A Systems Approach to Building MEY Crop Rotations

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Research is proving that each crop in a "3-crop/2-year" rotation can show significant yield increases with enhanced fertility, supplemental water, and appropriate variety selection.

A POPULAR ROTATION in the mid-Atlantic states includes corn, wheat and doublecropped soybeans. The "3-crop/2-year" system is ideally suited to the soils and climate of the area. All three crops are utilized by the large livestock and poultry industries located in the region. Increased production of these crops is a desirable goal because all three must be imported into the grain-deficit region to meet feed needs.

Yields of 110 bu/A corn, 50 bu/A wheat and 30 bu/A doublecropped soybeans are the average on the Delmarva Peninsula. Farmers with irrigation equipment for corn, and those that have adopted some of the intensive wheat management practices, consider 175 bu/A corn, 75 bu/A wheat, and 45 bu/A doublecropped soybeans as above average yields.

Higher yields can be profitably produced in the region in cropping systems that will protect the environment. We began studying ways to improve wheat production in 1980 and have been able to produce yields over 100 bu/A each year, regardless of weather patterns. Similar studies in Virginia and North Carolina have also shown that wheat yields can be profitably increased. Other maximum economic yield (MEY) studies on corn and soybeans in Maryland, New Jersey, North Carolina and Virginia have also proven successful. **The important next step is putting these MEY production packages together**, just as the farmer has to do. A systems approach to building a productive and environmentally safe "3-crop/2 year" rotation has been the objective of our 3-year study.

Systems Research Results

The study is located on a Matapeake silt loam soil on the Poplar Hill Research and Education Facility. Each year, half the experimental site is used for corn and half for wheat followed by doublecropped soybeans. We are looking at several variables on each crop and trying to incorporate those practices which prove best for the crop and the cropping system.

Corn Production Practices

Our MEY Yield Goal:	250 bu/A
Top Systems Research Yield:	222 bu/A
Three-year Avg. Systems Yield:	207 bu/A
Today's Good Farmer Yield:	175 bu/A

Hybrids and Row Spacing. Ten corn hybrids (five mid-season and five full season) were planted on May 14 in 15- and 30-inch rows with a final population of 31,000 plants per acre. With more intensive management, narrow rows have produced significantly higher yields. Also, hybrid variability to row spacing has been substantial (**Table 1**). Eight of the 10 hybrids averaged over 10 bu/A more when planted in 15-inch rows.

Fertilization. The objective is to eventually achieve 250 bu/A irrigated corn in

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Table 1. Yield response of corn hybrids to row spacing.

	Yield, bu/A		
	15-inch rows	30-inch rows	Mean
Top hybrid	221.8	210.8	216.3
Top 4 hybrids	210.4	200.7	205.6
Eight hybrids	193.4	182.8	188.1
Two hybrids	190.7	193.4	192.1
Bottom hybrid	166.9	147.4	157.2
Test Average	192.9	184.9	188.9

the production system. We want to achieve our yield goal with the highest possible level of input efficiency. That means that the high rates of fertilizer (**Table 2**) must provide nutrient balance and be applied at the optimum time for efficient utilization. Soil test levels for phosphorus (P) and potassium (K) are high in the plot area. Sidedress applications were made by injecting a custom blended fertilizer solution with Yetter coulters mounted on a 3-point hitch toolbar. For the 30-inch row spacing, a coulter was used between each row. For the 15-inch row spacing, a coulter was run between every other row.

Table 2. Corn fertilization program in a "3-crop/2-year" rotation system.

Application time and method	N	P_2O_5	K_2O	S	B	Mn	Zn	Cu
	-------------			lb/A				-----------
Preplant broadcast	60	40	40	20	-	6	2	2
With herbicide (preemergence)	-	-	-	-	1	-	-	-
Sidedress 5-leaf	110	20	60	10	-	-	-	-
Sidedress (row closer)	70	20	60	10	-	-	-	-

To achieve the 250 bu/A goal, higher rates of nitrogen (N) may be required, and will be introduced in 1992. Also, N source will be modified in 1992 to provide a higher ratio of ammonium-N to nitrate-N, particularly in the pre-tassel growth period. We believe 250 bu/A is a realistic goal . . . utilizing narrow row spacing, high plant populations, high soil test P and K, split applications of N, P, K and S, irrigation scheduling, and our IPM program for weeds, insects and diseases. However, as N rates are increased there is a legitimate concern over the potential impact on nitrate leaching.

Residual nitrate studies are planned, comparing a conventional corn production system with the MEY cropping system. Soil samples were taken in 1991 to a depth of 36-inches in 12-inch increments to measure residual soil nitrate-N at the test site. For comparison, measurements were taken from an adjacent field where the same hybrid was planted no-till on the same soil type with a currently recommended fertilizer program, including 120 lb/A N. Residual soil nitrate levels were relatively low under both the conventional and the MEY system (**Table 3**).

Table 3. Residual soil nitrate-N samples following corn harvest in 1991.

	Nitrate-N, lb/A	
Sampling depth, inches	Irrigated MEY system	Dryland conventional system
0-12	31.9	29.1
12-14	22.2	18.5
24-36	14.8	9.5
Hybrid—Pioneer 3241 in 30-inch rows	211 bu/A	134 bu/A

Rotations. Rotation studies conducted at Poplar Hill since 1981 to evaluate several cropping systems have shown that no-till corn planted into a wheat and doublecropped soybean stubble continuously produces the best yields. This includes yields of corn planted into a winter cover crop of hairy vetch. This is significant when one considers there is no expense involved for the wheat/soybeans stubble which provides a natural mulch following harvest of the two crops, as compared to the cost for establishing a legume winter cover crop. This rotation also provides a wheat crop following corn that will take up around 30 to 35 lb of residual N not utilized by the corn.

Wheat Production Practices

Our MEY Yield Goal:	125 bu/A
Top Systems Research Yield:	127 bu/A
1991 Yield from Field-size Systems Study:	96 bu/A
Today's Good Farmer Yield:	75 bu/A

The MEY wheat production package

has been well documented and will not be repeated in detail. Many farmers are adopting the intensive wheat management system, and record state average yields the past two years (51 and 53 bu/A) reflect this change. Several key factors are important to the consistently high yields being achieved in the mid-Atlantic region. These are (1) the selection of a high yielding, disease resistant variety from statewide variety trials; (2) following planting recommendations to achieve a uniform and vigorous stand; (3) soil testing and bringing soil nutrient levels into the high range; (4) using a scouting program to control weeds, insects and diseases when thresholds are reached; (5) using a growth regulator in combination with split applications of N when needed; and (6) paying strict attention to N management, including rate, source and timing.

It is essential to include the amount of residual soil N in the total N recommendation to help assure the most efficient N utilization. Soil N levels vary a great deal from one soil type to another in the region. Nitrogen applications should be adjusted to account for residual N levels, and split N applications in the spring must be timed to correspond to growth demands.

Doublecropped Soybean Production Practices

Our MEY Yield Goal:	65 bu/A
Top Systems Research Yield:	61 bu/A
1991 Yield from Field-size Systems Study:	50 bu/A
Today's Good Farmer Yield:	45 bu/A

Doublecropped soybean yields are the key to the success of the "3-crop/2-year" rotation. Farmer yields with doublecropped soybeans have historically been low because of the relatively short growing season, low moisture supplies and low fertility. Soybean yields can be increased by careful consideration of all cultural practices, including variety selection, irrigation and balanced fertility.

To maximize yields, soybeans must be planted as soon as the wheat is harvested. Each day's delay in planting can reduce yields. In Maryland, doublecropped soybean planting following wheat usually occurs during the first week in July. An unusually warm spring in 1991 hastened wheat maturity and permitted planting on June 21. The resulting doublecropped soybean yields were close to 60 bu/A in our best plots.

No-till planting helps reduce the time between wheat harvest and soybean seedling emergence. Soil moisture is preserved by no-till planting which facilitates quick germination and seedling emergence.

Row spacing is another important cultural practice which has a large effect on doublecropped soybean yields. Row spacing must be less than 20 inches to permit quick canopy closure, moisture conservation and maximum yields. Solid seedings (7-inch rows) are probably the ultimate goal, but reliable no-till drills are just now becoming available. We have been using a row spacing of 15 inches in our studies, with a seeding rate of 6 seeds/foot or about 209,000 seeds/A.

Irrigation. Farmers who could benefit from buying irrigation equipment for both soybeans and corn would be much more likely to purchase the equipment. Our irrigation treatments began at flowering to try to limit undesirable increases in vegetative growth. In 1991, five varieties averaged 56 bu/A with irrigation and 46 bu/A without. Irrigation did not increase plant height or lodging. Since length of growing season is a limiting factor, irrigation may play a role in helping to lengthen the time to maturity. Our results showed that maturity was delayed about 4 days by irrigation, with a beneficial lengthening of the seed filling period. These varieties responded to the irrigation treatments by producing more seeds per plant and larger seeds.

Varieties. The five varieties tested in the system were selected for their excellent yielding ability, but significant yield differences and responses to treatments occurred (**Table 4**).

Fertilization. Many farmers supply the nutrient requirements for the double-

A NATURAL MULCH of plant residue remains on this plot from harvesting wheat and no-till doublecropped soybeans. The mulch gives excellent protection against soil and water erosion during winter. Over a period of years, corn planted no-till into the mulch has yielded 15 to 20 bu/A more than corn planted after plowing the mulch under.

Table 4. Yields of five soybean varieties grown under conventional and MEY systems.

	No irrigation		With irrigation	
	Conventional	MEY	Conventional	MEY
	bu/A			
Top variety	44.8	51.7	55.8	59.3
Avg. 5 varieties	44.2	46.4	54.6	55.9
Bottom variety	39.8	43.2	54.0	55.0

cropped soybeans by fertilizing the preceding wheat crop. Several fertility practices are being studied in the MEY system to be sure that fertility is not a limiting factor. One variable is direct fertilization of the soybeans. Results to date, where high soil test levels for P and K are maintained, show that farmers have the option of applying the total two-crop P and K requirement to the wheat.

Research in New Jersey, Georgia and Ohio has shown that soybeans respond to N applied at pod-filling when yield potential is high. Our best yields have been obtained when N has been applied. But those yields are not always significantly better than the control plots. We will continue to experiment with N applications on soybeans.

The "3-Crop/2-Year" System

Our research is beginning to show that significant yield increases of all three crops in the system can be achieved with supplemental water, enhanced fertility and appropriate variety selection. Continued research is needed to fine tune the timing, rate and efficiency of the various inputs being utilized. We believe that developing new crop production practices through a "systems approach" has real merit. The high level of farmer interest in this research during field days at the Poplar Hill Research Facility supports this conclusion. ■