Purchase vs. Rent Decisions: No-till Drill Case Studies [*Journal of Farm Management*, ICFAI University Press, 2008]

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Abstract

Indices of size and cost efficiency were computed for actual no-till drill purchases versus renting for a sample of farms in eastern Washington and northern Idaho,USA. Positive efficiency for purchasing was observed in the entire sample due to economies of size and good cost management. Farms in a low precipitation region showed higher efficiency than in a high precipitation region. Farms with above average efficiency planted higher acreage, paid less for drills and had lower repair costs per acre.

Key Words: machinery acquisition, machinery ownership, no-till, no-till drill, rent-purchase decision

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Farm machinery constitutes a substantial portion of total capital investment for most farmers. With American farmers renting an increasing share of cropland, the proportionate share of machinery investment is growing. However, many farmers are now renting machinery as well. This makes the machinery "rent or buy" decision more important.

Several studies have proposed methods for determining least cost machinery acquisition (Bierman; Ford and Musser; Gordon; Hopkin; Lins; Miller and Upton; Myers, Dill and Bautista; Robertson, Musser and Tew; Robison and Barry; Willet and Penland; Willet, Burns and Schirman). Most base their comparisons on differences in discounted expected cash flows based on current market prices and rental rates. For example, Willett, Burns and Schirman determined least cost buy, lease or rent options for a no-till drill using net present value of expected cash outflow over five years. They used a partial budgeting investment analysis ignoring all common costs for purchase, rent and lease such as labor, seed, fertilizer and all costs related to power units (i.e., fuel, oil, repairs, depreciation, interest, property taxes, and insurance). While past studies provide normative decision support models for farmers, they do not provide positive information on how the efficiency of actual rent-purchase decisions compares across farms or across geographical regions. Descriptions of actual inefficiencies or efficiencies could be of interest to farmers and also to extension agencies that wish to assess the need for further educational efforts. The objective of this empirical study will be to extend the expected cash flow approach of Willett, Burns and Schirman to an actual sample of Pacific Northwest farmers who had purchased no-till drills.

Methods

Figure 1 illustrates size and cost efficiency. The horizontal axis shows acres no-tilled and the vertical axis shows the annual after tax net present cost of drill acquisition (ANPC). Farm specific no-till acreage (A_i) and costs underlying $ANPC_i$ were derived from a survey described below. The straight line from the origin, AF, describes the annual net present cost of renting ($ANPC_i^R$) as a function of acres. Rental rate per acre is exogenous for a given region, which underlies the linear relationship.

The after tax $ANPC_i^R$ is computed as:

(1) $$ANPC_i^R = \left(\frac{\sum_{t=0}^{n} d_t (1-T) R_t}{n}\right) * A_i$$

Where, R_t is the rental rate per acre, T is the marginal tax rate, and d_t is the discount factor. 't' ranges from 0,1,2,…,n where 'n' is the repayment period.

In Figure 1, coordinate O refers to the ANPC of a purchased drill, which is calculated as:

(2) $$ANPC_i^P = \frac{\sum_{t=0}^{n} d_t (V_t + I_t + M_t - TS_t) - d_n V_s}{n}$$

V_s is the salvage value of the drill at the nth year, V_t are the annual principal payments (V_0 denotes down payment), I_t is the annual interest payment, M_t is the annual maintenance cost (property tax and repairs), and TS_t is the annual tax saving.

The discount factor is computed as:

(3) $$d_t = \frac{1}{(1+r)^t}$$

Where, r is the discount rate.

Tax saving for each period (TS_t) is computed separately as:

(4) $$TS_t = (I_t + D_t + M_t)T \quad \text{for t = 0,1,2,…, n-1.}$$

(5) $$TS_n = (\sum_{t=0}^{n} V_t - \sum_{t=0}^{n} D_t - V_s)T + (I_n + D_n + M_n)T$$

Where, T is the marginal tax rate and D_t is the depreciation charged in the period t. Typically, the first depreciation and interest deduction occur in period 1.

For any coordinate in Figure 1, the percentage size efficiency index is defined as:

(6) $$S_i\% = (\frac{S_i}{A_i})*100$$

S_i, a size efficiency index, is the difference in acreage no-tilled with a purchased drill (A_i) and potential acreage no-tilled (PA_i) by renting. In this study, potential acreage is defined as:

(7) $$PA_i = \frac{ANPC_i^P}{ANPC_i^R} * A_i$$

Similarly the percentage cost efficiency index is defined as:

(8) $$C_i\% = (\frac{C_i}{ANPC_i^R})*100$$

Where, C_i is the difference of the potential cost of planting the farm's acreage by renting versus purchasing: ($ANPC_i^R - ANPC_i^P$).

The size (S_i or $S_i\%$) and cost indices (C_i or $C_i\%$) may be positive (negative) as point O in Figure 1 lies below (above) line AF. The index is positive if the farm has made an efficient purchase decision. If these indices are negative, the farm has made an inefficient purchase decision.

For a region with several farmers, $S_i\%$ (or $C_i\%$) may be distributed over a considerable range. Theoretically, $S_i\%$ (or $C_i\%$) may range between -100 to 100. It can be informative to compare distributions across regions or by farm/farm characteristics to make inferences on the relative efficiency of rent-purchase decision.

Size and cost percentage efficiencies ($S_i\%$ and $C_i\%$) are mathematically identical, as can be proven geometrically from Figure 1. Recall $S_i\% = (S_i / A_i)$*100 = (CD/AD)*100 in Figure 1. Also, $C_i\% = (C_i / ANPC_i^R)$*100 = (FO/FD)*100 in Figure 1. But, CD/AD = FO/FD in Figure 1 by similar right triangles; therefore, $S_i\% = C_i\%$.

Data

Data for this study comes from detailed personal interviews with ten successful long term no-till farmers in eastern Washington and northern Idaho (Camara, Young and Hinman 1999a and 1999b). The sample included six farmers growing wheat, barley, lentils, and peas in a 19-22 inch precipitation region and four farmers growing wheat and barley in a 8-13 inch precipitation region. Nine of the ten farmers who provided adequate data are included in this study (Table 1).

Purchase prices of drills and other costs were standardized to 1998 dollars. Where farmers had not provided salvage values, the average salvage values for similar drill were used from Smathers and Willett. Farmers' average annual drill repair costs were used when provided, otherwise average values based on age and use were used (Smathers and Willett).

Table 1 shows considerable diversity among the sample regarding drill investments and utilization levels. For example, Farmers paid from $15,000 to $100,000 depending on the size and condition of drills. Seventy percent of the farmers bought used drills. The annual use of the drills ranged from 120 to 500 hours. Annual repair costs ranged from $684 to $14,000. Assumptions used to derive the net present cost of both options are listed in Table 2.

Results and Discussion

Figure 2 plots the average annual net present after tax cost (ANPC) of actual purchased and hypothetical rented drills by annual acres no-tilled for the sample of nine farms. The cost of purchased drill includes down payment, principal payments, interest, property tax and repairs, net of tax earnings versus a flat rental charge per acre for rented drills. Following the partial budgeting approach of Willet, Burns and Schirman costs common to purchase and rent such as labor, seed, fertilizer and power unit costs are not considered. Figure 2 reveals that purchasing a drill is less expensive than renting for the entire sample. This result is not unexpected because the sample purposively targeted “successful long-term no-till farmers.” If these no-till farmers had been inefficient in drill acquisition, they might have been less financially successful in using no-till over the long run.

Figure 2 shows that the relative cost advantage of purchased drills increases with acres no-tilled. This pattern indicates economies of size for no-till drill purchase, not a surprising result. This pattern and its association with drill and farm characteristics will be explored below.

Size and Cost Efficiency

Table 3 shows the distribution of components of size and cost efficiencies along with the resulting absolute (S_i and C_i) and percentage efficiencies ($S_i\%$ and $C_i\%$), and their summary statistics across the nine sample farms. Components of size efficiency include actual acres no-tilled with the purchased drill and potential acres with a rented drill. Components of cost efficiency include ANPC of a purchased and rental drill. Summary statistics included are the mean and coefficient of variation (CV).

The sample farms showed a wide range of no-tilled acreage: from 1,538 for farm C to 5,000 for farm G, with a mean of 2,947 acres and a coefficient of variation of 43%. The potential area planted with a rented drill, given a constant rental rate per acre, was always smaller than the acres no-tilled with a purchased drill for this sample. Potential acres with the rented drill ranged from 295 acres for farm I to 2,069 acres for farm A with a mean of 1,409 acres. Absolute size efficiency (S_i), measured as additional acreage with the purchased drill over a rented drill, ranged from 358 acres on farm F to 3,608 acres on Farm G. The coefficient of variation was 76%.

The ANPC of a purchased drill ranged from $2,212 to $15,516 with a mean of $10,564 and coefficient of variation of 41%. As expected, there was a perfect correlation between acres no-tilled and ANPC of rented drill because the cost of a rented drill is a linear function of no-till acreage. The potential cost (ANPC) of a rented drill ranged from $11,535 (farm C) to $37,500 (farm G). Given the linear relationship between cost and acres, the coefficient of variation is identical for cost and acres no-tilled (43%).

Absolute cost efficiency (C_i), measured as additional potential annual cost of a rented drill over a purchased drill, ranged from $2,685 (farm F) to $27,063 (farm G). The coefficient of variation (76%) was higher than that for both the annual costs of purchased and rented drills.

Table 3 shows that percentage size ($S_i\%$) and cost efficiency ($C_i\%$) ranged from 20% (farm F) to 90% (farm I). The mean efficiency was 47%. Although the minimum percentage efficiency farm (F) was the same as that shown by the absolute measures (S_i or C_i), the maximum efficiency farms were different for the two measures; farm G shows maximum absolute efficiency while the farm I shows maximum percentage efficiency.

Efficiency and Precipitation Region

Table 4 presents means and CVs of selected no-till drill purchase and rental characteristics across precipitation regions (see footnote a in Table 1 for location of farms). These characteristics include percentage size and cost efficiency, acres no-tilled with a purchased and rented drill, ANPC of purchased and rented drill, purchase price of drill, repair costs per acre, and ANPC per acre. Sample farms in the high (19-22 inch) and low (8-13 inch) precipitation zones were the sub samples for this analysis. Statistical tests are omitted due to small samples.

Table 4 shows that farms in the low precipitation region averaged higher efficiency (53%) than those in the high precipitation region (42%). This shows that a typical farm in the low precipitation region was able to save more by purchasing compared to renting the no-till drill. Variability of efficiency was also higher in the low versus the high precipitation region (CV= 63% versus 28%).

Table 4 reveals that a typical farm in the low precipitation region no-tilled more acres (3,172) compared to the high precipitation region (2,767). If the typical low precipitation farm had rented a no-till drill, they could have no-tilled 1,283 acres compared to 1,509 acres in the high precipitation region. The additional acreage no-tilled with purchased drills resulted in size/cost efficiencies of 42% and 53% in the high and low precipitation regions, respectively (Table 4). Similarly, farms in the low precipitation region averaged an ANPC of a purchased drill of $9,620 compared to $11,319 for the high precipitation region. Higher savings with purchased drills in the low precipitation region translated into a higher cost efficiency.

Farms in the low precipitation region bought slightly more expensive drills on average ($70,158 compared to $65,699), possibly due to slightly higher acreage no-tilled. However, variability around the mean was also higher in the low precipitation region (54%) compared to high precipitation region (33%). Low precipitation region farms averaged lower annual repair expenses of $ 0.70 per acre compared to $1.90 per acre in the high precipitation region.

All cost factors combined led to $3.50 mean ANPC per acre of drill use in the low precipitation region compared to $4.40 in the high precipitation region. However, the variability was much higher (71%) in the low precipitation region compared to 20% in the high precipitation region.

The 26% efficiency advantage in the low precipitation region was associated with 15% higher mean acreage, 15% lower mean ANPC of purchased drill use, 7% higher mean drill purchase price, 63% lower mean repair costs per acre, and 20% lower mean ANPC per acre for purchased drills.

Characteristics of Above and Below Average Efficiency Farms

Table 5 compares the mean and CV of efficiencies and the associated characteristics of less efficient and more efficient farms in terms of drill use (see efficient farm identification in Table 1). Farms with cost and size efficiency above the average (47% efficiency) are categorized as above average efficiency farms (AAEF) and those below as below average efficiency farms (BAEF). Clearly farms in the less efficient group will have higher costs, but the purpose of this section is to examine the magnitude of differences and identify, if possible, characteristics contributing to higher costs. Characteristics compared are acres no-tilled (with purchased and rented drills), ANPC of purchased and rented drills, drill price, repair costs per acre and ANPC per acre of purchased drills.

Not surprisingly, farms in the AAEF category shows desirable characteristics compared to BAEF (Table 5). The expected efficiency for AAEF is 66% compared to 31% for BAEF. Table 5 shows that a typical AAEF no-tilled more acres (4,098 acres) compared to BAEF (2,026 acres). If AAEF had rented a drill, this group would have averaged 1,433 acres compared to 1,389 acres for BAEF. The extra acreage no-tilled by AAEF translates into a higher size efficiency for AAEF compared to BAEF. Although AAEF averaged slightly higher ANPC of a purchased drill ($10,748) compared to BAEF ($10,417), the much higher potential ANPC of a rented drill for AAEF ($30,731 compared to $15,198) translates into a 66% cost efficiency for AAEF compared to 31% for BAEF.

AAEF paid less for the drills ($62,543) compared to a BAEF ($71,791). However, the CV is much higher (56%) compared to 34% for BAEF. Similarly, AAEF also incurred lower repair costs per acre ($1) compared to a BAEF ($2). These and other savings resulted in a lower per acre ANPC of drill use ($3) compared to BAEF ($5).

The 113% higher mean efficiency for AAEF compared to BAEF is associated with 102% higher acres no-tilled and only 3% higher ANPC of purchased drills (Table 5) which shows the dominance of former factor. This is also substantiated by the fact that a 4% lower CV of efficiency is also accompanied by a 5% less CV of acres no-tilled in AAEF. The 13% lower mean purchase price and 50% lower mean repair cost per acre contributed to 40% lower per acre annual NPC of drill for AAEF.

Discussion

The efficiency gain of drill purchases (Figure 2) is consistent with the sample selection for this study. The sample included ”successful no-till farmers” who had negotiated the learning curve for no-till and had time to determine the size of drill consistent with their operation (Camara, Young and Hinman 1999a and 1999b). If the sample had contained beginning no-till farmers, it is likely that more variation in drill purchase efficiency would have been observed. Juergens et al.’s general survey of farmers in the same region who were in transition to no-till provides support for this argument. His survey showed that only 22% had purchased a no-till drill in the first years of the transition and the remaining 78% either rented or custom hired drills. However, they were no-tilling only 2% to 71% of their land in the first year. But by the end of fifth year, 67% had purchased drills and they were no-tilling 12 to 100% of their land. The same survey showed that mean acres no-tilled for six farms ranged from the 460 acres in the first year to 1,417 acres by the end of the fifth year. This pattern shows that farmers may quite reasonably postpone purchasing a no-till drill until economies of size justify their purchase.

In this sample of experienced no-tillers, increases in efficiency were also associated with increases in acres no-tilled. These economies of size for no-till drill purchase are consistent with economies of size observed by Held and Helmers for purchase of specialized machines in sugar beet farms.

This study imposed some restrictions whose relaxation could better represent reality, but at the price of added complexity. Neutral risk preferences (or identical risks) were assumed for both methods of drill acquisition. In addition to variable cash flows, purchasing may involve technology obsolescence risk. Renting may involve risk of unavailability at the time the drill is needed. Timeliness cost has been a subject of inquiry for both agricultural economists and engineers (Edward and Boehlje; Ozkan, He and Holmes; Short and Gitu). While these and other risks considerations will be important for many growers, we believe the major deterministic cost advantage evident for this sample of farmers probably underlay the specialized machinery purchases of many farmers. Of course aversion to timeliness risk would further augment the advantage of purchasing.

The effect of capital rationing also was not considered in this analysis. A long term borrowing rate and a fixed marginal tax rate were used across farms. A single rental rate was assumed given the close geographical proximity of the farms. Some of these restrictions could be easily relaxed if the data and purpose required. The exact numerical results in this study are of course specific to the regional data and assumptions used.

Conclusions

Acquisition of a no-till drill is a major investment decision for a farmer. Two major no-till acquisition alternatives are rent and purchase. This study evaluated actual efficiency of no-till drill purchase versus rent decisions made by a sample of no-till farmers in the American Pacific Northwest. Size and cost efficiencies of no-till drill purchases were computed on both absolute and percentage terms. Efficiency percentages were mathematically identical for both measures.

The entire sample of nine successful long-term no-till farmers exhibited positive efficiency for purchasing no-till drills. Purchasing efficiency, relative to renting ranged from 20% to 90% with a mean of 47%. Purchasing efficiency increased as acres in no-till increased indicating economies of size in no-till drill ownership.

Purchase efficiency relationships were examined by classifying the sample into subgroups. Analysis showed that farms in a low precipitation region no-tilled more acreage, spent less on drills, and generated higher efficiency than farms in a high precipitation region. Secondly, above average efficiency farms (AAEF) no-tilled higher acreage and experienced lower per acre annual drilling costs compared to below average efficiency farm (BAEF). The more efficient farms incurred smaller annual drilling cost per acre due to purchase of cheaper and/or more reliable drills (less per acre repair cost) and using them on larger acreages.

Adoption of no-till also serves a wider public interest by safeguarding water and air quality. It also sustains long term agricultural productivity through soil erosion control. Given the diseconomies of size in purchasing of no-till drills by small farmers, public support for rental no-till drills could improve incentives for no-till adoption. However, these solutions would have to address risk of availability of rental drills which could discourage some potential adopters.

Education on drill acquisition might assist farmers adopt no-till technology. Information on the wide range of kinds, sizes, and costs of drills is critical in finding a drill suitable for individual farmers. Finally, farmers can be encouraged to achieve the economies of size in no-till acreage, possibly by renting cropland, so that they reap full efficiency from a purchased drill.

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Table 1. Characteristics of no-till drill investments and their utilization by the sample farms

Farm[a]	Drill Price($)[b]	Drill Width (feet)	Years to Trade	Year Purchased	Condition at Purchase	Drill Use (Hrs./year)	Repair Cost ($/year)
A*	58,800	29	11	1997	New	500	14,000
B*	93,370	20	21	1991	Used	500	6,000
C	34,339	15	17	1993	Used	200	2,500
D	64,963	33	11	1997	New	166	1,501
E(1)	30,000	na	10	1994	Used	120	750
E(2)	47,024	na	7	na	Used	160	1,333
F	82,631	na	20	1990	Used	180	1,499
G*	83,000	35	15	1996	Used	400	800
H	100,000	20	20	1984	New	260	5,000
I*	15,000	na	22	1996	Used	300	684

[a] Farm A to E are from 19-22 inch precipitation region and farm F to I are from 8-13 inch precipitation region. Farm E owns two no-till drills.
[b] Drill price in 1998 dollars.
*Above average efficiency farm.
na = not available.

Source: Camara, Young and Hinman, 1999a, 1999b

Table 2. Assumptions used

Down payment: 30% of actual drill purchase price

Interest rate: 10.15% per annum (average at time of survey)

Loan repayment period: 5 years

Tax deductible expenses (excluding expenses common to purchase and rental):

1) Purchase: interest on debt, depreciation, property taxes, and repair
2) Rent: Rental fees

Marginal Tax Rate(MTR): 28% (federal income + social security tax)

Depreciation: Modified Accelerated Cost Recovery System

Annual property taxes: 1.5% times average investment

Tax on depreciation recapture: (salvage value – undepreciated basis) x MTR

Rental fee: $12 per acre

Discount rate: 7.5% per annum

Table 3. Efficiency indices and their components for sample farms

Farm [a]	Acres [b] With Purchased Drill (acre/yr.)	Acres with Rented Drill (acre/yr.)	S_i [c] (acres)	ANPC [d] of Purchased Drill ($)	ANPC of Rented Drill ($)	C_i [e] ($)	$S_i\%=C_i\%$ (%)
A	4,545	2,069	2,476	15,516	34,088	18,572	54
B	3,845	1,977	1,868	14,825	28,838	14,013	49
C	1,538	948	590	7,111	11,535	4,424	38
D	2,075	1,160	915	8,697	15,563	6,866	44
E	1,830	1,393	437	10,446	13,725	3,279	24
F	1,800	1,442	358	10,815	13,500	2,685	20
G	5,000	1,392	3,608	10,437	37,500	27,063	72
H	2,889	2,002	887	15,015	21,668	6,653	31
I	3,000	295	2,705	2,212	22,500	20,288	90
Mean	2,947	1,409	1,538	10,564	22,102	11,538	47
CV (%)	43	41	76	41	43	76	49

[a] Farm A to E are from 19-22 inch precipitation region and farm F to I are from 8-13 inch precipitation region.
[b] Acres with purchased drill = (Hours/ Year) X (Acres no-tilled/Hour).
[c] S_i = size efficiency = (Acres with purchased drill-Acres with rented drill).
[d] ANPC is the after tax annual net present cost of the drill.
[e] C_i = cost efficiency = (ANPC of rented drill –ANPC of purchased drill).

Table 4. Summary statistics for no-till drill purchase and rental across precipitation regions

Statistics	Size & Cost Efficiency (%)	Acres With Purchased Drill	Acres with Rented Drill	ANPC [b] of Purchased Drill ($)	ANPC of Rented Drill ($)	Drill [c] Price ($)	Annual Repair Cost ($/ac)	Annual NPC of Drill ($/ac)
8-13 inch ppt.region (n = 4) [a]								
Mean	53	3,172	1,283	9,620	23,792	70,158	0.7	3.5
CV (%)	63	42	56	56	42	54	99.0	71.0
19-22 inch ppt.region (n = 5)								
Mean	42	2,767	1,509	11,319	20,750	65,699	1.9	4.4
CV (%)	28	48	33	33	48	33	59.0	20.0

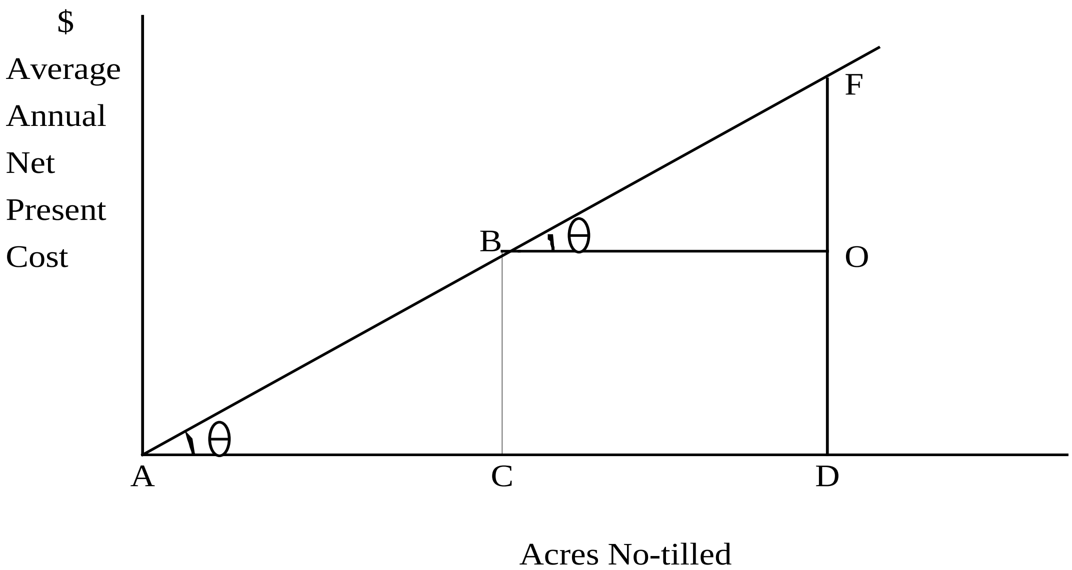
[a] n = number of observations.
[b] ANPC is the after tax annual net present cost of the drill.
[c] Drill price in 1998 dollars.

Table 5. Summary statistics for less efficient and more efficient farms with respect to no-till drill use

Statistics	Size & Cost Efficiency (%)	Acres With Purchased No-till Drill	Potential Acres with Rented Drill	ANPC [c] of Purchased Drill ($)	ANPC of Rented Drill ($)	Drill [d] price ($)	Repair Cost ($/ac)	Annual NPC of Drill ($/ac)
	AAEF(Efficiency>47%)[a]							
Mean	66	4,098	1,433	10,748	30,731	62,543	1	3
CV (%)	28	21	57	57	21	56	109	56
	BAEF(Efficiency<=47%)[b]							
Mean	31	2,026	1,389	10,417	15,198	71,791	2	5
CV (%)	32	26	28	28	26	34	67	15

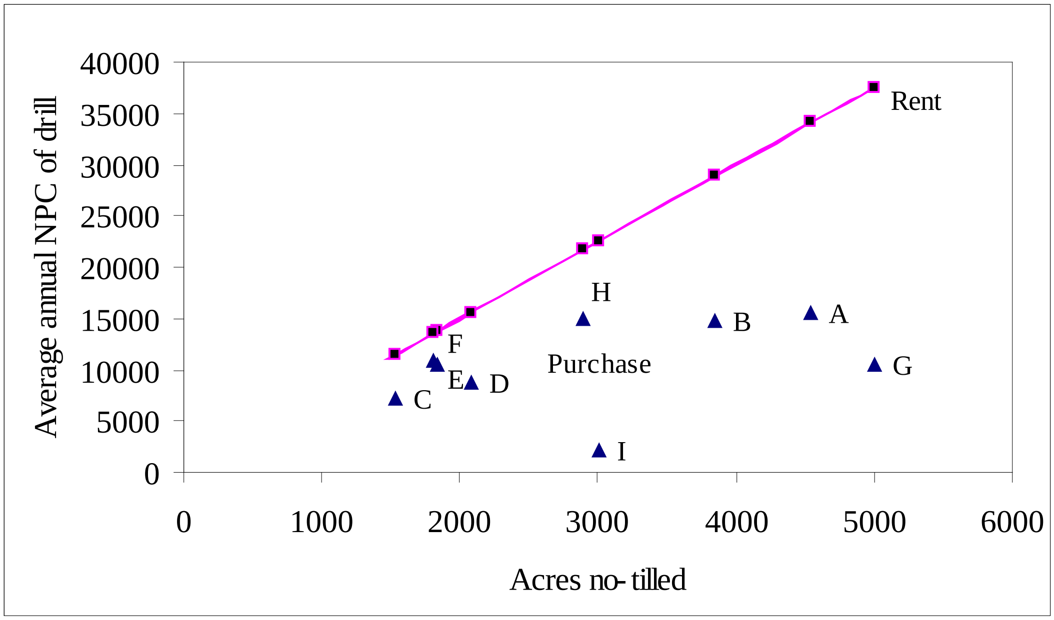
[a] AAEF =Above average efficiency farm, number of observation = 4.
[b] BAEF = Below average efficiency farm, number of observation = 5.
[c] ANPC is the after tax annual net present cost of the drill.
[d] Drill price in 1998 dollars.

Figure 1. Efficiency derivation on rent purchase decision



Notes: Coordinate O is the purchased drill; AF is the cost line for rental; line AD = A_i (acres for purchased drill O); AC = PA_i (potential acres with rented drill given O's cost expenditure). OB = $A_i - PA_i = S_i$ (additional acres no-tilled relative to renting the drill). BC is the annual net present cost (ANPC) of a purchased drill. FD is the potential cost for rented drill ($ANPC_i^R$). FO = C_i (cost saving due to purchasing the drill). Percentage size efficiency (S_i%) = (S_i / A_i) 100 = ($C_i / ANPC_i^R$) 100 =Percentage cost efficiency (C_i%).

Figure 2. Relationship between cost of purchased and rented drill in the sample farms



Note: Squares equal rented drills and triangles equal purchased drills. A-I are sampled farms.