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Probability Forecasts on U.S. Corn Prices

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From the mid 1950's to the late 1960s, the U.S. was saddled with grain surpluses and corn prices were closely tied to the government loan rate. Market prices could be forecast with a high degree of accuracy and farmers participating in the government program were assured that they would receive at least the loan rate (less carrying costs) for their grain.

During much of the 1970s, the supply-utilization balance was closer and market prices were much more volatile. Farmers faced substantial price risks. In 1980, for example, nearby futures prices on the Chicago Board of Trade ranged from a low on corn of $2.56/bu. to a high of $3.96. Soybean futures ranged from $5.70/bu. to $9.56. Wheat futures ranged from $3.80/bu. to $5.44. These swings make a tremendous difference in farm profits.

In 1981 and 1982, stocks again accumulated and pushed prices down near to and below the regular loan rates. The difference from the 1950s and 1960s is the reserve program. The price outlook depends not only on the total supply-utilization balance and the regular loan rate but also how much of the grain is in the reserves--and also owned by CCC. These stocks can be released only if market prices reach certain levels well above the regular loan rate.

As producers make plans for the new planting season and review their alternatives under the farm program, they need to formulate ideas on the price outlook for crops that compete for the same land.

Unfortunately, prices cannot easily be predicted at planting time since weather is such a predominant cause of price variations. Long range weather

forecasting is not yet very dependable so we must resort to probability statements about both weather and price forecasts.

A procedure for generating probability price forecasts on corn is illustrated in the following pages. Table 1 contains the annual area harvested, yields and production on coarse grain since 1970 for the world, the U.S. and the world outside of the U.S. Most, though not all, of coarse grains are fed to livestock and would include corn, grain sorghum, oats, barley and millet.

Note that the U.S. has just over 10 percent of the world's coarse grain area, but because of higher yields, produces about one-third of the world's crop. As is shown in the last two columns of Table 1, the world outside the U.S. produces less coarse grain than is consumed there while the U.S. is an exporter.

Note in particular that in each year, the level of U.S. exports was closely tied to the level of the deficit outside the U.S. The implication is that, if we could predict the deficit outside the U.S., we would have a good handle on what U.S. exports would be.

As one studies the trends and year to year variations in production and consumption of coarse grains outside the U.S., several conclusions can be reached. Both have been increasing over time with consumption increasing more rapidly than production. Consumption increased at a rate of about 12 mil. MT per year during the 1970s while production increased at a rate of about 8 mil. MT per year. These trends point to increased U.S. exports as the world turns more to animal protein.

Year to year changes in consumption were correlated with year to year changes in production. A large crop such as the 483 mil. MT output in 1973 was accompanied by a jump in consumption. Note, however, that there was a

more steady climb over the years in consumption than production. Consuming animal products is a habit most populations prefer to maintain and increase. There is a tendency to import more feed grain when local crops are poor rather than cut back consumption.

The point is that year to year variations in the coarse grain deficit in the world outside the U.S. is closely correlated with production outside the U.S. Because the area harvested does not change substantially from year to year, the variations in production are due mostly to yields. Year to year variations in yields are caused mostly by weather and weather is very capricious and hard to predict.

Figure 1 shows the trends in yields of coarse grain and wheat outside the U.S. since 1960. While the trends are clear, yields in any given year were seldom on the trend. This is more evident on U.S. corn yields charted in Figure 2. Notice how much yields in individual years departed from the trend line. Our traditional procedure of making single value forecasts of prices on next year's corn crop assuming trend yields leaves something to be desired.

One way out of this dilemma is to admit that we know little about what yields will be but that we do have a fairly good idea of what the probability distribution of yields around the trend line will be. If we can make a reasonable forecast of area planted and consumption in the coming crop year, then we have a basis for forecasting prices at various yield levels.

Following the procedure outlined in the paper, "Using the Fundamentals of the Grain and Soybean Markets to Predict Prices," (AEC Staff Paper 81-2), price forecasts of the 1983 corn crop were generated as given in Table 2. Two probability distributions were estimated, one for the yield of coarse grain outside of the U.S. and one for the yield of corn in the U.S.

The trend line on coarse grain yields outside the U.S. pointed to about 1.80 MT per hectare in 1982. To determine how yields might vary from that trend, deviation from a trend line for 1960-82 were tabulated. If the pattern of the past 23 years holds in 1983, yields will be within .3 MT of 1.80 MT with a probability of 39.1 percent, i.e., there is nearly a 40 percent chance that coarse grain yields in 1983 will be 1.77-1.83 MT per hectare as given in the table. Yields could be as high as 1.89-1.95 with a probability of 4.3 percent or as low as 1.65-1.71 with a probability of 4.3 percent also.

For each level of yields of coarse grain outside the U.S., there is an array of yield possibilities on corn within the U.S. The probabilities associated with various yield levels were derived the same way as for coarse grain yields outside the U.S. Deviations from trends over the 1960-82 period were applied to the trend yield of 1.10 bushels per acre projected to 1983. Note in Table 2 that while the trend is 110 bushels per acre, the probability is less than one-fourth that yields will be 107-113 bushels.

To calculate the probability of each event presented in Table 2, the individual probabilities are multiplied. For example, the probability that coarse grain yields outside of the U.S. will be 1.77-1.83 MT and that U.S. corn yields will be 107-113 bushels is .392 times .217 which is .0851 i.e., there is about an 8-9 percent chance that these two events will occur. The chance of an above-average world coarse grain crop outside the U.S. (over 1.83 MT/ha) and an above average U.S. corn crop (over 113 bu/acre) is $[(.261 + .043) \times (.304 + .130)] = .132$. The chance of this event is about 1 year in 8. Similarly, the chance that coarse grain yields outside the U.S. will be less than 1.77 MT and that U.S. corn yields will be less than 107 bu. is about 1 year in 9.

For each combination of yields, the farm price of corn was predicted from the procedure outlined in AEC Staff Paper #81-2. If harvested area of coarse grain outside the U.S. is 302 million hectares in 1983, the various yield levels determine production levels. The deficit was estimated assuming that consumption would be about 600 million MT. The deficit, then, was used to predict U.S. exports of corn.

For U.S. corn production, harvested area for 1983 was forecast at 66 million acres. The balance sheet on corn (Table 1) and carryover - price chart (Figure 1) in AEC Staff Paper #81-2 provided the means to translate the various levels of exports and U.S. production into price forecasts. U.S. domestic utilization of corn was assumed to be unaffected by supplies and prices unless the projected carryover was to drop below 10 percent of annual utilization. This is how the price data in Table 2 were derived.

The "most likely" scenario in Table 3 compiles the probabilities of prices within the designed ranges as derived from Table 2. When the probabilities of prices at each level are multiplied by the prices and these products are added together, we calculate what is known as the "expected" price. The column labeled "cumulative probability" indicates the chances that prices will be less than the upper end of the range at each specified price level.

The "optimistic scenario" was calculated in a similar manner. The only difference is that harvested acres of corn in the U.S. is assumed to be 62.3 million acres rather than 66. This would require roughly a 75 participation rate in the 1983 Feed Grain Program.

What value is this information for decision making? For one, the breakeven price between participating and not participating in the 1983 Feed Grain Program is around $2.80. The probabilities that farm prices will

be below $2.80 is nearly 3 years out of 4 in the "most likely" scenario and over 50 percent in the "optimistic scenario." This provides a perspective for those trying to decide on participating.

TABLE 1. WORLD COARSE GRAIN AREA, PRODUCTION AND CONSUMPTION, WITH COMPARISONS WITH THE U.S.

Year	Area Harvested			Yields		World		U.S.		World Less U.S.			U.S. Exports
	World	U.S.	World Less U.S.	World Less U.S.	U.S.	Production	Consumption	Production	Consumption	Production	Consumption	Prod'n Less Consump'n	
	mil ha												
1970	332	41	291	1.48	3.68	576	593	146	142	430	452	-21	19
1971	333	44	290	1.52	4.38	629	615	190	151	440	464	-24	24
1972	329	38	292	1.47	4.78	610	627	182	159	428	468	-40	39
1973	345	42	303	1.59	4.50	670	674	187	156	483	518	-36	41
1974	342	41	301	1.58	3.70	628	634	151	122	477	512	-35	36
1975	348	43	306	1.50	4.35	645	646	185	134	460	512	-52	50
1976	344	43	300	1.70	4.49	704	685	194	131	510	554	-44	51
1977	345	44	301	1.64	4.65	701	692	206	138	495	554	-59	56
1978	343	43	300	1.77	5.14	754	748	222	157	532	591	-60	60
1979	342	42	300	1.67	5.71	741	741	239	161	503	579	-77	71
1980	342	41	300	1.77	4.80	730	741	198	147	532	594	-62	70
1981	346	44	303	1.71	5.72	766	731	248	152	517	579	-62	59
1982	345	43	302	1.75	5.84	780	751	253	158	527	593	-66	63
1983													
1984													
1985													

TABLE 2

POSSIBLE IMPACT OF COARSE GRAIN YIELDS ON THE PRICE OF THE 1983 CORN CROP[1/]

YIELD OF CORN IN U.S.		YIELD OF COARSE GRAIN OUTSIDE U.S.				
		MT/HA				
BU/ACRE		1.65-1.71	1.71-1.77	1.77-1.83	1.83-1.89	1.89-1.95
	PROBABILITY	.043	.261	.392	.261	.043
		FARM PRICE OF CORN				
89-95	.045	4.00	3.50	3.25	3.25	2.50
95-101	.130	3.60	3.30	3.25	3.15	2.45
101-107	.174	3.50	3.25	3.15	2.45	2.40
107-113	.217	3.25	3.15	2.67	2.40	2.35
113-119	.304	3.25	3.15	2.45	2.35	2.35
119-125	.130	3.25	2.45	2.40	2.35	2.25

[1/]ASSUMES:

1. HARVESTED AREA OF COARSE GRAINS OUTSIDE U.S. = 300 MILLION HECTARES
2. HARVESTED AREA OF CORN IN U.S. IS 66 MILLION ACRES
3. WORLD CONSUMPTION OF COARSE GRAIN OUTSIDE U.S. IS 600 MILLION MT
4. U.S. DOMESTIC UTILIZATION OF CORN IS 5.1 BILLION BU.

TABLE 3

PROBABILITY DISTRIBUTIONS OF
FARM PRICES ON THE 1983 CORN CROP

PRICE RANGE $/BU	MOST LIKELY[1/] PROB-ABILITY	MOST LIKELY[1/] CUMU-LATIVE PROB-ABILITY[3/]	OPTIMISTIC[2/] PROB-ABILITY	OPTIMISTIC[2/] CUMU-LATIVE PROB-ABILITY[3/]
2.20 AND UNDER	.006	.006	--	--
2.21-2.40	.457	.463	.256	.256
2.41-2.60	.201	.664	.206	.462
2.61-2.80	.068	.732	.085	.547
2.81-3.00	.006	.738	--	.547
3.01-3.20	.166	.904	.238	.785
3.21-3.40	.094	.998	.188	.973
3.41 AND OVER	.002	1.000	.027	1.000
TOTAL	1.000		1.000	
"EXPECTED" PRICE =	$2.60		"EXPECTED" PRICE =	$2.78

1/ DERIVED FROM TABLE 2.

2/ DERIVED IN THE SAME MANNER AS FOR THE "MOST LIKELY" DISTRIBUTION EXCEPT THAT HARVESTED ACREAGE WAS ASSUMED TO BE 62.3 MILLION ACRES. THIS IMPLIES ABOUT A 75% PARTICIPATION RATE IN THE 1983 FEED GRAIN PROGRAM.

3/ PROBABILITY THAT PRICES WILL BE LESS THAN THE UPPER END OF THE RANGE AT EACH SPECIFIED PRICE LEVEL.

FIGURE 1

WORLD GRAIN YIELDS OUTSIDE OF U.S.

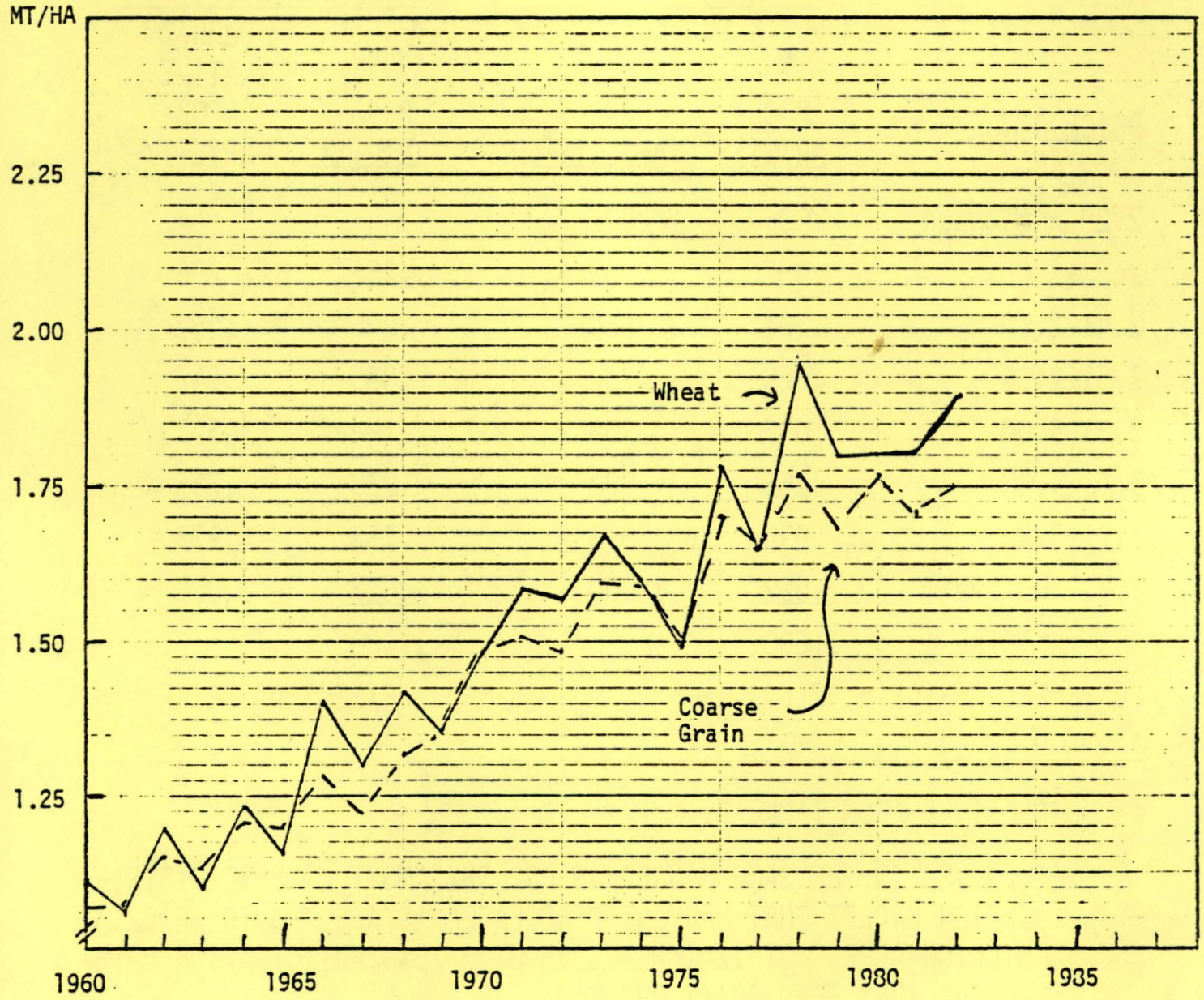
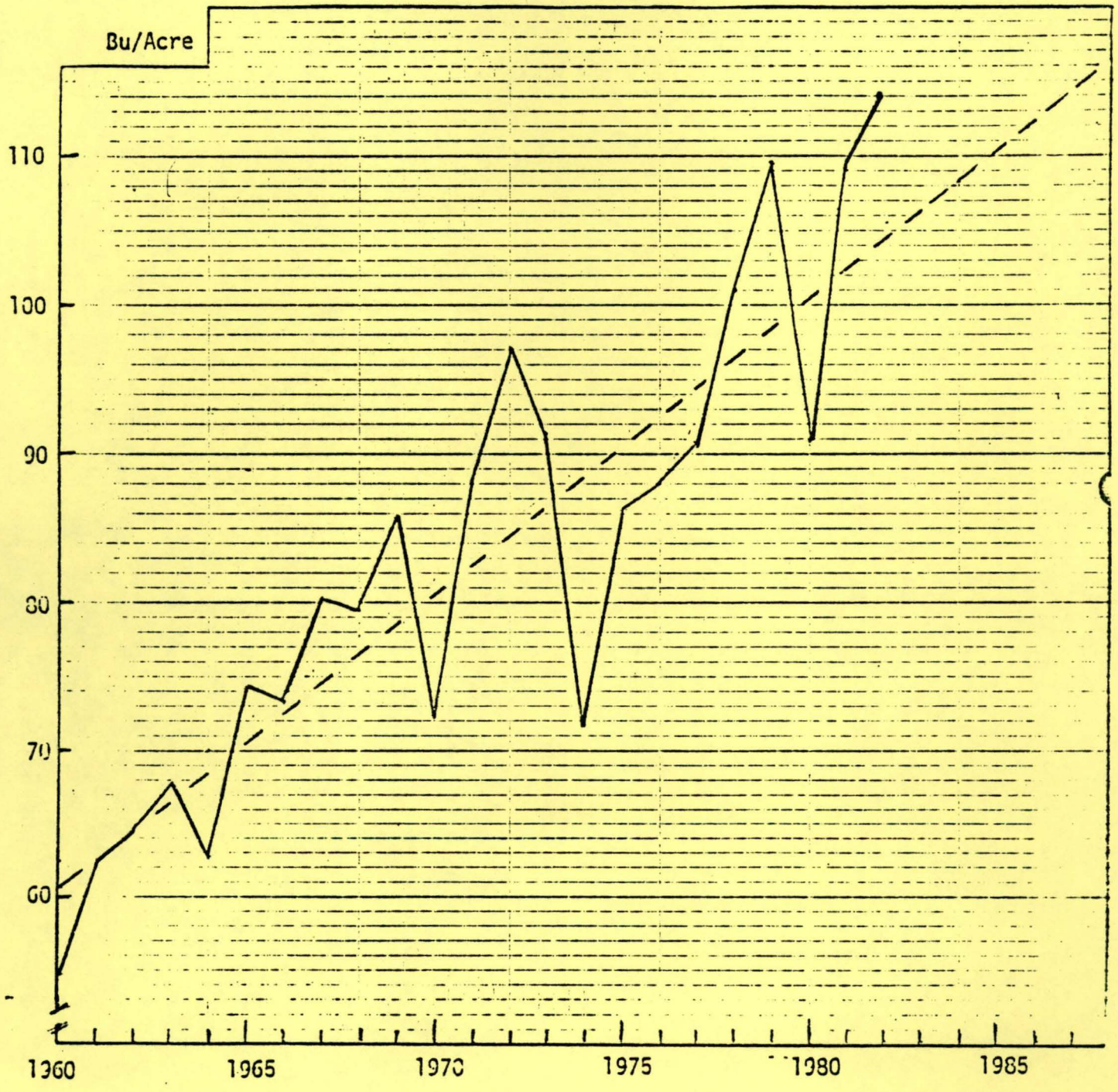


FIGURE 2

U.S. CORN YIELDS



Crop Years Beginning October 1