investment will be magnified for tree fruits compared to annual row crops.

Targeting Efforts to Mitigate Asset Fixity

Asset fixity in agricultural production deals with investment in inputs and how these inputs adjust in the long run. The formulation and implementation of policies to mitigate the problematic asset fixity is complex. In general, policies should vary based on the characteristics of the fragmented agricultural production and marketing sectors and should include tax collection, price supports, and production control; direct income transfer should be specific to production and marketing regions. When identifying targeted crops for policies oriented to mitigate asset fixity, tree fruits stand out from annual row crops. The investment in orchard infrastructure is extensive and irreversible, and there is a lack of secondary market for such capital goods. The recuperation period on the investment is longer for tree fruits, proving that asset fixity problems are exacerbated for tree fruits compared to annual row crops. Policies directed to mitigate asset fixity in tree fruits as described in the literature could range from contracts and revenue insurance, as market price stability is crucial in ensuring positive returns in the future.

For More Information

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