October 1980 A.E. Res. 80-27

GRADUATED PAYMENT SCHEDULES FOR FARMLAND PURCHASES

Loren W. Tauer

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

Table of Contents

GRADUATED PAYMENT SCHEDULES

FOR FARMLAND PURCHASES

Introduction

The recent use of graduated payment mortgages (GPMs) in the housing mortgage market has raised the question as to whether GPMs might also be used in farm mortgages. Graduated payment mortgage payments begin at a lower amount than conventional level mortgages, and the payments increase during the life of the mortgage. Because they begin at a lower amount, GPMs have opened up the housing market to many families that otherwise would not be able to purchase homes. GPMs in the farm mortgage market may also open up the farmland market to farm families that otherwise would not be able to purchase farmland.

The acquisition of land and buildings is paramount to the success of a farm business. To insure the stability and viability of their farm businesses most established farmers own at least some of the farmland that they use. Financing the purchase of this farmland has often been difficult for many farmers. The problem centers around the dilemma that land has an infinite life and its market value is based upon the income it will produce into perpetuity, yet the land has to be paid for in a finite period of time. One solution to the dilemma is to stretch out the debt repayment period so that the yearly debt payments closely correspond to the yearly income capacity of the land. That approach works well when the income generated by the land is relatively constant. However, in today's land market, the current income that land generates is considerably less than the yearly payments necessary to finance the land purchase, even when 30- and 35-year payment periods are used. This increasing inability of land to self-liquidate its own debt early in a payment period has serious implications for new farm entrants whose only source of income is the purchased farmland.

One reason why the price of land may be high is that the income stream from land may be expected to increase annually into perpetuity. This expectation of continually increasing annual returns from land results in a market price that is much greater than if annual returns remained constant. In order for land to self-liquidate its own debt it is not only necessary to extend debt payment periods, but also to use a payment schedule that more closely corresponds to the expected income stream from land. The graduated debt payment schedules presented in this article may be used to accomplish this. These schedules can be used in seller-financed transactions (via contract or mortgage), or in third-party lender mortgages.

E.L. LaDue and B.F. Stanton provided helpful comments on an initial draft of this paper. Janelle Tauer edited the paper. Mary Chaffee typed and prepared the manuscript for reproduction.

This article first reviews the present use of GPMs in the farmland and housing market. Then, a geometric GPM and its characteristics are introduced. The flexibility available in arranging geometric GPMs is illustrated. This article also discusses the potential use of geometric GPMs by financial intermediaries and in seller-financed sales.

Graduated Payment Mortgages in the Farm Credit Market

Graduated payment plans have had very little use in the farm credit market except in credit transactions between individuals. Any payment plan approximating a graduated payment plan in this market has usually been the result of emergency or unforeseen conditions rather than preplanned arrangements. Often when a farmer develops financial difficulities because of a crop loss or other disaster, rather than foreclose, many lenders will refinance the loan if it appears that refinancing will reasonably insure a manageable cash flow for the farmer and final repayment of the debt.

Most banks and Production Credit Associations (PCAs) will arrange a line of credit for production purposes and permit a farmer to repay the debt during the production year when he is able. However, for machinery, equipment, breeding livestock, and milk cows, banks and PCAs use fixed payment schedules. The Federal Land Banks also use fixed payment schedules for mortgages although they, like the PCAs, have variable interest rates and will allow variable payments if necessary. Life insurance companies use level amortization payment plans.

Land contracts (or mortgages) between a buyer and seller have often been based on fixed amortization payments, but other payment plans designed for specific situations have been used. A special type of payment plan that is often used is the balloon payment arrangement. With a balloon payment schedule, payments are low for 10 or 15 years, usually consisting of interest only, but the last payment is a large lump sum -- or balloon payment. To make this last payment, the land is often mortgaged through a conventional financial institution.

The inability of farmland to service its own debt because of discrepancies between cash flow generated by the land and debt service requirements has been addressed by various researchers. Baker developed a plan where debt payments could be adjusted according to variations in a borrower's income. Payment ability could be calculated by price, cost, and yield indices. By requiring excess payments in high income years, Baker's plan might insure a constant payment to the lender if a large number of borrowers were involved in the program. Lee described graduated payment mortgages (GPMs) and discussed the flexibilities that were available to meet the requirements of borrowers and lenders. He indicated that GPMs might be especially useful in meeting the credit needs of beginning farmers. Lins and Aukes have also demonstrated the potential of GPMs in matching cash flows. They conclude that, although lenders might hesitate to use GPMs because of the increase in the unpaid balance which results, the risk might be lessened with a sufficient down payment and with increases in farmland value.

Graduated Payment Mortgages in the Housing Market

The Federal Housing Administration (FHA) provided the impetus for graduated payment mortgages in the housing market. The FHA has five GPM payment plans. Three plans permit payments to increase at 2½, 5, and 7½ percent annually for five years with constant payments after the fifth year. Two other plans allow payments to increase 2 and 3 percent annually for ten years with constant payments after the tenth year. In these plans the early monthly payments are not sufficient to pay the accrued interest so the loan balance increases. However, the projected loan balance cannot exceed 97 percent of the projected value of the house at any time. For this test a maximum 2½ percent annual rate of price appreciation of the house is allowed. During 1979 approximately 27 percent of the new FHA single-family mortgages were GPMs (Melton).

Most institutional lenders have not used GPMs extensively. The primary reason appears to be that GPMs reduce a lender's cash inflow during the early periods of a mortgage. Since many financial institutions operate with short-term sources of funds, (i.e., deposits) they need sufficient cash inflow to maintain a liquid asset portfolio. The fact that aged GPMs have a greater cash inflow may not be relevant since very few mortgages are held to their full term. Another problem with GPMs for conventional financial institutions is that the annual accrued interest is not fully paid in the early years of the mortgage. Since most financial institutions report income taxes on an accrual basis, their cash inflow from graduated mortgage payments is not consistent with their tax liability.

Both of these problems have been alleviated by a unique loan arrangement in which the loan granted is larger than the funds needed to finance the house. The additional loan amount is placed into a pledged savings account. The GPM payments are supplemented with payments from the savings account so that total payments are constant as in a conventional mortgage, but larger. The difference in the mortgage interest rate and the savings rate is an additional cost to the borrower, which provides him a tax advantage since his cash interest tax deduction will be larger than his cash payments in the early years. However, since many borrowers are attracted to GPMs because of their low initial incomes, and thus have low tax rates, this tax consequence may not be very advantageous.

Geometric Graduated Debt Payment Schedules

Typically long-term debt is amortized with level payments by the formula:

$$C = \frac{P}{(1+r)} + \frac{P}{(1+r)^2} + \dots + \frac{P}{(1+r)^n} \quad (1)$$

Where C is the amount of debt, P is the level payment, r is the period interest rate, and n is the number of payments.

If debt is amortized over n periods and the payments increase each period by g percent, then the amortization of that debt is:

$$C = \frac{P}{(1+r)} + \frac{P(1+g)}{(1+r)^2} + \dots + \frac{P(1+g)^{n-1}}{(1+r)^n} \quad (2)$$

This equation can be reduced to the formula:

$$\frac{P}{C} = \frac{(r-g)(1+r)^n}{(1+r)^n-(1+g)^n} \qquad (3)$$

In the discussion that follows a period will be defined as one year.

If r is the annual interest rate and C is the amount of debt, it is possible to select a desired initial payment, P, and solve for the annual percentage increase in debt payments, g, that is necessary to amortize the debt. Solving for g is an iterative process, preferably done with a computer. It is possible to select an arbitrary value for P. However, it would be better to choose P based upon business or financial criteria. One possible value for P is the first year's cash rent value of the farmland. (The GPM used here does not level out after a certain number of years but continues to increase, as one would expect rental rates to increase.) It is also possible to base the first year's payment upon the debt payment capacity of the borrower. In many cases, this ability would be closely related to the income producing capacity of the land and would result in a payment equal to the rental income expected from the land. Another possibility is to set the initial payment equal to the first year's accrued interest.

Accrued Interest as Initial Payment

If the first payment is set equal to the accrued interest of the first year, the outstanding principal after the first payment will remain at the original loan amount. The second and following payments will increase and ensure a continuous reduction in the outstanding principal. As shown in Table 1, the yearly percentage increase in the annual payments will depend upon the length of the payment period and the interest rate. Shorter payment periods at any interest rate require greater yearly percentage increases in order to pay the total principal. Higher interest rates require smaller yearly percentage increases. (Because the first payment begins at a higher level, a smaller percentage increase in that higher payment is necessary to pay the principal.)

A comparison of the first year's geometric payment, consisting of accrued interest only, and the first and constant payment of a level amortized payment schedule is made in Table 2. To amortize a six percent annual interest rate, $1,000 loan in five years would require level annual payments of $237. In comparison, the first geometric payment would be only $60. The second geometric payment (calculated by multiplying $60 by 1.7625) is $105.75. The fifth and final payment would be $579, which is considerably greater than the level payment of $237. To amortize a 10 percent interest rate, 30-year loan would require level payments of $106. With the geometric payment plan the first payment would be $100.

The geometric payment schedule significantly reduces early payments only when payment terms are less than about 20 years (when the first payment is set at the first year's accrued interest). It is possible to set the first year's geometric payment at an amount that is less than the first year's accrued interest. However, if the first or any other payment is less than the accrued interest, then obviously there will be an increase in the outstanding balance of the loan. As mentioned previously, one other alternative is to set the first payment equal to the cash rent value of the property. If the purchaser had been renting the land then he should be able to begin debt payments at the cash rent amount. The debt payments will increase each year, but then the renter would also expect his rent to increase.

Table 1. Yearly Percentage Increase in Annual Payments When the First Year's Payment is Accrued Interest

Annual Interest Rate	Term of Payment (Years) 5	10	15	20	25	30	35
	- - - Yearly Percentage Increase - - -						
6%	76.25%	18.87%	8.44%	4.60%	2.77%	1.77%	1.18%
7	69.19	16.77	7.29	3.85	2.25	1.39	.90
8	63.38	15.03	6.35	3.26	1.84	1.11	.69
9	58.49	13.57	5.58	2.78	1.52	.88	.53
10	54.29	12.31	4.92	2.38	1.26	.71	.41
11	50.64	11.22	4.36	2.05	1.05	.57	.32
12	47.44	10.27	3.88	1.77	.88	.46	.25
13	44.59	9.43	3.47	1.52	.74	.37	.19
14	42.04	8.69	3.10	1.33	.62	.30	.15
15	39.75	8.02	2.78	1.15	.52	.24	.12

Table 2. Comparison of First Year's Geometric Payment (Consisting of Accrued Interest) and Level Amortized Payment ($1000 loan)

Annual Interest Rate	First Year's Geometric Payment	Term of Payment (Years) 5	10	15	20	25	30	35
		- - - Level Amortized Payment - - -						
6%	$ 60	$237	$136	$103	$ 87	$ 78	$ 73	$ 69
7	70	244	142	110	94	86	81	77
8	80	250	149	117	103	94	89	86
9	90	257	156	124	110	102	97	95
10	100	264	163	131	117	110	106	104
11	110	271	170	139	126	119	115	113
12	120	277	177	147	134	128	124	122
13	130	284	184	155	142	136	133	132
14	140	291	192	163	151	146	142	141
15	150	298	199	171	160	155	152	151

Rent as Initial Payment

The yearly percentage increase in annual geometric payments for various payment periods and interest rates that results if the first payment is set at four percent of the debt is shown in Table 3. Current return from farmland in recent years has averaged approximately four to five percent of the current value of land (Melichar). This means that $500-an-acre land should rent for $20 per acre, $1000 land for $40, and $2000 land for $80. At every interest rate level the yearly percentage increase diminishes as the term of payment increases. A higher interest rate at any payment term, rather than reduce the percentage, requires a larger annual percentage increase, because the first payment is only four percent of the debt and higher interest rates will result in greater accumulation of accrued unpaid interest.

A scenario of this geometric payment plan is presented in Table 4. In the example, rent begins at four percent of the land's current market value. Rent and the value of the land will probably increase erratically, but both are assumed to increase by five percent a year. These increases will maintain the current rent return at four percent. The first row in Table 4 illustrates what is expected to happen to rent over a 30-year period. The expected increase in geometric debt payments when the interest rate is six percent, the loan is for 30 years, and the loan is for the full value of the land (no down payment) is shown in the second row. The increase in debt payments is almost identical to the expected increase in rent payments. Thus, with no down payment and a 30-year loan at six percent, a farmer can acquire ownership of land at almost the identical cost of renting the land for 30 years under the assumptions used concerning rent.[1]

1 The cost differential becomes larger when real estate taxes and property maintenance costs are added to the cost of ownership. The income tax consequences of renting versus ownership will also affect costs. Rent is a fully deductible farm business expense. However, only the interest on debt is deductible, but by paying only interest for the first few years a buyer gets both interest expense and any depreciation expense. The portion of the purchase price not recovered by depreciation is subtracted from the sales price of the land, if it is sold, to compute taxable gain.

Table 3. Yearly Percentage Increase in Annual Geometric Payments When First Year's Payment is Four Percent of the Debt (Cash Rent)

Annual Interest Rate	Period of Payment (Years)						
	5	10	15	20	25	30	35
	- - - Yearly Percentage Increase - - -						
6%	101.65%	27.65%	14.15%	9.04%	6.51%	5.08%	4.19%
7	104.17	29.05	15.36	10.16	7.60	6.14	5.24
8	106.69	30.46	16.56	11.29	8.69	7.20	6.28
9	109.22	31.88	17.77	12.42	9.77	8.27	7.33
10	111.77	33.29	18.98	13.55	10.86	9.33	8.38
11	114.32	34.70	20.19	14.68	11.95	10.40	9.43
12	116.87	36.12	21.40	15.81	13.04	11.46	10.48
13	119.43	37.54	22.62	16.94	14.13	12.53	11.53
14	121.99	38.95	23.83	18.08	15.22	13.60	12.58
15	124.57	40.38	25.04	19.21	16.31	14.66	13.63

Table 4. Expected Rent or Debt Payment Per $1000 of Farmland* 30-Year Loan, Six Percent Annual Interest, No Down Payment

	Year					
	1	3	5	10	20	30
Expected Rent	$40	$44	$49	$62	$101	$165
Graduated Debt Payment	$40	$44	$49	$62	$102	$167
Unpaid Balance	$1,020	$1,057	$1,090	$1,141	$977	0
Land Value	$1,050	$1,102	$1,216	$1,551	$2,527	$4,116
Ratio: Balance/Land Value	.97	.96	.90	.74	.39	0
Constant Debt Payment	$73	$73	$73	$73	$73	$73

* Initial rent is $40 per $1000 land value.
Both rent and land value increase five percent each year.

The scenario appears attractive, but a farmer could not expect to find a six percent interest rate, 30-year geometric payment loan with no down payment at a financial institution. It might be available, however, from a parent or relative. If the parents' objective is to rent the land to a child and then pass it on to him at their death, they can use the geometric payment plan, receive loan payments equal to what they expect to receive as rent, and pass ownership to the child before their death. If the parents sell the land to a child at its fair market value and charge an interest rate equal to or greater than six percent simple interest, there is no gift made.[2] The parents would pay less income tax on the debt payments than on rent payments because some of the debt payments involve recovery of the land's tax basis and most or all of the gain on the sale would receive capital gain treatment. However, only interest would be received for a number of years and interest would be ordinary income.

There are reasons for parents to be cautious about selling farm property. One danger is that they may lose an income hedge against unexpected inflation because land rent typically increases with inflation. There is also a chance that they may outlive the debt payments. If they decide to sell, then the geometric payment plan has some features that may be attractive to them. One attractive feature is that the payments increase over time. Additionally, they will receive more money over the life of the payment period. As shown in Table 5, the total payment per $1000 of debt is $2692. If a level amortized payment plan had been used, the total payment per $1000 of debt would have been only $2179.

2 The IRS has released proposed regulations that will increase the test interest rate for installment sales from six percent simple interest to nine percent simple interest effective for sales on or after September 29, 1980.

Table 5. Geometric Payment Schedule
Loan is $1000, 30 Years, Six Percent Interest Rate

Year	Payment	Interest	Principal	Balance
1	$ 40.00	$ 40.00	0	$1020.00
2	42.03	42.03	0	1039.17
3	44.16	44.16	0	1057.35
--	--	--	--	--
5	48.76	48.76	0	1090.09
--	--	--	--	--
10	62.47	62.47	0	1140.92
--	--	--	--	--
15	80.02	80.02	0	1119.63
--	--	--	--	--
19	97.55	97.55	0	1018.14
20	102.50	79.22	23.28	976.72
--	--	--	--	--
25	131.30	43.60	87.71	638.92
--	--	--	--	--
30	167.32	9.47	157.85	0
Total	$2692.24	$1692.25	$1000.00	

Many parents and children would not be comfortable with a 30-year payment plan. A parent aged 65 or 70 may not expect to live another 30 years. However, if the payment arrangement provides sufficient income for the parents, there may be no need to shorten the payment period. If it is shortened and the parents have more funds than they need for living expenses they will invest the excess funds into another form of savings. When they die, their savings will be passed on to their heirs. The parents could just as well let the excess cash remain in the land contract (or mortgage) unless the excess cash is invested into property that was more inflation resistant than the contract. A child may prefer a shorter payment plan that would allow him to eliminate his debt quickly. Because a geometric plan is used and early payments are smaller, the child may be able to amass a larger asset base more rapidly and ultimately be able to repay the debt in a shorter period of time.

The effect on annual payments when a 20- rather than a 30-year payment plan is used is shown in Table 6. The graduated payment begins at $40 but increases faster than with a 30-year payment plan. At year five, the difference between the debt payment of $57 and the expected rent of $49 is $8. A constant amortized payment would be $87. By year 10 the geometric debt payment is $87 compared to an expected rent of $62.

Table 6. Expected Rent or Debt Payment Per $1000 of Land*
20-Year Loan, Six Percent Annual Interest, No Down Payment

	Year					
	1	3	5	10	15	20
Expected Rent	$40	$44	$49	$62	$79	$101
Graduated Debt Payment	$40	$48	$57	$87	$134	$206
Unpaid Balance	$1,020	$1,052	$1,071	$1,021	$731	0
Land Value	$1,050	$1,102	$1,216	$1,551	$1,980	$2,527
Ratio: Balance/Land Value	.97	.95	.88	.66	.37	0
Constant Debt Payment	$87	$87	$87	$87	$87	$87

* Initial rent is $40 per $1000 land value.
Both rent and land value increase five percent each year.

The close match of geometric debt payments with expected rent in Table 4 was not a fluke. It was accomplished by starting the first debt payment at the current rent, and then selecting a payment length, given the interest rate, such that the geometric percentage increase closely approximated the expected percentage increase in rent. For example, if the interest rate used is eight percent, and if the rent, which begins at $40 (four percent of current value), is expected to increase nine percent a year, then (as illustrated in Table 3), a 25-year payment plan with annual payment increases of 8.69 percent will cause debt payments to follow expected rent payments. If rent is expected to increase by less than five percent a year, then a payment length of 35 years or more is needed. At higher interest rates, longer payment periods must be selected in order to track debt payments with expected rent payments. If the expected increase in rent becomes very small relative to the interest rate, the payment length becomes unrealistically long.

If rent is expected to increase by less than five percent a year, then current rent probably will be greater than four percent of the current value of the land. If rent and the debt payments begin at a higher percentage of the market value of the land, then a smaller percentage increase in annual debt payments is necessary to repay the loan. This is shown in Table 7 where the first debt payment begins at five percent rather than four percent of the debt. By comparing this table to Table 3 it can be seen that the percentage increase in payments is smaller at every interest rate and payment length combination.

Table 7. Yearly Percentage Increase in Annual Geometric Payments When First Year's Payment is Five Percent of the Debt

Annual Interest Rate	Term of Payment (Years)						
	5	10	15	20	25	30	35
	- - - Yearly Percentage Increase - - -						
6%	87.44%	22.84%	11.05%	6.65%	4.51%	3.32%	2.60%
7	89.80	24.20	12.23	7.76	5.58	4.37	3.63
8	92.16	25.57	13.42	8.87	6.66	5.42	4.67
9	94.54	26.93	14.60	9.98	7.73	6.48	5.71
10	96.92	28.31	15.78	11.09	8.81	7.53	6.75
11	99.30	29.68	16.97	12.20	9.88	8.58	7.79
12	101.70	31.05	18.16	13.32	10.96	9.64	8.83
13	104.10	32.42	19.34	14.43	12.04	10.69	9.87
14	106.51	33.80	20.53	15.55	13.11	11.75	10.91
15	108.92	35.18	21.72	16.66	14.19	12.80	11.96

What has not been explained about the example illustrated in Table 4 is how it is possible to purchase land with debt payments which are not greater than expected rent payments. It is difficult to visualize a seller willing to sell land for a limited number of payments that he could receive as rent into perpetuity. It would be expected that one or more of the assumptions used in Table 4 were incorrect. An analysis of these assumptions follows.

Land can be valued by the capitalization formula:

$$V = \frac{R}{k-g} \tag{4}$$

Where V is the capitalized value, R is the initial year return (rent), k is the discount rate (cost of capital or interest rate), and g is the annual percentage increase in rent (R).

If any three variables in the formula are known, then the fourth variable can be determined. To determine the maximum interest rate that could be charged and yet have payments less than expected rent, it is necessary to solve for k.

$$k = \frac{R}{V} + g. \tag{5}$$

In the first example, the value of the land is $1000, the first year's rent is $40, and rent is assumed to increase by five percent a year. Inserting these values into equation (5) results in a k value of nine percent. However, in the first example an interest rate of six percent was used. At six percent interest it was possible to arrive at a limited time period debt payment closely matching expected rent payments with no down payment. This would in fact be possible for any interest rate below nine percent, although as the interest rate approached nine percent, the payment period would become extremely long. If nine percent interest is used, then it is not possible to closely equate debt payments to expected rent payments over a limited time period. As shown in Table 3, at 35 years and nine percent interest, the geometric increase is still 7.33 percent, which is significantly greater than five percent.

In a family transaction parents may be willing to accept an interest rate below the market rate, but greater than the IRS required six percent simple interest.[3] The sales price of the land can be the fair market value independent of the interest rate. However, in transactions between nonrelated individuals, a market interest rate would be used. If a lower interest rate is used, the sales price of the land will be increased to reflect the value of the lower interest rate. To gain the income tax advantage of shifting ordinary interest income to capital gain income, the low interest rate is often used. For credit transactions where the lender is not the farmland seller, a market interest rate would be used.

When unrelated individuals develop a payment plan it is impossible to closely approximate expected rent payments unless a down payment is made on the farmland purchase. Very few sellers or lenders other than family are interested in selling or financing land without a down payment. This might be especially true if a geometric payment schedule is used. With geometric payments the principal is not reduced quickly. It often increases before it is reduced. This is illustrated in Table 5. In that example the unpaid balance increases each year until year 11 when it reaches a peak of $1,143. This is $143 or 14 percent more than the original indebtedness. If there is no down payment, then, depending upon the interest rate and period of payment, the outstanding balance may exceed the market value of the land in the early years of the payment period unless the land appreciates significantly in value.

3 In the examples the six percent interest used is not six percent simple interest, but six percent interest compounded annually.

Impact of Down Payment

The size of a down payment does not alter the geometric characteristics of the resulting debt. The previous examples that involved debt of $1000 may have been the result of a 20-percent down payment on a $1250 purchase or a 40-percent down payment on a $1667 purchase. However, if it is desired to start the first payment based on the first year's return from the land rather than as a percent of the debt, then the payment schedule is altered.

The characteristics of a geometric payment schedule involving a 30 percent down payment loan of $1000 financed at 10 percent interest for 25 years with the first payment set equal to the first year's rent of $40, are highlighted in Table 8. The debt payments increase by 7.509 percent a year, which is greater than the five percent increase in rent. Since the early payments are lower than the accrued interest, the unpaid balance increases until year 13 when it peaks at $989. However, because the value of the land is projected to increase five percent annually, the ratio of the unpaid balance and land value decreases during most of the payment period. If a level amortization schedule had been used, the yearly payments would be $77. The geometric payments begin at $40 and do not reach $77 until year ten. Total payments for 25 years with the geometric schedule would be $2722 per $1000 of original debt. With a level amortization payment, total payments would be only $1928.

Table 8. Expected Rent and Debt Payment Per $1000 of Land*
25-Year Loan, Ten Percent Annual Interest, $300 Down Payment

	Year					
	1	3	5	10	15	25
Expected Rent	$40	$44	$49	$62	$79	$129
Graduated Debt Payment	$40	$46	$53	$77	$110	$226
Unpaid Balance	$730	$790	$848	$963	$974	0
Land Value	$1,050	$1,102	$1,216	$1,551	$1,980	$3,225
Ratio: Balance/Land Value	.70	.72	.70	.62	.49	0
Constant Debt Payment	$77	$77	$77	$77	$77	$77

* Initial rent is $40 per $1000 land value.
Both rent and land value increase five percent each year.

Modified Geometric Payment Schedules

The preceding geometric payment schedules were based on the premise that payments should increase geometrically each year. If returns from the farmland also increase geometrically, it would be possible to match cash inflow and outflow. A geometric payment plan entails substantially more interest costs than a level amortization payment plan. Many borrowers would find the early payments of a geometric payment schedule attractive, but would consider the increased interest costs a severe disadvantage. In addition, many borrowers would not consider the low payments to be necessary after the first few years.

For these borrowers a plan that began at a low payment level but increased quickly to a higher level payment, which is sustained for the remainder of the repayment period, might be attractive. This is the feature of the FHA housing mortgages discussed earlier. Mathematically, that payment schedule is:

$$C = \frac{P}{(1+r)} + \frac{P(1+g)}{(1+r)^2} + \ldots + \frac{P(1+g)^{m-1}}{(1+r)^m} + \ldots + \frac{P(1+g)^{m-1}}{(1+r)^n} \qquad (6)$$

Where C is the amount of debt, P is the initial payment, r is the period interest rate, n is the length of the payment period, m is the length of the geometric period, and g is the geometric increase in payments.

Formula (6) can be rearranged as:

$$\frac{C}{P} = \frac{[(1+r)^m - (1+g)^m]}{(r-g)(1+r)^m} + \frac{(1+g)^{m-1}[(1+r)^n - 1]}{r(1+r)^n} - \frac{(1+g)^{m-1}[(1+r)^m - 1]}{r(1+r)^m} \qquad (7)$$

Where $r \neq g$.

Any of the parameters of Formula 7 could be adjusted to derive a payment schedule that meets the needs of a borrower and lender. However, only one parameter could be varied at a time; all other parameters of the equation must be held constant. The amount of debt can be adjusted by altering the down payment. Except for seller financed sales where the interest rate might be negotiated, the interest rate would be based upon competitive market rates.

An example of a modified geometric payment is illustrated in Table 9. In that example, land was purchased for $1250 with $250, or 20 percent paid down, leaving a balance of $1000. The loan is for 25 years at 10 percent annual interest with geometric increases of six percent annually for the first 10 years. This results in a first year payment of $78.78. The payments level off to $133.10 a year after 10 years. If a level amortization payment plan had been used, the yearly payments would have been $110. Thus, the modified geometric schedule provides a payment schedule that is lower than level amortization payments in the early periods, but at the sacrifice of higher level payments later. The modified geometric total payments are $3035. For a level amortized payment schedule the total payments are $2754, or $281 less. Since the initial payments are lower than the accrued interest on the loan, there is an increase in the unpaid balance of the loan which peaks at $1076 in the sixth year. This is still substantially below the original sales price of $1250.

Table 9. Modified Geometric Graduated Debt Payment, $1000 Debt, 10 Percent Interest, 25-Year Term. Geometric Payment Increase of Six Percent for 10 Years

Year	Payment	Interest	Principal	Balance
1	$ 78.78	$ 78.78	0	$1021.22
2	83.51	83.51	0	1039.83
--	--	--	--	--
5	99.46	99.46	0	1074.23
6	105.43	105.43	0	1076.22
--	--	--	--	--
10	133.10	133.10	0	1012.39
11	133.10	113.63	$ 19.47	980.53
--	--	--	--	--
15	133.10	86.45	46.65	817.87
--	--	--	--	--
20	133.10	57.97	75.13	504.60
--	--	--	--	--
25	133.19	12.11	121.08	0
Total	$3035.00	$2035.00	$1000.00	

Another modified geometric payment is illustrated in Table 10. Again the loan is for 25 years at 10 percent annual interest, but the geometric increase is 12 percent annually for the first five years. The first payment is $76.74. Payments level off to $120.75 after five years. Thus, this payment schedule begins at approximately the same value as the previous 10-year, six percent geometric payment schedule, increases faster, but levels off at a lower value. The first payment is $33 less, and the fifth and then constant payments are only $11 more than a level amortized payment. Total payments over the loan are only $148 more than the level amortized schedule.

Table 10. Modified Geometric Graduated Debt Payment, $1000 Debt, 10 Percent Interest, 25-Year Term. Geometric Payment Increase of Twelve Percent for 5 Years

Year	Payment	Interest	Principal	Balance
1	$ 76.74	$ 76.74	0	$1023.26
2	85.95	85.95	0	1039.64
3	96.26	96.26	0	1047.34
--	--	--	--	--
5	120.75	120.75	0	1027.94
--	--	--	--	--
7	120.75	110.98	$ 9.77	990.23
--	--	--	--	--
10	120.75	94.46	26.29	918.31
--	--	--	--	--
15	120.75	78.41	42.34	741.76
--	--	--	--	--
20	120.75	52.56	68.19	457.43
--	--	--	--	--
25	120.25	10.93	109.32	0
Total	$2902.26	$1902.26	$1000.00	

Summary and Conclusions

This article discussed the use of geometric graduated debt payment schedules to finance farmland purchases. Geometric payments begin at a lower amount than level amortized payments and increase by a fixed percent each year. Because of the lower early payments, geometric payments may help alleviate the early cash flow problems that prevent many farmers from purchasing farmland. At current farmland prices, current income from farmland is not sufficient to meet the early debt payments of a level amortized loan. It is expected, however, that income from farmland will increase in the future to adequately service geometric payments. A geometric payment plan is only one of the many graduated payment possibilities, but the geometric increase (percentage increase) most closely approximates what is generally expected to occur to land prices and returns.

Geometric payment plans can be modified to fit the needs of borrowers and lenders. This article showed the effects of setting the first payment at the first year's accrued interest and the first year's cash rent. Setting the first payment at the first year's accrued interest greatly reduces the early debt payments for short payment terms but not for long payment terms. With a 30-year payment term, the reduction in the first year's debt payment for a 10 percent interest rate loan is only six dollars per one thousand dollars of debt. The same loan, except written for 10 years, has a first payment reduction of $63. Since most mortgage payments are written for 20 or more years, a geometric payment with the first payment set equal to the first year's accrued interest does not solve the cash flow dilemma.

Setting the first payment at the beginning cash rent, which is normally below the first year's accrued interest, allows a close match between expected returns from the land (cash rent as proxy) and debt payments. Unless a large down payment is used, it is not possible to exactly equate cash rent with debt payments. This inability is logical since the price of land is based upon returns into perpetuity, but debt payments are made only for a limited time period. A rational person would not be expected to trade a perpetual cash flow for an identical but truncated cash flow.

An exception can occur in family transactions. Since sellers only need to charge six percent simple interest for income tax purposes in seller financed sales, families can use an interest rate below market rates and arrange a payment schedule with no down payment that closely tracks expected cash rent. If the land is sold at its market value, exclusive of financing arrangements, there is no gift. Parents, who plan to rent farmland to their children and then pass the farmland to them at their death, can sell the farmland to their children before their death and expect to receive identical payments as if they had rented the land to the children. There are some disadvantages to this arrangement. The most serious is that parents who sell their land lose their hedge against inflation since they trade a real asset for a financial asset at a fixed interest rate.

Beginning the first payment lower than the first year's accrued interest will increase the amount of unpaid balance for a number of years. This may be undesirable for many lenders. Unless there is a sufficient down payment, the unpaid balance may exceed the original value of the farmland and in some instances may exceed the current market value of the land. The last situation would be especially severe since it would encourage defaults and result in losses to lenders.

Another concern to many lenders is that a geometric payment reduces the cash inflow during the early period of the loan. If a lender is operating on short-term deposits, it would be difficult to match liquidity of assets (loans) with liabilities (deposits). For commercial banks this already limits the amount of farm mortgages they are willing to extend. Switching to geometric payments could further reduce the amount of farm mortgages. An additional concern is that most lenders report income taxes on an accrual basis. If a geometric payment is lower than the accrued interest on the loan, a lender could have difficulties matching income tax liability with cash inflow. Since geometric payments would be an additional service to a borrower and there is more risk than conventional mortgages, it would be expected that the rate interest charged would be higher than with a conventional mortgage.

Although geometric payments offer low initial payments, they do so at the cost of additional interest expense over the life of the loan. Many borrowers would be attracted to the low initial payment but would not like the higher interest expense. In that case, a modified geometric payment that begins at a low amount but increases geometrically to a fixed payment level could be used. The initial payment can be as low as with a complete geometric payment schedule, but the percentage increase must be greater to quickly reach the level payment amount. The level payment is higher than a completely level amortized payment plan. The total interest with a modified geometric payment plan is greater than with a level amortized plan, but less than with a completely geometric payment plan. Modified geometric plans are currently used in the Federal Housing Administration's insured graduated payment mortgages (GPMs).

The effect the widespread use of graduated payment mortgages may have on the farmland market has not been analyzed in this article. It should be assumed that GPMs would increase the number of potential buyers in the market. It is not certain, however, whether the price of land would be increased. If the market without GPMs already contains those individuals who have the highest value of marginal production function, then the aggregate demand function for farmland should not be altered. However, it is difficult to argue that in every regional farmland market, those farmers with the highest value of marginal product function are already in the market. If they are not, then GPMs would increase the efficiency of land markets and increase land prices. It is also possible, although less plausible, that GPMs may increase the number of sellers who like the increasing and greater total payments of seller financed sales, and increase the supply curve of land, which would lower the price of farmland. Thus, the net effect may be an increase or decrease in price.

Whether graduated payment mortgages will be used in the farmland market remains to be seen. Since there are so many disadvantages to lenders using GPMs, the agricultural finance industry will probably not utilize them unless there is a strong economic incentive. One possibility is a higher interest rate on GPMs.

In the housing market GPMs have been sponsored by the Federal Housing Administration, but that action does not appear to have induced other lenders to use GPMs for their conventional mortgages. So, the use of GPMs by the Farmers Home Administration may not induce the use of GPMs in the private farmland mortgage market. The cooperative Federal Land Banks, however, could provide this leadership. Since they have a significant share of the farmland mortgage market, if they offered a GPM plan, then other lenders may follow. After all, it was the Federal Land Banks who revolutioned the farmland mortgage market at the turn of the century when they wrote mortgages for periods in excess of five years, which was not a standard practice at that time. Of course, it is always possible for seller-financed land sales to be financed by a GPM arrangement, especially if the transaction is between family members. This may be the greatest potential for GPMs, at least initially.

Bibliography

Baker, C.D. "A Variable Amortization Plan to Manage Farm Mortgage Risks." Agricultural Finance Review, ERS, USDA, 36, April 1976.

Lee, W. F. "Some Alternatives to Conventional Farm Mortgage Loan Repayment Plans." Canadian Farm Economics, 44(1-2), February-April 1979.

Lins, D.A. and R. Aukes. "Buying Farmland: Will Cash Flows Cover the Loan Payments?" Agricultural Finance, 21(2), February 1979.

Melichar, E. "Capital Gains versus Current Income in The Farming Sector." American Journal of Agricultural Economics, 61(5), December 1979.

Melton, W.C. "Graduated Payment Mortgages." Federal Reserve Bank of New York - Quarterly Review, 5(1), Spring 1980.

Appendix A. Payments More Frequent Than Annually

Many loan payment schedules are arranged for payments more frequent than the annual payments used in the previous examples. Often semiannual, monthly, or bi-weekly payment plans are used. Payments more or less frequent than an annual payment are easily incorporated into any of the geometric payment schedules. There are two possibilities. The first is to use other than yearly periods in the geometric formulas (2) and (6) by modifying the period interest rate, number of payments, and the amount of the first payment. If payments occur more frequently than annually, the result will be a slightly reduced geometric trend and less total interest paid because some principal is paid sooner than with annual payments.

It can be rather impractical and tedious to increase each payment if payments occur more often than annually. Accounting may be simplified if all payments during a given year are constant with increases occurring each year. This is possible by taking the annual payment at the end of any given year and discounting it into equal payments over that year. Since the annual payment is calculated for the end of the year, but payments would occur during that year, it is necessary to equate the future value of payments in a given year to the annual payment amount.

This is accomplished by the formula:

$$M = \frac{Ai}{(1+i)^{n}-1} \qquad (8)$$

Where M is the amount of payment, A is the annual payment for the year, n is the number of payments during the year, and i is the interest rate.

Appendix B. Fortran Computer Program to Compute Payment Schedules

```
      C
      C
      C THIS PROGRAM COMPUTES A GEOMETRIC DEBT PAYMENT SCHEDULE,
      C  A MODIFIED GEOMETRIC PAYMENT SCHEDULE, OR A LEVEL
      C  AMORIZATION PAYMENT SCHEDULE
      C
      C
      C  WRITTEN BY
      C                     LOREN TAUER
      C                     DEPT. OF AG. ECON.
      C                     CORNELL UNIVERSITY
      C
      C
            REAL*8 INT,ND
            DOUBLE PRECISION P,PRIN,ZINT,PAY,BAL,A,PD,G
            DOUBLE PRECISION SPAY,SINT,SPRIN
            DATA FINI,GEOM,AMOR,GEMO/'FINI','GEOM','AMOR','GEMO'/
            PD=.000001
            ND=-PD
        98  CONTINUE
            KK=0
      C
      C
            READ(5,101)COM,P,AR,NP,Y,A,M
       101  FORMAT(A4,6X,F10.2,F10.6,7X,I3,F10.6,F10.2,7X,I3)
      C
      C
      C    *****  DEFINITION OF INPUT VARIABLES  *****
      C
      C COM IS FINI TO STOP, GEOM FOR GEOMETRIC PAYMENT SCHEDULE,
      C  AMOR FOR LEVEL AMORIZATION PAYMENT, GEMO FOR MODIFIED
      C  GEOMETRIC PAYMENT SCHEDULE
      C P   IS THE DEBT
      C AR  IS THE ANNUAL INTEREST RATE
      C NP  IS THE NUMBER OF PAYMENTS A YEAR
      C Y   IS THE NUMBER OF YEARS
      C A   IS THE VALUE OF THE FIRST PAYMENT FOR GEOMETRIC PAYMENTS.
      C      ENTER ZERO FOR LEVEL AMORTIZED SCHEDULE
      C M   IS THE NUMBER OF PAYMENTS FOR GEOMETRIC INCREASES FOR A
      C      MODIFIED GEOMETRIC PAYMENT, ENTER ZERO OTHERWISE
      C
      C
            IF(COM.EQ.FINI) GO TO 999
            R=AR/(100.*NP)
            N=NP*Y
            S=(1+R)**N
            WRITE(6,201)
       201  FORMAT('1')
            IF(COM.EQ.GEOM) WRITE(6,202)
       202  FORMAT('0',5X,'GEOMETRIC GRADUATED DEBT PAYMENT SCHEDULE',/)
            IF(COM.EQ.AMOR) WRITE(6,302)
       302  FORMAT('0',5X,'LEVEL AMORTIZED DEBT PAYMENT SCHEDULE',/)
            IF(COM.EQ.GEMO) WRITE(6,501)
       501  FORMAT('0',5X,
           #'MODIFIED GEOMETRIC GRADUATED DEBT PAYMENT SCHEDULE',/)
```

```
      WRITE(6,203)P
  203 FORMAT( 7X,F10.2,' IS THE AMOUNT OF DEBT')
      WRITE(6,303)NP
  303 FORMAT( 14X,I3,' IS THE NUMBER OF PAYMENTS PER YEAR')
      WRITE(6,304)Y
  304 FORMAT( 7X,F10.2,' IS THE NUMBER OF YEARS')
      WRITE(6,204)N
  204 FORMAT( 13X,I4,' IS THE TOTAL NUMBER OF PAYMENTS')
      WRITE(6,305)AR
  305 FORMAT( 10X,F7.4,' IS THE ANNUAL INTEREST RATE')
C
      SM=P*S*R/(S-1.)
      IF(A.GT.SM) GO TO 994
      IF(COM.EQ.AMOR) GO TO 995
      RAT=A/P
      GH=10.
      G=5.
      GL=0.
      IF(COM.EQ.GEMO) GO TO 717
C
C THIS SECTION COMPUTES THE PERCENTAGE INCREASE OF A GEOMETRIC
C  PAYMENT SCHEDULE
C
      M=N
   15 CONTINUE
      KK=KK+1
      IF(KK.GE.10000) GO TO 993
      TES=(S*(R-G))/(S-(1.+G)**N)
      CHK=RAT-TES
      IF(CHK.LE.PD.AND.CHK.GE.ND) GO TO 701
      IF(CHK.LE.0.) GO TO 31
      GH=G
      G=G-(G-GL)/2.
      IF(G.EQ.R) G=G-PD
      GO TO 15
   31 GL=G
      G=G+(GH-G)/2.
      IF(G.EQ.R) G=G+PD
      GO TO 15
C
C THIS SECTION COMPUTES THE PERCENTAGE INCREASE OF A MODIFIED
C  GEOMETRIC SCHEDULE
C
  717 CONTINUE
      M1=M-1
      SS=(1.+R)**M
      SM1=S-1.
      SSM1=SS-1.
      SR=S*R
      SSR=R*SS
  719 CONTINUE
      KK=KK+1
      IF(KK.GE.10000) GO TO 993
      TES=(SS-(1.+G)**M)/((R-G)*SS)+((1.+G)**M1*SM1)/SR
     # -((1.+G)**M1*SSM1)/SSR
```

```
      TES=1./TES
      CHK=RAT-TES
      IF(CHK.LE.PD.AND.CHK.GE.ND) GO TO 701
      IF(CHK.LE.0.) GO TO 71
      GH=G
      G=G-(G-GL)/2.
      IF(G.EQ.R) G=G-PD
      GO TO 719
   71 GL=G
      G=G+(GH-G)/2.
      IF(G.EQ.R) G=G+PD
      GO TO 719
C
  701 CONTINUE
      WRITE(6,206)A
  206 FORMAT( 7X,F10.2,' IS THE AMOUNT OF THE FIRST PAYMENT')
      GG=G*100.
      WRITE(6,207)GG,M
  207 FORMAT( 10X,F7.4,
     #' IS THE PERCENT INCREASE IN EACH PAYMENT FOR',
     #I3,' PERIODS',/)
      WRITE(6,208)
  208 FORMAT( 7X,'_______________________________________________________',
     #'________________________________________________________________')
      WRITE(6,209)
  209 FORMAT( 10X,'NUMBER',10X,'PAYMENT',10X,'INTEREST',10X,
     #'PRINCIPAL',10Y,'BALANCE')
      WRITE(6,208)
C
      J=1
      PAY=A
      ZINT=P*R
      INT=PAY
      IF(PAY.GE.ZINT) INT=ZINT
      ZINT=ZINT*100.+.5
      NZINT=IDINT(ZINT)
      ZINT=NZINT/100.
      INT=INT*100.+.5
      NINT=IDINT(INT)
      INT=NINT/100.
      IF(INT.GT.PAY) INT=PAY
      PRIN=PAY-INT
      BAL=P-PRIN+ZINT-INT
      SPAY=PAY
      SINT=INT
      SPRIN=PRIN
      WRITE(6,301)J,PAY,INT,PRIN,BAL
  301 FORMAT( 13X,I3,7X,F10.2,8X,F10.2,9X,F10.2,7X,F10.2)
      DO 41 J=2,N
      IF(J.GT.M) G=0.
      PAY=PAY+PAY*G
      ZINT=BAL*R
      V=BAL+ZINT
      IF(PAY.GE.V.OR.J.EQ.N) PAY=V
      PAY=PAY*100.+.5
```

```
      NPAY=IDINT(PAY)
      PAY=NPAY/100.
      INT=PAY
      TV=BAL-PAY
      OV=P-BAL
      IF(TV.LT.P) INT=ZINT+BAL-P
      IF(INT.GT.PAY) INT=PAY
      IF(PAY.GE.ZINT.AND.OV.GT.0.) INT=ZINT
      ZINT=ZINT*100.+.5
      NZINT=IDINT(ZINT)
      ZINT=NZINT/100.
      INT=INT*100.+.5
      NINT=IDINT(INT)
      INT=NINT/100.
      PRIN=PAY-INT
      BAL=BAL-PRIN+ZINT-INT
      SPAY=SPAY+PAY
      SINT=SINT+INT
      SPRIN=SPRIN+PRIN
      WRITE(6,301)J,PAY,INT,PRIN,BAL
   41 CONTINUE
      WRITE(6,208)
      WRITE(6,210)SPAY,SINT,SPRIN
  210 FORMAT('0',10X,'TOTAL',7X,F10.2,8X,F10.2,9X,F10.2)
      WRITE(6,208)
      GO TO 98
C
  994 CONTINUE
      WRITE(6,211)A,SM
  211 FORMAT(//,' THE FIRST PAYMENT ',F10.2,
     #' IS LARGER THAN THE FIRST AND CONSTANT PAYMENT',
     #F10.2,' OF AN AMORTIZED PAYMENT')
      GO TO 98
C
  995 A=SM
      A=A*100.+1.
      NA=IDINT(A)
      A=NA/100.
      G=0.
      GO TO 701
  993 CONTINUE
      WRITE(6,992)
  992 FORMAT( //,' EXCESSIVE ITERATIONS IN LOOP 15 OR 719')
      GO TO 98
  999 CONTINUE
      STOP
      END
```