ABSTRACT

A simulation model representing a north central U.S. corn and soybean farm was used to estimate the degree of financial risk borne by the tenant and the landlord under 10 different types of flexible cash leases. Probability distributions for yields, prices, and production costs were incorporated. Measures of risk included standard deviation of profits, probability of loss, and 10th percentile value at risk. A profit sharing lease that included rent adjustments for all three variables shifted the most risk from the tenant to the landowner, and reduced the tenant's probability of incurring an economic loss from 51 percent to 37 percent.

Sharing Financial Risk through Flexible Farm Lease Agreements

By William M. Edwards & Chad E. Hart

Introduction

For several decades an increasing number of farm leases in the north central region of the U.S. have called for a fixed cash rent payment instead of sharing crop production and input costs between the tenant and the landowner (Duffy et al, 2008). This has resulted in a significant transfer of financial risk from landowners to tenants over time.

Cash rents are usually negotiated directly between tenants and owners, or with the intervention of a professional farm manager, trustee, or other agent. It is common for rental rates to be fixed for only a year at a time, even when lease agreements continue between the same parties for many years. Rates are usually negotiated before the new lease year begins, sometimes as much as six months in advance. In times of stable economic conditions this may not present a major problem, but when commodity prices and input costs are in a period of high volatility, arriving at a rental rate that will be consistent with the profit levels realized from the next crop can be difficult.

William M. Edwards and Chad E. Hart are professor and associate professor of economics, respectively, at Iowa State University.

Flexible Cash Leases

An intermediate alternative between a fixed cash rent lease and a crop share lease is a flexible (or variable) lease. A flexible lease determines the cash rent by a formula that includes variables for which values are not known until near the end of the lease period. The relevant variables affect the profitability of the crops grown on the rented land during the production cycle covered by the lease period. Setting the rent by a formula ensures that the final rent is commensurate with the potential returns the tenant earns during that cycle. An additional benefit is that once an acceptable formula is agreed on, the level of rent is determined automatically each year. The tenant and owner or manager do not have to renegotiate it annually, based solely on forecasts.

The use of flexible cash leases appears to be increasing in the Corn Belt. Data collected in a survey of farmland tenure arrangements in Iowa in 1993 showed that 3.5 percent of the cash leases had flexible provisions (Edwards, 1993). A similar survey in 2003 showed that 11 percent of the cash leases had flexible provisions (Duffy et al., 2003); a 2007 survey showed 12 percent (Duffy et al., 2008). A 1999 research project in Ohio revealed that eight percent of the cash leases in that state had some flexible provisions (Fleming & Breece, 2008). A 2012 survey of professional farm managers in Illinois showed that variable leases accounted for 17 percent of all lease arrangements under their management, and 32 percent of the cash leases were variable (Schnitkey, 2012).

Many variations of flexible cash leases are in use today (Lemmons, 2011). They can be classified according to the variables included in the formula used to determine the final rent. The most common types flex on (1) yield only; (2) price only; (3) both price and yield; and (4) price, yield, and costs of production. Table 1 shows the relative frequencies of the first three types, as reported in the Iowa and Illinois surveys cited earlier. Neither survey included flexible leases that adjusted for changes in production costs. The more variables included in the rent formula, the closer the flexible lease comes to sharing risk in the same manner as a traditional crop share lease. At the same time, the formula becomes more complex and requires more information to be implemented. The variables which present the greatest source of risk depends on the crops produced, the geographic location of the land being rented, and the current supply and demand conditions for each crop. Interactions and correlations between prices and yields of individual crops, among different crops, and among crop prices and prices of inputs make the assessment of how overall risk is shared under any particular lease arrangement complex.

The Current Research

The objective of the current research project was to compare how the risks of uncertain yields, prices, and input costs were shared between tenants and landowners under ten different models of flexible cash leases, using a fixed cash rent agreement as a benchmark. Davis carried out a similar analysis for South Carolina farms producing six different crops, but analyzed only three types of flexible leases, those with a price adjustment, a yield adjustment, and a price times yield adjustment (Davis, 2004).

A similar study from Illinois compared the standard deviation and probability of a positive net farm

income to the tenant under a fixed cash lease, a crop share lease, and flexible leases adjusted by a price index, a yield index, and a combined price and yield index (Muzinga, Lins, and Boehlje, 1997).

The ten types of flexible leases chosen are described in Table 2 and are grouped according to which variables are included in each rent formula. The degree of risk borne by each party under a traditional crop-share agreement (crop production and costs for seed, fertilizer, pesticides, and grain drying are shared equally) and under a custom farming agreement (landowner pays all input costs and a fixed fee to the custom operator and receives all the crop) was also estimated to provide comparisons.

Results were generated for two crops – corn and soybeans – each assumed to be grown on half of the rented acres. Table 3 summarizes the other parameter values used in the analysis. These values were generally representative of yield potential, market conditions, and input costs in the U.S. Corn Belt at the time of the study. However, it is expected that the estimated degree of risk sharing among the various lease types will generally hold true over a wide range of yield, price and cost values.

Description of Methodology

To examine the risk sharing relationship, values for yields, prices, and costs were modeled within a Monte Carlo simulation. There were eight random variables in the analysis: corn and soybean prices; corn and soybean yields; corn and soybean machinery costs; and the sum of corn and soybean seed, fertilizer, pesticides, insurance, interest, and miscellaneous costs. The prices and costs were assumed to have lognormal distributions, whereas the crop yields were assumed to follow beta distributions.

The values for the beta distribution parameters were chosen so as to be consistent with the Yield Protection (YP) crop insurance rates for corn and soybeans at the 65 percent coverage level for Story County, Iowa, in 2012. The YP rates were obtained from the Risk Management Agency's Actuarial Data Master database. The price and cost means were set at the values outlined in Table 3. The standard deviations of prices and costs were defined as the product of the mean and the implied volatility from "at the money" options on the first trading day in September 2011.

A method for imposing correlations first proposed in 1982 (Iman & Conover, 1982) was implemented. The procedure is open-ended and can be imposed on any combination of densities. The method is fully transparent since the only manipulation to the original marginal probability draws is a resorting of the draws. The means and standard deviations of the price, cost, and yield distributions are not affected by the procedure. For this analysis, target rank correlations were derived from historical data. The Monte Carlo analysis consisted of 5,000 draws based on the parameter values in Table 3.

The terms of the various flexible rent agreements that were compared are representative of those reported in a recent Iowa survey (Edwards, 2008). Their values were deliberately set so that the mean cash rent paid under each type of lease was nearly equal to the fixed cash rent assumed. That was done so that attention could be focused on the differences

in risk sharing between the parties rather than profit sharing.

Results of the Simulation

The 5,000 simulated values for yields, prices, and input costs were substituted into each flexible rent formula and the three benchmark agreement formulas. The standard deviations of profit per acre for each party that resulted are summarized in Table 4. The standard deviation for the overall profit per acre, i.e., the tenant's and landowner's profits combined, was $385. A standardized value was calculated by dividing the tenant's and landowner's profit standard deviations for each type of lease agreement by this value. These standardized percentages are also shown in Table 4 and in Figure 1.

Note that in the simulations a negative correlation between yield and price for both corn and soybeans was assumed. Furthermore, a positive correlation between corn/soybean prices and the variable input costs was assumed, which reflected the impact of variations in energy prices on both of them. Under a fixed cash rent agreement, both of these correlations tend to reduce the overall variability of profit for the tenant, i.e., when yields are down, prices are up, and when prices are down, inputs costs are also lower. However, as the impacts of variable yields, prices, and costs are shifted between the tenant and landowner, the offsetting effects of the correlations do not always accrue to the same party, causing the sum of the standard deviations of the tenant and landlord to exceed the standard deviation of overall profit under a fixed cash rent lease.

Price and Yield Risk

The first two types of flexible leases tested, where the rent is equal to a fixed charge per bushel of actual yield realized (Type 1) or to a base rent value times the ratio of the actual yield to a fixed base yield (Type 2), had almost exactly the same standard deviations. This is because for both of them the rent paid varies according to the actual yield only. However, the tenant's standard deviation in profit was reduced by only three percent, while the landlord's profits now had a standard deviation equal to twelve percent of the overall value. Due to the assumed negative correlations between crop yields and prices, in many years the adjustment made to cash rent based on the yield variation was larger than the variation in gross income, so these lease types did not do much to stabilize the tenant's profits while they increased the variability of the landowner's profits.

Lease Type 3 sets the rent equal to the actual selling prices of corn and soybeans each year times a fixed number of bushels of each crop, and Type 4 sets the rent equal to a base rent value times the ratio of each year's actual selling price to a fixed base price. Both lease types varied the rent according to actual prices only, and gave nearly identical standard deviations. However, because prices were expected to vary more than yields, based on the data used in the study, considerably more of the variability in profit was shifted to the landowner than under Types 1 and 2. The tenant's standard deviation decreased to 74 percent of the total profit standard deviation (Figure 1), while the landowner's standard deviation rose to above 30 percent of the overall level.

Gross Revenue Risk

From an economic point of view, profits depend more directly on the product of price and yield each year than on either price or yield alone. Thus, the Type 5 lease sets the cash rent as a fixed percent of gross revenue (actual price times actual yield). The fixed percentages of gross revenue used to calculate the rent were 29 percent and 35 percent for corn and soybeans, respectively, approximately equal to the ratio of cash rent to gross crop value observed in Iowa in recent years (Edwards & Johanns, 2012). The Type 5 lease reduced the tenant's profit standard deviation more than any of the previously discussed leases, to only two-thirds of the overall standard deviation of profit (Figure 1). Conversely, the landowner's profit standard deviation was equal to a third of the overall standard deviation.

Lease Type 7, under which the rent is set equal to a fixed base rent times both the ratio of actual yield to a base yield and the ratio of actual price to a base price, gave nearly the same results as Type 5. This result was similar to that observed in Davis' study, where a flexible lease with both a yield and price index adjustment reduced the standard deviation of the tenant's net return more than leases with a yield or price index adjustment only (Davis, 2004). Similar results were also reported by the Illinois study, which projected that the standard deviation of a tenant's net farm income would be reduced more by leases flexing on price or gross income than on yield only (Muzinga, Lins and Boehlje, 1997).

Lease Type 6 is the same as Type 5 except both a minimum ($150) and a maximum ($400) annual rent are imposed. This actually increased the standard deviation of the tenant's profits substantially. In years of very low gross income the tenant must still pay the minimum rent, whereas under Type 5 a lower rent would be due. This accentuates losses in a "bad" year. Just the opposite takes place in a high gross income year. The tenant never pays more than the maximum rent, so enjoys even higher profits in an extraordinarily good year. Both of these cases increased the variability of the tenant's profits and decreased the variability of the landowner's profits.

Lease Type 8 sets the rent equal to a base value, then adds a bonus if the gross revenue each year is greater than a fixed value. The base gross revenue values were set equal to the projected gross revenue for each crop using the expected yields and selling prices, $845 per acre for corn and $600 per acre for soybeans. The bonus is equal to half of the amount by which the actual gross revenue exceeds the projected gross revenue, i.e., the tenant and landowner divide equally any "extra" revenue. There are no negative bonuses, so the base rent is also the minimum rent. Because the landowner is not bearing any downside risk in the event that gross revenue is lower than expected, the base rent was set at a lower level than the fixed cash rent. In this case it was at $150 per acre, the same as the minimum rent under lease Type 6. The base rent plus bonus lease had a slightly lower standard deviation for the tenant than the percent of gross revenue leases (Types 5 and 7), at only 65 percent of the overall profit standard deviation. The landowner's profit standard deviation was higher than for the previous types, but most of the added variation was on the up side rather than the down side, due to the imposition of a minimum rent.

Cost of Production Risk

Recent large swings in the costs of some crop production inputs, most notably nitrogen fertilizer, have caused tenants to consider incorporating production cost risk factors into flexible leases. Lease Type 9 is the same as Type 8 except the base gross revenue is set equal to the tenant's costs of production each year for each crop. Costs include seed, fertilizer, pesticides, and other input costs; machinery and drying costs; labor cost; and the base rent amount. If the actual gross revenue exceeds the base gross revenue (total costs), 50 percent of the excess revenue is added to the cash rent. If the actual gross revenue is below the base value, the rent is not lowered. Thus, the lease is actually a "profit sharing" agreement. Because the expected costs of production are lower than the expected gross revenue used as the base revenue in Type 8, the expected bonus in Type 9 is larger. To offset this, the base rent was reduced from $150 in Type 8 to $100 in Type 9.

In the simulation, only variability of production costs related to energy prices was taken into account. Separate distributions were estimated for the sum of seed, fertilizer, pesticide, and drying costs, and for machinery costs (fuel). The tenant's standard deviation of profit for lease Type 9 was only 56 percent of the overall standard deviation, compared to 65 percent under Type 8. Introducing cost of production risk into the rent equation shifted more of the profit variation from the tenant to the landowner, and approached the nearly equal sharing of risk observed under a 50-50 crop share lease.

The last flexible lease type, Type 10, is similar to Type 7, but in addition to a yield index and a price index it contains a cost of production index adjustment. The index is equal to the projected cost of production for each crop (excluding rent) divided by the tenant's actual cost of production each year. Note that it is inverted from the yield and price indices, so that the rent is increased when actual costs are below expected levels and decreased when actual costs exceed expected levels. The standard deviation of profit for the tenant under this lease type was lower than the price index lease (Type 4), but actually higher than for the yield and price index lease (Type 7). This can be explained by the assumed positive correlation of production costs with grain prices. In today's markets, energy prices affect the cost of crop inputs, but also impact crop selling prices, especially corn. Thus, in years when the tenant's profits were high due to high selling prices, production costs were also high. Incorporating production costs into the rent formula reduced the rent paid in those years and made the tenant's profits even higher, while the opposite occurred in low price years. This had the effect of increasing the tenant's profit standard deviation (Figure 1).

Downside Risk

One drawback of comparing the standard deviations of profit under the various lease types is that above average profits are treated the same as below average profits. In reality, only years with below average profits pose a financial risk to the tenant or to the landowner, particularly those years in which revenue is below total costs. Figure 2 shows the probability of the tenant incurring a negative profit (economic loss) under each lease type, using the assumed values in Table 3 and the simulation results

described earlier. For example, the probability of a loss under a fixed cash lease was 51 percent.

Incorporating yield variability into the rent formula (Types 1 and 2) had little effect on the probability of a loss for the tenant, while incorporating price variability (Types 3 and 4) reduced it some, and incorporating both price and yield variability (Types 5, 6 and 7) reduced it even more, to about 45 percent. Shifting to a base rent plus a bonus (Type 8) further reduced the chances of a loss to 41 percent, and basing the bonus on revenue earned in excess of production costs (Type 9) lowered the odds to only 37 percent, actually lower than the probability of a loss under a 50-50 crop share lease (39%). Reducing the minimum cash rent to $150 and $100 for Types 8 and 9, respectively, helped turn some of the loss years into profitable years for the tenant.

Value at Risk

Another way to look at the effect of the terms of the lease on the tenant's financial risk is to look at the projected value for profit at the tenth percentile of the whole profit distribution. In other words, what is the value that profit will exceed 90 percent of the time and be less than 10 percent of the time? This is commonly called "value at risk." A similar value at risk could be calculated for other percentile points of the profit distribution. For example, the fiftieth percentile value at risk would indicate the level where half the time profits are higher and half the time profits are lower.

Table 5 summarizes the tenth percentile value at risk for the tenant and the landowner for each type of lease. Higher profits or smaller losses indicate less financial risk. Not surprisingly, the tenant's projected profit in the ninth worst year out of 10 was negative under all the agreements except the custom farming. The landowner, on the other hand, showed a positive profit under all the cash rent alternatives. The owner's costs were assumed to be only $40 per acre for real estate taxes and upkeep, however, and did not include any debt servicing or returns to equity capital. The profits accruing to the tenant and the landowner should not be compared directly to each other, because the two parties are contributing quite different resources to the agreement.

The lease types that incorporate both prices and yields into the rent formulas (Types 5, 7, 9, and 10) had the smallest losses for the tenant in the ninth worst year out of ten. On the other hand, Type 6 and Type 8, which both called for a minimum rent of $150, resulted in larger losses for the tenant in years of low gross revenue. Type 9 had a minimum rent of only $100, and Types 5, 7, and 10 had no minimum rents, which decreased the chances of a large loss.

Of course less risk for the tenant leads to more risk for the landowner, as can be seen in the second column of Table 5. The lowest estimated 10 percent values at risk for the landowner were for the leases that had no minimum rent (Types 3, 4, 5, 9, and 10), and were in the range of $60 to $65 for each one. The crop share lease about broke even at the tenth percentile, and the custom farming agreement projected a loss of $128 per acre for the landowner.

Summary

Flexible cash leases are an effective way to share yield, price, and cost risks between farm tenants

and landowners while preserving the traditional operational aspects of a fixed cash rent lease. Under simulated conditions for corn and soybean production in the U.S. Corn Belt, leases that adjusted for only yield variability shifted very little risk from tenant to landowner. Leases that incorporated price variability shifted more risk, and leases that included both price and yield risk factors shifted even more risk. A lease that called for a base rent plus a bonus based on how much revenue exceeded costs of production each year shifted the most risk, and provided the tenant with the lowest probability of suffering a loss in any given year.

The terms of the leases in this study were set so that all of them would return approximately the same level of profit to the tenant and landowner. However, reducing financial risk for the tenant necessarily means increasing financial risk for the landowner. Flexible leases allow landowners to capture higher returns when crop revenues are strong and help maintain tenant returns when crop revenues are weak. In order for the landowner to accept additional risk, the terms may have to be adjusted so that the expected profit to the landowner is also increased. This study highlights the relative amount of risk shared between landowners and tenants under various rental arrangements, holding average returns constant. Further research needs to be done to determine the magnitude of the risk/return trade off under typical farm leasing conditions.

Several decision tools are available to help tenants, landowners and farm managers analyze the potential results from various types of flexible lease agreements under different yield, price and cost expectations. A partial list is as follows:

1) Flexible Lease Agreement Worksheet from Iowa State University Extension and Outreach (http://www.extension.iastate.edu/agdm/wholefarm/xls/c2-21flexiblerentanalysis.xls)
2) FlexRent from Kansas State University Research and Extension (http://www.agmanager.info/farmmgt/land/lease/tools/FlexRent.xls)
3) Cash Rent with Bonus Worksheet from University of Illinois Fast Tools: (http://www.farmdoc.illinois.edu/fasttools/index.asp)

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Table 1. Percent of Variable Cash Leases Using Selected Variables to Determine the Rental Rate

	Iowa	Illinois
Yield only	28%	7%
Price only	10%	8%
Gross revenue	62%	85%

Sources: Duffy, et al, 2008, and Schnitkey.

Table 2. Flexible Lease Types and Benchmark Lease Types Considered

Flexible leases based on yield variability

Type 1. Cash rent is equal to the actual yield times a fixed value per bushel (rent per bushel).
Type 2. Cash rent is equal to a base rent times the actual yield divided by a base yield (yield index).

Flexible leases based on price variability

Type 3. Cash rent is equal to the actual price times a fixed number of bushels (value of fixed yield).
Type 4. Cash rent is equal to a base rent times the actual price divided by a base price (price index).

Flexible leases based on yield and price variability

Type 5. Cash rent is equal to a fixed percent times the actual yield times the actual price (percent of gross revenue).
Type 6. Cash rent is equal to a fixed percent times the actual yield times the actual price, with both a minimum and a maximum rent specified (percent of gross revenue within a range).
Type 7. Cash rent is equal to a base rent times the actual yield divided by a base yield, times the actual price divided by a base price (yield and price index).
Type 8. Cash rent is equal to a base rent plus half the actual gross revenue (actual yield times actual price) in excess of the projected gross revenue (base rent plus bonus).

Flexible leases based on yield, price and cost variability

Type 9. Cash rent is equal to a base rent plus a fixed percent times the actual gross revenue (actual yield times actual price) in excess of a base gross revenue equal to the tenant's actual cost of production (profit share).
Type 10. Cash rent is equal to a base rent times the actual yield divided by a base yield, times the actual price divided by a base price, times a base cost of production divided by the tenant's actual cost of production (yield, price and cost index)

Benchmark leases

Fixed cash. Cash rent is equal to a fixed value with no adjustments for actual yields, prices or costs of production.
Crop share. No cash rent is paid. The landowner receives 50% of the crop and pays 50% of the costs for seed, fertilizer, pesticides and drying.
Custom farming. No cash rent is paid. The tenant provides all labor and machinery and receives a fixed payment from the landowner.

Table 3. Parameter Values Used to Generate Revenue and Cost Comparisons

	Corn	Soybeans
Percent of rented acres in each crop	50%	50%
Expected yield, bushels per acre	169	50
Expected harvest selling price, $ per bushel	$5.00	$12.00
Seed, fertilizer, pesticide, and other direct costs, $ per acre	$341	$181
Machinery and labor costs, $ per acre	$141	$109
Drying costs, $ per acre	$35	$0
Fixed cash rent, $ per acre	$225	$225
Fixed $ of rent paid per bushel of yield	$1.50	$4.00
Fixed bushels per acre used to set rent	50	17
Percent of gross crop value used to set rent	29%	35%
Maximum cash rent, $ per acre	$400	$400
Base rent (minimum), $ per acre	$150	$150
Base gross crop value, $ per acre	$845	$600
Base rent for profit share lease	$100	$100
Percent of gross crop value over base paid for bonus	50%	50%
Percent of crop given to owner (crop share)	50%	50%
Percent of inputs paid by owner (crop share)	50%	50%
Custom farming payment, $ per acre	$160	$150
Real estate taxes and upkeep costs, $ per acre	$40	$40

Table 4. Standard Deviation of Simulated Profit, by Type of Lease

Type of lease	Standard deviations of tenant's and landowner's profits, $ per acre		Standard deviations of tenant's and landowner's profits, as % of standard deviation of overall profit	
	Tenant	Landowner	Tenant	Landowner
Fixed cash rent	$385	$0	100%	0%
Type 1, rent per bushel of yield	$374	$48	97%	12%
Type 2, yield index	$373	$48	97%	12%
Type 3, value of fixed yield	$283	$122	74%	32%
Type 4, price index	$285	$119	74%	31%
Type 5, % of gross revenue	$259	$126	67%	33%
Type 6, % of gross revenue within a range	$312	$80	81%	21%
Type 7, yield and price index	$261	$124	68%	32%
Type 8, base rent plus bonus	$250	$149	65%	39%
Type 9, profit share over actual costs	$217	$173	56%	45%
Type 10, yield, price and cost index	$276	$109	72%	28%
50-50 crop share	$190	$195	49%	51%
Custom farming agreement	$9	$390	2%	101%

Table 5. Expected Value of Profit at the Tenth Percentile, by Type of Lease

Type of lease	Value for which profit will be less than, 10% of the time, $ per acre	
	Tenant	Landowner
Fixed cash rent	$(292)	$185
Type 1, rent per bushel of yield	$(276)	$118
Type 2, yield index	$(274)	$117
Type 3, value of fixed yield	$(196)	$65
Type 4, price index	$(195)	$65
Type 5, % of gross revenue	$(168)	$58
Type 6, % of gross revenue within a range	$(217)	$110
Type 7, yield and price index	$(167)	$57
Type 8, base rent plus bonus	$(217)	$110
Type 9, profit share over actual costs	$(168)	$60
Type 10, yield, price and cost index	$(173)	$64
50-50 crop share	$(102)	$(6)
Custom farming agreement	$1	$(128)

Figure 1. Tenant's and Landowner's Standard Deviations for Profit as a Percent of the Standard Deviation of Overall Profit, by Type of Lease

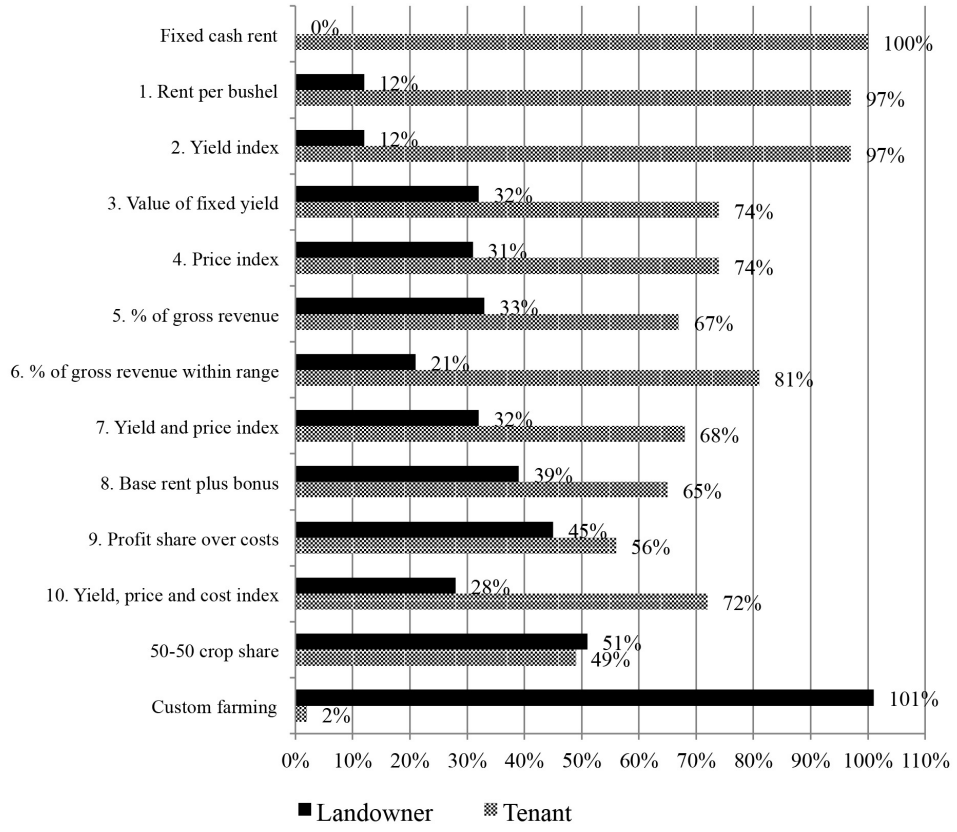

Figure 2. Tenant's Probability of Incurring an Economic Loss, by Type of Lease