

PLANT NUTRITION TODAY

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4R PLANT NUTRITION AND FARM NET PROFITS



Dr. Jensen visiting the experimental 4R winter wheat field in southcentral Alberta.

Farmers want to manage their farms so that they are sustainable, and the key indicators of farm sustainability are its **Social, Environmental, and Economic** goals and outcomes. Individual farms vary in size. But all farms need to be managed so that they contribute to society, help look after the environment, and function economically so the farm is profitable and contributes to the local economy.

The use of 4R Nutrient Stewardship is succinctly described as managing nutrient inputs on a farm in a way that the Right Sources of Nutrients are applied at the Right Rate, Right Time, and Right Place. Often the environmental aspects of these principles are initially easier to understand, and social contributions to the persons living on the farm and stakeholders in society are important, but economic viability is vitally important to sustainability.

The importance of this can be illustrated in the following example. In the late 1970s and early 1980s there was a movement to improve soil

conservation by use of conservation tillage methods. The main technology tried and adopted in semiarid western Canada, where I worked, was no-till planting. This cropping method reduces the amount of tillage, to the point that the only soil disturbance occurring was that done when the crops were planted using a no-till planter (now called an air-drill). All crop residues remaining from the previous crop were left on the soil surface. The tillage operations—previously used to manage crop residues, control emerged pre-plant weeds, and prepare a seed bed—are replaced by a non-selective, pre-plant herbicide application. I used to attend farm meetings where research results demonstrating the benefits of no-till seeding were shown and discussed. Benefits were higher crop yields due to improved moisture use efficiency, reduced soil erosion losses, and reduced fuel, machinery and labor costs. However, at that time the cost for glyphosate, the main non-selective herbicide used to make no-till planting possible, applied at 1 US quart/acre was US\$28/acre. After



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the economics were calculated, the no-till system gave less net income compared to alternative tillage methods, mostly due to the high herbicide cost. So, even though no-till planting was environmentally beneficial, its economic feasibility was less. Since then, cost of glyphosate has been reduced to about US\$5/quart, and no-till cropping is used because of its economic as well as its environmental and social feasibility.

What about 4R Nutrient Stewardship? Is it economically beneficial? Fortunately, the answer is clearly yes. When nutrient applications are applied using effective sources, rates, placements, and timings, crop yields are improved, unwanted environmental losses are reduced, social benefits are achievable, and net economic returns are increased. The following is an economic comparison calculated using research results of nitrogen (N) fertilizer applied to a winter wheat crop, in southcentral Alberta, Canada. There were 44 combinations of Source, Rate, Timing, and Placement assessed, but for the 2007 crop year there was one combination that resulted in the highest income (i.e., Gross returns - Fertilizer cost and application). **It was granular urea**

– applied at a rate of 80 lb N/acre – in mid-April (when the wheat was beginning to regrow in the spring) – broadcast placed on the soil surface. In the table below is a comparison of the economic returns of five selected Source-Rate-Time-Placement combinations.

The two highest yielding 4R combinations were close in calculated income, \$399 and \$397 respectively, for spring broadcast urea and spring broadcast ammonium nitrate. The same N fertilizer sources, applied at the same rate but side-banded at planting of the winter wheat, both had much lower yields, attributed to denitrification losses over the fall, winter, and early spring period.

This is just one example of how choosing the Right combination of form-rate-timing-placement of nutrients can help farms achieve their Social, Environmental, and Economic goals and outcomes. The excessive losses from the urea or ammonium nitrate fertilizers applied at planting as opposed to early spring application timing, resulted in much lower economic returns, as well as risk of harm to the environment. **4R Nutrient Stewardship** can help farms be more sustainable.

TABLE 1: Comparison of Partial Returns from Select Source-Rate-Time-Placement Combinations of N Fertilizer Applied to Winter Wheat, Southcentral Alberta, 2017.

| Nitrogen fertilizer source | Rate of application, lb N/A | Timing | Placement | Yield, bu/A | Income (Gross return - Fertilization cost), US\$/A |
|----------------------------|-----------------------------|----------------|-----------------------------------------------------------|-------------|----------------------------------------------------|
| Urea (46-0-0) | 80 | Early Spring | Surface broadcast | 90 | 399 |
| Ammonium nitrate (34-0-0) | 80 | Early Spring | Surface broadcast | 91 | 397 |
| Urea | | Late September | Side banded (1 in. below and to the side of the seed row) | 67 | 292 |
| Ammonium nitrate | 80 | Late September | Side banded | 51 | 205 |
| No N fertilizer added | 0 | NA | NA | 42 | 210 |

Price for granular urea was US\$500/ton, granular ammonium nitrate a 15% premium per lb of N, wheat price was \$5/bu, and spring broadcast application cost \$8/A.