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# Agronomic and economic benefits of fertilizing crops

Karamanos, R.E.

# Agronomic and Economic Benefits of Fertilizing Crops

Rigas E. Karamanos, Norm A. Flore and John, T. Harapiak

Western Cooperative Fertilizers Limited, BOX 2500, Calgary, AB T2P 2N1

**Key words:** barley, canola, wheat, return-less-fertilizer-expense, nitrogen, phosphorus, micronutrients

## Abstract

Operating costs at farm level can be divided into essential, enhancement, maintenance, protection and insurance. Save growth hormones, which are not common in western Canada, fertilizer and better quality of seed are the only types of operating costs that enhance yield. Economic returns from these two inputs must be sufficient to allow for financing all other operating (and fixed) costs. A series of experiments (279) have been used to demonstrate the economic return to fertilizer application. A number of experiments (13) are designed to included gradual additions of all fertilizer forms and demonstrate the contribution of each individual nutrient to the final yield and economic return from its use. An N return calculator, in excel format, has been developed by adapting a University of Wisconsin model to assist with this evaluation. Not all fertilizer products provided maximum economic return and choice of appropriate nutrients to achieve this has become crucial.

## Introduction

The recent increase in N fertilizer prices and the historically stable crop prices have resulted in farmers reconsidering their fertilization practices in order to maximize their profits. Although crop prices have remained relatively unchanged over the last 15 years, fertilizer prices, especially N, have nearly doubled. This begs the question of whether the “fundamentals” of fertilizing crops have indeed changed and if a need exists for considering a fertilizer rate change (reduction), shift in ratios of usage of various fertilizer products (e.g., N vs. $P_2O_5$), inclusion of other nutrients, etc.

Farm operating costs can be divided into five categories (Keith Mills, personal communication), namely, essential (seed), enhancement (fertilizer and seed), maintenance (fertilizer and herbicide), protection (herbicide, insecticide and fungicide), and insurance (herbicide, insecticide, fungicide and fertilizer). The benefit from all these inputs is not additive; for example, no yield benefit should be contemplated from herbicide application on a field that is clear of weeds; similarly, if a yield increase ensued from a herbicide application, it would still be realized when wrong weed chemistry applied to the field with no impact on existing weeds (may injure the crop itself); this, of course, is not true. Therefore, the additive approach to inputs reported in popular farm magazines is wrong. The fact remains that any gains in yield can only be achieved via better quality seed and fertilization; hence, maximum economic benefit must be derived from these two operating inputs in order to cover the remaining costs.

Recently, Upadhyay et al. (2006) demonstrated that to maximize canola profit a decrease in the level of fertilizer N application in canola at the expense of canola productivity is necessary as the N-canola price ratio increases. This decrease, for example in comparing 2002 to 2005 N fertilizer prices, is in the order of 25-30 lb N/acre when growing either open-pollinated or hybrid canola (Figure 1). The same authors demonstrated the impact of changing canola and fertilizer N prices on the optimum fertilizer N rate (Table 1).

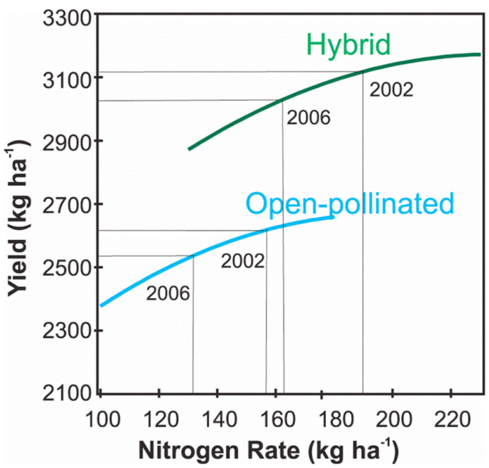


**Figure 1**. Impact of N fertilizer price on optimal N rate (soil plus fertilizer) and canola yield at Fort Saskatchewan, Alberta {canola price = \$300.00 $t^{-1}$ (2002) and \$250 $t^{-1}$ (2006); N price = \$0.75 $kg^{-1}$ (2002) and \$1.00 $kg^{-1}$(2005)} (from Poster by Upadhyay et al. 2006)

**Table 1.** Optimal N (lb /acre of soil + fertilizer N) for hybrid canola cultivars (adapted from Upadhyay et al. 2006)

| | N Price (¢/lb N) | | |
|---|---|---|---|
| Canola Price (\$ $t^{-1}$) | 0.23 | 0.34 | 0.45 |
| 150 | 155 | 129 | 103 |
| 250 | 178 | 161 | 145 |
| 350 | 187 | 175 | 164 |

The objective of this work was to utilize the extensive database of fertility experiments developed by Western Cooperative Fertilizers Limited (Westco) to assess whether changes in agronomic and economic fertilizer practices are required in view of high fertilizer prices, especially N. Three cases compiled out of three separate sets of experiments are presented here.

**Case 1: Fertilizer Economics of N:$P_2O_5$ Ratios**

A historical perspective of the change in N:$P_2O_5$ usage in western Canada is presented in Figure 2. A steady widening of the N:$P_2O_5$ ratio from 0.5 to 2.8 between the sixties and early nineties was followed by a stabilization in the ratio and actually a slight drop to 2.6 in the last couple of years. The drop is related to a proportionally grater drop in N compared to $P_2O_5$ usage.

A steady increase in fertilizer prices with proportionally unchanged crop prices has led to erosion in the fertilizer "grain purchasing power", or the amount of fertilizer purchased by one bushel of grain for both N (Figure 3) and $P_2O_5$ (Figure 4). For example, one bushel of wheat would have bought 18 lb N in 1990, whereas it is estimated that it will be buying 10 in 2006.

The impact of crop and fertilizer prices on the return from fertilizer was examined by analyzing fifteen experiments with barley (eleven on stubble and four on fallow) and five with wheat on fallow that were carried out between 1988 and 1994.

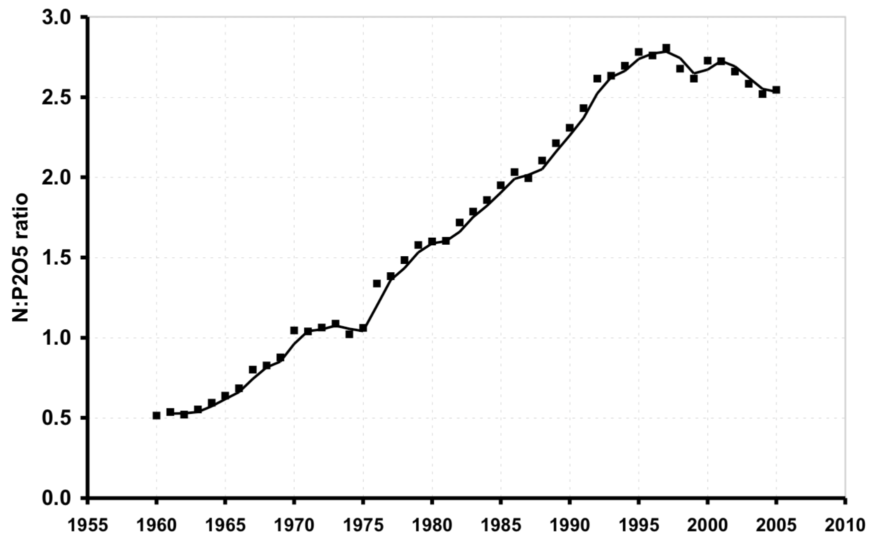


**Figure 2**. Ratio of N to $P_2O_5$ usage in Western Canada. (Sources: Western cooperative Fertilizers Limited and Canadian Fertilizer Institute)

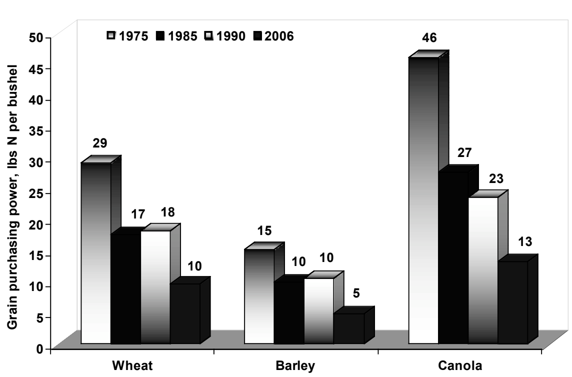


**Figure 3**. "Grain purchasing power" for nitrogen fertilizer.

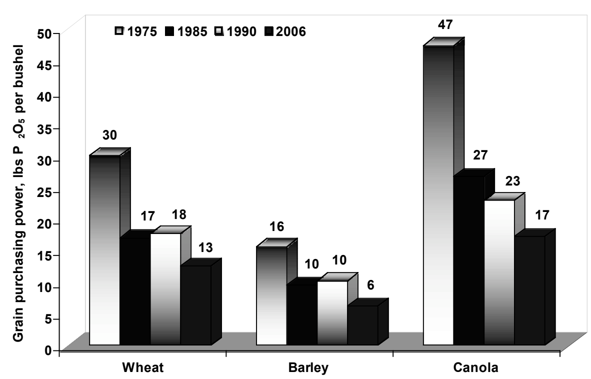


**Figure 4**. "Grain purchasing power" for phosphate fertilizer.

The experimental design consisted of five rates of "total" product (0, 60, 70, 80 and 90 lb/acre for barley grown on fallow soils and also the wheat experiments, and 0, 80, 90, 100 and 110 lb/acre for barley grown on stubble soils) that were applied in their entirety as N (except the

controls, of course) or with 5, 10, 15, 20, 25 and 30 lb $P_2O_5$/acre substituting the equivalent amount of N in the "total" products, thus resulting in 28 different combinations, each replicated six times. Two sets of prices were utilized, namely 26¢/lb and 42¢/lb for N and 27¢/lb and 32¢/lb, representing approximate corresponding fertilizer prices in 1990 and 2006. Three prices for barley ($1.50, $2.00 and $2.50 per bushel) and three for wheat ($3.00, $4.00 and $5.00) were used for the economic analysis, which consisted in calculating return less fertilizer expense as follows:
Yield increase (bu/acre) x price per bushel ($/bu) – Fertilizer rate (lb/acre) x Price per lb ($/lb)

***Barley on stubble fields***

Yield response of barley to various combinations of "total" product are shown in Table 2.

**Table 2**. Yield increase and economic return after fertilizer expense from growing barley on stubble at different combinations of N and $P_2O_5$ fertilizer rates.

| Nitrogen | Phosphate | Yield increase | Return less fertilizer expense, $ | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 26¢ /lb N and 27¢ /lb P2O5 | | | 42¢ /lb N and 32¢ /lb P2O5 | | |
| lb/acre | | bu/acre | $1.50 | $2.00 | $2.50 | $1.50 | $2.00 | $2.50 |
| 80 | 0 | 43.7 | 44.7 | 88.4 | 93.2 | 31.9 | 53.8 | 75.6 |
| 75 | 5 | 44.7 | 49.3 | 96.0 | 100.5 | 34.0 | 56.4 | 78.8 |
| 70 | 10 | 41.4 | 41.2 | 82.6 | 86.7 | 29.5 | 50.2 | 70.9 |
| 65 | 15 | 40.2 | 39.3 | 79.5 | 83.2 | 28.2 | 48.2 | 68.3 |
| 60 | 20 | 37.8 | 35.8 | 73.6 | 77.0 | 25.2 | 44.1 | 63.0 |
| 55 | 25 | 37.6 | 35.4 | 73.0 | 76.0 | 25.3 | 44.1 | 62.9 |
| 50 | 30 | 35.0 | 31.4 | 66.4 | 69.1 | 21.9 | 39.4 | 56.9 |
| | | | | | | | | |
| 90 | 0 | 44.1 | 44.9 | 92.2 | 102.5 | 28.3 | 50.4 | 72.4 |
| 85 | 5 | 45.4 | 43.8 | 90.4 | 95.2 | 30.9 | 53.6 | 76.3 |
| 80 | 10 | 43.1 | 43.4 | 89.7 | 89.1 | 27.9 | 49.5 | 71.1 |
| 75 | 15 | 42.3 | 43.8 | 90.4 | 86.5 | 27.1 | 48.2 | 69.4 |
| 70 | 20 | 43.4 | 42.2 | 87.8 | 88.8 | 29.2 | 50.9 | 72.6 |
| 65 | 25 | 40.6 | 38.3 | 81.3 | 81.4 | 25.5 | 45.8 | 66.1 |
| 60 | 30 | 37.6 | 37.6 | 80.2 | 73.7 | 21.6 | 40.4 | 59.3 |
| | | | | | | | | |
| 100 | 0 | 47.3 | 48.9 | 97.1 | 98.2 | 28.9 | 52.5 | 76.2 |
| 95 | 5 | 46.6 | 44.7 | 90.1 | 96.1 | 28.4 | 51.7 | 75.0 |
| 90 | 10 | 46.3 | 41.2 | 84.4 | 95.0 | 28.5 | 51.6 | 74.8 |
| 85 | 15 | 46.6 | 39.8 | 82.1 | 95.3 | 29.4 | 52.7 | 76.0 |
| 80 | 20 | 45.6 | 41.4 | 84.8 | 92.4 | 28.4 | 51.2 | 74.0 |
| 75 | 25 | 43.0 | 37.2 | 77.8 | 85.5 | 25.0 | 46.5 | 68.0 |
| 70 | 30 | 42.6 | 32.7 | 70.4 | 84.1 | 24.9 | 46.2 | 67.5 |
| | | | | | | | | |
| 110 | 0 | 49.9 | 46.2 | 96.1 | 102.7 | 28.6 | 53.5 | 78.5 |
| 105 | 5 | 49.1 | 45.0 | 94.2 | 100.4 | 28.0 | 52.5 | 77.1 |
| 100 | 10 | 52.0 | 49.3 | 101.2 | 107.1 | 32.8 | 58.8 | 84.7 |
| 95 | 15 | 52.5 | 50.0 | 102.4 | 108.0 | 34.0 | 60.3 | 86.5 |
| 90 | 20 | 53.1 | 50.9 | 104.0 | 109.2 | 35.5 | 62.1 | 88.6 |
| 85 | 25 | 49.3 | 45.0 | 94.3 | 99.2 | 30.2 | 54.8 | 79.5 |
| 80 | 30 | 45.6 | 39.5 | 85.2 | 89.7 | 25.2 | 48.0 | 70.9 |

A ranking of all these treatments is shown in Figure 5. Agronomically, the top treatments (90:20, 95:15 or 100:10) included a relatively high total rate with wide (4:1 to 5:1) N:$P_2O_5$ ratio. Economically, the top three agronomic treatments ranked in the same order in spite of the dramatic difference in N prices (26¢ vs. 42¢/lb of N) between the two years (Figure 6). However, this most likely should be interpreted as indicating that a relatively low rate of $P_2O_5$ (10-20 lb $P_2O_5$/acre) is required to obtain maximum yield rather than that there is a need for adherence to a certain N:$P_2O_5$ ratio.

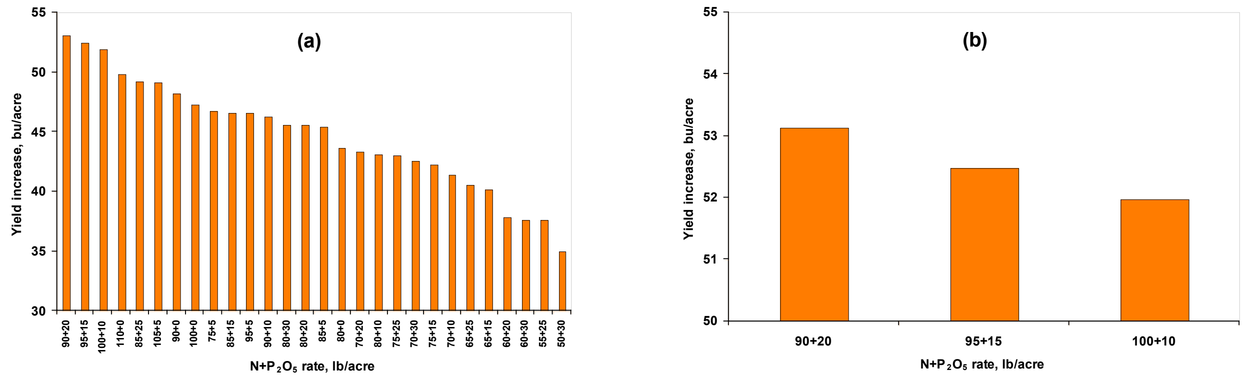


**Figure 5.** Ranking of all possible (a) and the top three (b) N+$P_2O_5$ combinations of barley grown on stubble.

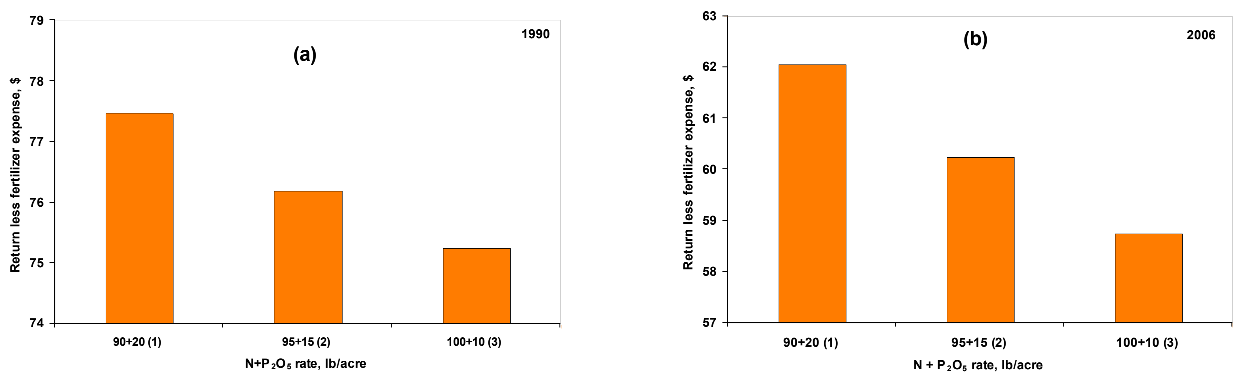


**Figure 6**. Top three ranking treatments for \$2/bu barley on stubble based on 1990 (a) and 2006 (b) N and $P_2O_5$ fertilizer prices.

***Barley on fallow fields***

Corresponding yield response of barley grown on fallow to various combinations of "total" product is shown in Table 3. The impact of narrowing the N:$P_2O_5$ ratio was more pronounced at the lower "total" fertilizer rates on barley grown on fallow soils compared to that grown stubble soils (Table 2). Maximum N rate in all combinations was between 60 and 70 lb /acre and ranking of the three top treatments suggested that $P_2O_5$ rates for fallow fields were higher than those for stubble fields; the top treatment (65:25) had a N:$P_2O_5$ ratio that was narrower than that for stubble fields (2.7:1) (Figure 7). Agronomically, the top treatments (65:25, 70:20 or 60:20) included a total rate that was approximately 30 lb/acre less with narrow (2.7:1 to 3.5:1) N:$P_2O_5$ ratio. Economically, the top three agronomic treatments ranked in the same order similarly to barley grown on stubble, however, $P_2O_5$ rates were approximately 10 lb/acre higher (Figure 8). The need of higher P fertilization of fallow crops is well established (Stewart 1989; Henry and Gares 1993; Schoenau 1996).

Thus, both agronomic and economic principles in essence remain unchanged in spite the wide difference in fertilizer, especially N fertilizer, price. However, the drop in return-less-fertilizer expense was noticeable in all cases, with a net loss of $18 to $20 per acre between 1990 and 2006 for $2/bu barley grown on stubble and $12 to $14 per acre for $2/bu barley grown on fallow, respectively, for the three top ranking treatments.

**Table 3**. Yield increase and economic return after fertilizer expense from growing barley on fallow at different combinations of N and $P_2O_5$ fertilizer rates.

| Nitrogen | Phosphate | Yield increase | Return less fertilizer expense, $ | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 26¢ /lb N and 27¢ /lb P2O5 | | | 42¢ /lb N and 32¢ /lb P2O5 | | |
| lb/acre | | bu/acre | $1.50 | $2.00 | $2.50 | $1.50 | $2.00 | $2.50 |
| 60 | 0 | 28.9 | 27.7 | 42.2 | 56.6 | 18.1 | 32.6 | 47.0 |
| 55 | 5 | 30.8 | 30.5 | 45.9 | 61.2 | 21.4 | 36.8 | 52.2 |
| 50 | 10 | 32.2 | 32.5 | 48.6 | 64.7 | 24.0 | 40.1 | 56.2 |
| 45 | 15 | 30.8 | 30.5 | 45.9 | 61.3 | 22.5 | 38.0 | 53.4 |
| 40 | 20 | 27.4 | 25.3 | 39.1 | 52.8 | 17.9 | 31.7 | 45.4 |
| 35 | 25 | 25.6 | 22.5 | 35.3 | 48.1 | 15.7 | 28.5 | 41.3 |
| 30 | 30 | 21.4 | 16.2 | 26.9 | 37.6 | 9.9 | 20.6 | 31.3 |
| 70 | 0 | 31.2 | 31.5 | 48.9 | 66.3 | 18.7 | 36.1 | 53.5 |
| 65 | 5 | 33.9 | 32.0 | 49.7 | 67.3 | 19.8 | 37.4 | 55.0 |
| 60 | 10 | 36.4 | 32.7 | 50.6 | 68.4 | 21.0 | 38.9 | 56.7 |
| 55 | 15 | 34.0 | 33.2 | 51.2 | 69.2 | 22.0 | 40.0 | 58.1 |
| 50 | 20 | 32.3 | 34.3 | 52.7 | 71.1 | 23.7 | 42.1 | 60.5 |
| 45 | 25 | 28.5 | 28.6 | 45.2 | 61.7 | 18.6 | 35.1 | 51.7 |
| 40 | 30 | 26.7 | 28.6 | 45.2 | 61.7 | 19.1 | 35.7 | 52.2 |
| 80 | 0 | 34.8 | 28.6 | 44.2 | 59.8 | 17.4 | 33.0 | 48.6 |
| 75 | 5 | 35.3 | 32.6 | 49.5 | 66.5 | 21.9 | 38.9 | 55.8 |
| 70 | 10 | 35.7 | 36.4 | 54.6 | 72.8 | 26.3 | 44.5 | 62.7 |
| 65 | 15 | 36.1 | 32.7 | 49.7 | 66.7 | 23.1 | 40.1 | 57.1 |
| 60 | 20 | 36.9 | 30.0 | 46.1 | 62.3 | 21.0 | 37.1 | 53.3 |
| 55 | 25 | 33.1 | 24.2 | 38.5 | 52.7 | 15.8 | 30.0 | 44.2 |
| 50 | 30 | 33.1 | 21.6 | 34.9 | 48.3 | 13.7 | 27.0 | 40.4 |
| 90 | 0 | 37.6 | 33.1 | 51.9 | 70.7 | 18.7 | 37.5 | 56.3 |
| 85 | 5 | 37.8 | 33.2 | 52.1 | 71.0 | 19.4 | 38.3 | 57.2 |
| 80 | 10 | 37.4 | 32.5 | 51.2 | 69.9 | 19.2 | 37.9 | 56.6 |
| 75 | 15 | 37.1 | 32.2 | 50.7 | 69.3 | 19.4 | 38.0 | 56.6 |
| 70 | 20 | 39.0 | 34.8 | 54.3 | 73.8 | 22.6 | 42.1 | 61.6 |
| 65 | 25 | 42.4 | 39.9 | 61.1 | 82.3 | 28.3 | 49.5 | 70.7 |
| 60 | 30 | 36.7 | 31.3 | 49.6 | 68.0 | 20.2 | 38.5 | 56.9 |

### *Wheat on fallow fields*

Results were similar for spring wheat with the same three treatments ranked at the top independently of the N and $P_2O_5$ price (Figure 9); however, $P_2O_5$ rates required for maximum wheat yield appeared to be slightly lower than those for barley.

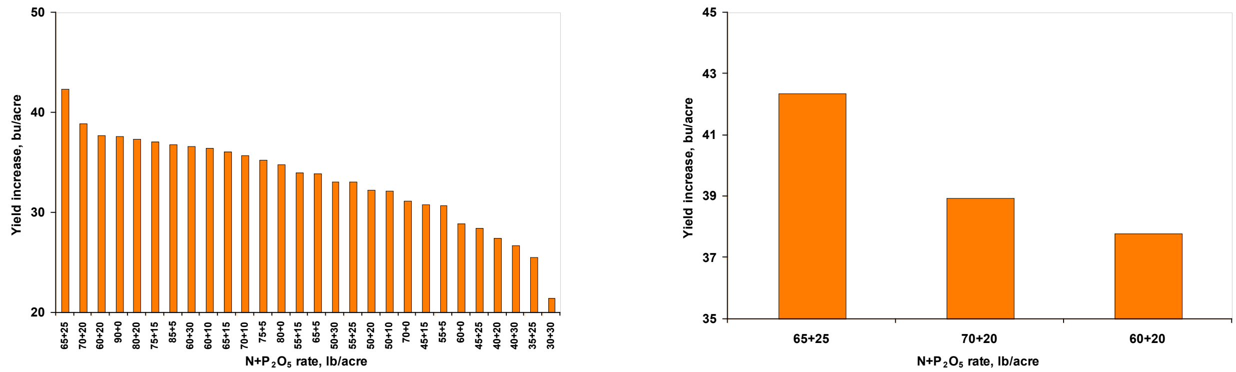


**Figure 7.** Ranking of all possible (a) and the top three (b) N+$P_2O_5$ combinations of barley grown on fallow.

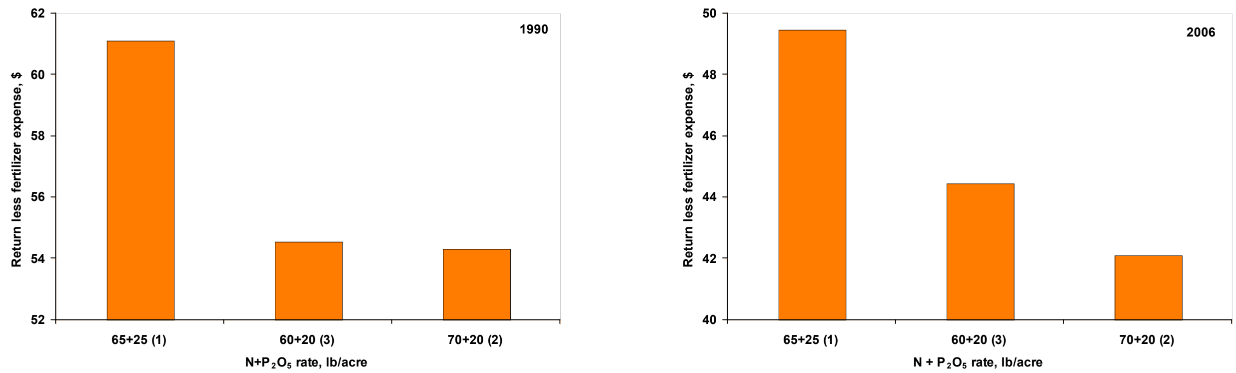


**Figure 8**. Top three ranking treatments for \$2/bu barley on fallow based on 1990 (a) and 2006 (b) N and $P_2O_5$ fertilizer prices.

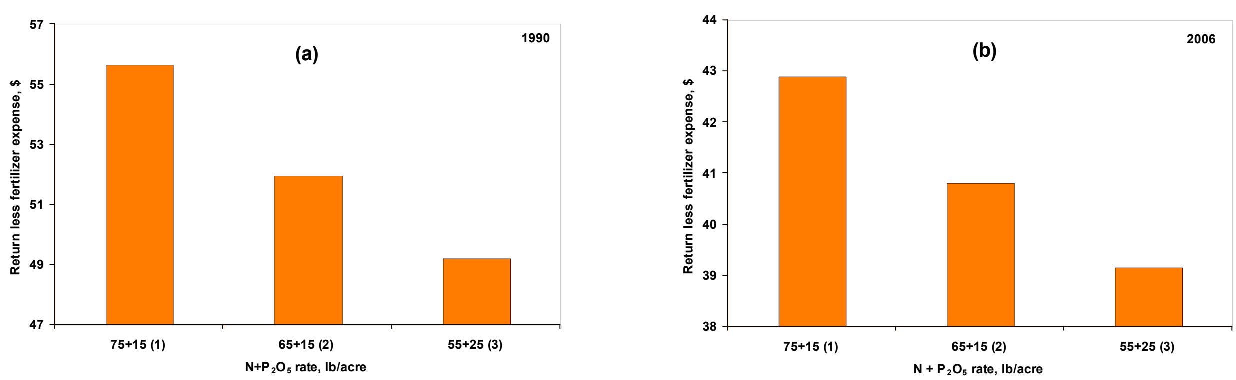


**Figure 9**. Top three ranking treatments for \$4/bu wheat based on 1990 and 2006 N and $P_2O_5$ fertilizer prices.

**<u>Case 2</u>: Fertilizer Economics of Nitrogen**

To avoid inclusion of obscure and largely abandoned varieties, only experiments that were carried out between 1989 and 1998 by Westco that involved at least four nitrogen fertilizer rates were utilized. The general characteristics of the population of experiments used are given in Table 4.

Interpretation of nitrogen soil testing criteria on the prairies is commonly based on various agro-ecological areas that are characterized by a diversity of both climatic and soil conditions. For example, Meyers and Karamanos (1997) described thirty Soil Climatic Zones covering the three Canadian Prairie Provinces. Compilation of site-years of nitrogen experiments based on soil test levels for each agro-ecological region, although desirable, was not possible due to the limited number of site-years for that purpose. Rather data were summarized based on the frequency of response and the magnitude of a yield increase (Tables 5 and 6). Generally, higher soil test levels and/or drier regions with lower organic matter levels would result in lower nitrogen fertilizer rates.

**Table 4.** General parameters on the nitrogen experiment database.

| Parameter | units | Barley | Canola | Wheat |
|---|---|---|---|---|
| Number of experiments | | 133 | 34 | 129 |
| Range of control yields | bu/acre | 17-131 | 6-60 | 8-74 |
| Mean control yield | bu/acre | 64 | 26 | 34 |
| Mean yield increase | bu/acre | 37 | 16 | 17 |
| Median yield increase | bu/acre | 36 | 15 | 16 |
| Mode of yield increase | bu/acre | 45 | 26 | 3 |
| Std deviation of yield increase | bu/acre | 19 | 8 | 11 |

**Table 5.** Probability of obtaining a yield increase through application of N.

| | Yield increase of (bu/acre) | | |
|---|---|---|---|
| Crop | >10 | >20 | >30 |
| Wheat | 70% | 40% | <10% |
| Barley | 90% | 80% | 60% |
| Canola | 70% | 25% | <10% |

**Table 6.** Yield increase (bu/acre) obtained by application of fertilizer N.

| | Optimum fertilizer N rate, lb/acre | | | | |
|---|---|---|---|---|---|
| Crop | <40 | 40-60 | 60-80 | 80-100 | >100 |
| Barley | 18 | 22 | 38 | 45 | 53 |
| Wheat | 7 | 15 | 19 | 25 | 32 |
| Canola | 9 | 12 | 15 | 18 | 23 |

A spreadsheet developed by Rankin (2005) to derive economic return from N fertilizer use for corn was modified by utilizing the barley and wheat data from the experiments included in Table 4 as well as the canola data from a recent three-year Westco project that compared hybrid to conventional canola (Karamanos et al. 2005). Yield responses are averages from 133 site-years of Westco N-rate studies for barley and 129-site for wheat years in the three Prairie Provinces (Table 3). Canola yield responses are based on 17 site-year average (Karamanos et al. 2005). Calculations are based on the premise that an "ideal" fertilization program results in 30 lb N/acre residual N in 0-24" depth. To derive economic return comparisons to N fertilization the recommended N rate from a soil test report or common practice has to be entered into the spreadsheet along with the soil test result for 0-24" depth. The spreadsheet calculates net return as follows:

Net Return = (wheat price x yield increase) - (N price x N rate),

and provides a Crop:N Price Ratio range, which in essence represents lb of N that can be purchased with one bushel of each crop ("grain buying power") used in the spreadsheet. The spreadsheet allows simultaneous comparison of two N sources for barley, wheat, conventional canola and hybrid canola and is available from the senior author (r.karamanos@westcoag.com). An example of the use of this spreadsheet in comparing maximum economic N rates based on 26¢ and 42¢ /lb N is shown in Figures 10 and 11. Figure 10 represent the data entry screen; in this example, a 0-24" soil test of 40 lb/acre was utilized to derive recommendations for 40 bu of 13.5% protein wheat in the Black Soil Climatic Zone based on the system utilized by Envirotest Laboratories.

A first observation in Figure 11 is that the data is based on the yield average responses of 129 site-years at the recommended rate of 88 lb N/acre does not provide maximum economic return independently of the price of N fertilizer. A second observation is that a price of $4.00 per bu the "wheat purchasing power" would be 15 lb N with 26¢ /lb N, and 10 lb N with 42¢ /lb N. A third observation is that in spite of a 60% increase in fertilizer price (i.e., from 26¢ to 42¢ /lb N), the reduction in the maximum economic return rate was only 20 lb N/acre or approximately 15%. Finally, not overseeing the obvious, the recommended N rate (88 lb N/acre) would have returned $17.75/acre more in 1990 compared to 2006 given the exactly same parameters. Hence, increases in fertilizer N price do not warrant dramatic reduction (e.g. equivalent to N fertilizer price increase) in fertilizer rates used and may result in an economic disadvantage.

| N Source #1 | |
|---|---|
| Fertilizer Type | UREA |
| Cost/tonne | $425.00 |
| %N | 46 |
| Cost/Unit of N | $0.420 |
| Fertilizer N incremement | 10 |
| Commodity price increment, $ | $0.1 |
| Soil test N (0-24") lb N/acre | 40 |

| N Source #2 | |
|---|---|
| Fertilizer Type | UREA |
| Cost/tonne | $275.00 |
| %N | 46 |
| Cost/Unit of N | $0.272 |
| Fertilizer N incremement | 10 |
| Commodity price increment, $ | $0.1 |
| Soil test N (0-24") lb N/acre | 40 |

| Crop and Soil data | |
|---|---|
| **Current N Rate (lb N/acre):** | |
| CWRS Wheat | 88 |
| Barley | 90 |
| Canola | 90 |
| Canola (hybrid) | 90 |
| **Expected prices ($/bushel):** | |
| CWRS Wheat | $4.00 |
| Barley | $2.00 |
| Canola | $5.50 |
| Canola (hybrid) | $5.50 |

**Figure 10**. Data entry of crop and fertilizer prices in the N calculator spreadsheet.

**Nitrogen Source and $ Rate of Return Calculator**

**Western Canada (All Zones)**

**N Source #1**

| | |
|---|---|
| Fertilizer Type | **UREA** |
| Cost/ton | $425.00 |
| %N | 46 |
| Cost/Unit of N | **$0.420** |
| Fertilizer N increment | **10** |
| Commodity price increment, $ | **$0.1** |
| Soil test N (0-24") lb N/acre | **40** |

| | | **Expected CWRS Wheat Price** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **$3.70** | **$3.80** | **$3.90** | **$4.00** | **$4.10** | **$4.20** | **$4.30** |
| | **Yield Increase from 0 lb. N** * | **Net Return ($/ac.)** ** | | | | | | |
| **N Rate** | | **CWRS Wheat:N Price Ratio** | | | | | | |
| (lb./acre) | (bu./ac.) | **8.8** | **9.0** | **9.3** | **9.5** | **9.8** | **10.0** | **10.2** |
| **48** | 15.6 | **$37.73** | **$39.29** | **$40.86** | **$42.42** | **$43.99** | **$45.55** | **$47.12** |
| **58** | 18.5 | **$44.06** | **$45.91** | **$47.76** | **$49.61** | **$51.46** | **$53.31** | **$55.15** |
| **68** | 21.0 | **$49.28** | **$51.38** | **$53.49** | **$55.59** | **$57.70** | **$59.80** | **$61.90** |
| **78** | 23.3 | **$53.39** | **$55.72** | **$58.05** | **$60.38** | **$62.70** | **$65.03** | **$67.36** |
| Current N Rate **88** | 25.2 | **$56.39** | **$58.91** | **$61.44** | **$63.96** | **$66.48** | **$69.01** | **$71.53** |
| **98** | 26.9 | **$58.28** | **$60.97** | **$63.66** | **$66.35** | **$69.03** | **$71.72** | **$74.41** |
| **108** | 28.2 | **$59.06** | **$61.89** | **$64.71** | **$67.53** | **$70.35** | **$73.17** | **$76.00** |
| **118** | 29.3 | **$58.73** | **$61.66** | **$64.59** | **$67.51** | **$70.44** | **$73.37** | **$76.29** |
| **128** | 30.0 | **$57.29** | **$60.30** | **$63.30** | **$66.30** | **$69.30** | **$72.30** | **$75.30** |

*Yield responses are averages from 129-site years of Westco N-rate studies for wheat in the three prairie provinces
Calculations are based on the premise that an "ideal" fertilization program results in 30 lb N/acre residual N in 0-24" depth
Current N rate from your soil test report or common practice
**Net Return = (wheat price x yield increase) - (N price x N rate)
Net return in blue represents maximum for the CWRS Wheat:N Price Ratio range in this table and in Orange
within $1.00 of maximum

**N Source #2**

| | |
|---|---|
| Fertilizer Type | **UREA** |
| Cost/ton | $275.00 |
| %N | 46 |
| Cost/Unit of N | **$0.272** |
| Fertilizer N increment | **10** |
| Commodity price increment, $ | **$0.1** |
| Soil test N (0-24") lb N/acre | **40** |

| | | **Expected CWRS Wheat Price** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **$3.70** | **$3.80** | **$3.90** | **$4.00** | **$4.10** | **$4.20** | **$4.30** |
| | **Yield Increase from 0 lb. N** * | **Net Return ($/ac.)** ** | | | | | | |
| **N Rate** | | **CWRS Wheat:N Price Ratio** | | | | | | |
| (lb./acre) | (bu./ac.) | **13.6** | **14.0** | **14.4** | **14.7** | **15.1** | **15.5** | **15.8** |
| **48** | 15.6 | **$44.84** | **$46.41** | **$47.97** | **$49.54** | **$51.10** | **$52.67** | **$54.23** |
| **58** | 18.5 | **$52.66** | **$54.51** | **$56.36** | **$58.20** | **$60.05** | **$61.90** | **$63.75** |
| **68** | 21.0 | **$59.36** | **$61.46** | **$63.57** | **$65.67** | **$67.77** | **$69.88** | **$71.98** |
| **78** | 23.3 | **$64.95** | **$67.28** | **$69.61** | **$71.94** | **$74.27** | **$76.59** | **$78.92** |
| Current N Rate **88** | 25.2 | **$69.44** | **$71.96** | **$74.48** | **$77.00** | **$79.53** | **$82.05** | **$84.57** |
| **98** | 26.9 | **$72.81** | **$75.50** | **$78.18** | **$80.87** | **$83.56** | **$86.25** | **$88.93** |
| **108** | 28.2 | **$75.07** | **$77.89** | **$80.72** | **$83.54** | **$86.36** | **$89.18** | **$92.00** |
| **118** | 29.3 | **$76.22** | **$79.15** | **$82.08** | **$85.00** | **$87.93** | **$90.86** | **$93.78** |
| **128** | 30.0 | **$76.27** | **$79.27** | **$82.27** | **$85.27** | **$88.27** | **$91.27** | **$94.27** |

*Yield responses are averages from 129-site years of Westco N-rate studies for wheat in the three prairie provinces
Calculations are based on the premise that an "ideal" fertilization program results in 30 lb N/acre residual N in 0-24" depth
Current N rate from your soil test report or common practice
**Net Return = (wheat price x yield increase) - (N price x N rate)
Net return in blue represents maximum for the CWRS Wheat:N Price Ratio range in this table and in Orange
within $1.00 of maximum

Developed by Rigas Karamanos, Western Cooperative Fertilizers Limited, Calgary, AB.

**Figure 11**. Output from the N calculator using the input data from Figure 8 and average yield increases from 129 site-years of wheat responses to N in the Prairie Provinces.

## Case 3: Fertilizer Economics of "Complete" or "Balanced" Programs

Balanced nutrition is a concept that is often being misused, as it is taken to mean that a "balanced" proportion of nutrients should be applied to crops rather than that the nutrition of crops should be balanced. The latter does not necessarily involve application of all fertilizer nutrients, since soil supplies are often more than adequate in supplying a number of nutrients to crops. Hence, a number of fertilization programs have been developed based on the concept of "balanced" nutrition that involve application of all nutrients, independently of whether they are deficient in the soil or not.

We analyzed the data from thirteen experiments carried out between 1989 and 1998 to assess the agronomic and economic impact of stepwise nutrient addition to barley. They experiments were seeded with two bushels of either Virden or Stetson barley and involved four N fertilizer rates (control, 72, 144 and 216 lb N/acre). Phosphorus as 0-45-0 and potassium as 0-0-60 were each seed-placed at 27 lb $P_2O_5$ or $K_2O$/acre each. Sulphur as 20-0-0-24 was band applied at 21 lb S/acre. Micronutrients were applied as chelated Cu and Zn at 2 lb/acre of actual nutrient. The experiments received a blanket application of "Tilt" fungicide.

We averaged the 72 lb N/acre N treatment to carry out economic analysis, since maximum yield in 10 of the 13 experiments was obtained with that rate. The average "yield increase" and the "return-less-fertilizer expense" along with the fertilizer cost per nutrient are shown in Figure 12. The Return ($) to Fertilizer Cost ($) ratio for N and P applied on an individual basis were 2.2:1 and 2.6:1, respectively and 2.3:1 when the two nutrients were applied together (Figure 13). However, inclusion of all nutrients resulted in only 1.8:1 ratio.

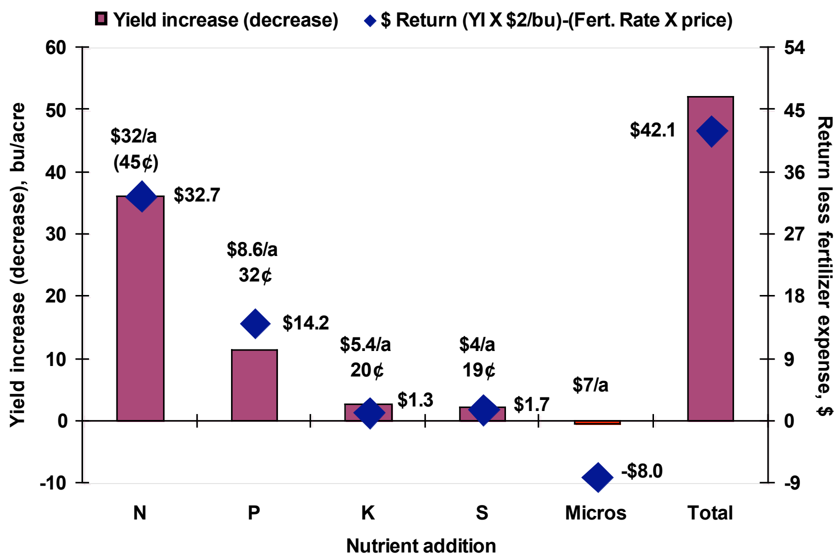


**Figure 12.** Contribution of individual fertilizer nutrients to the yield of barley and economic return of their stepwise addition.

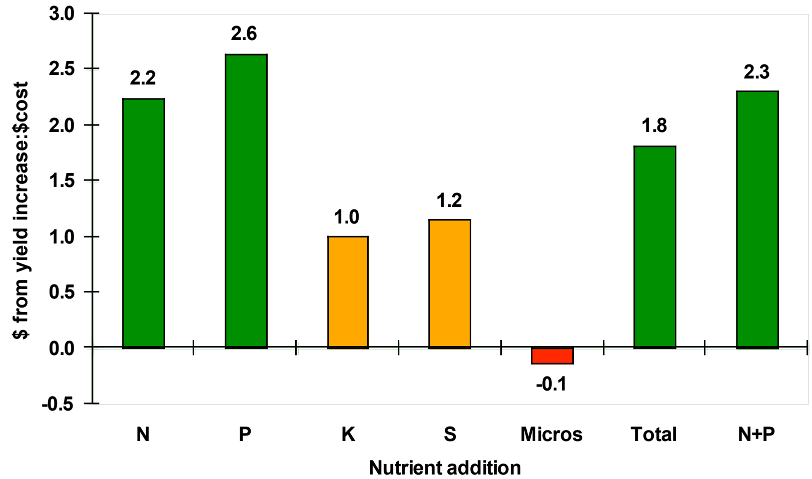


**Figure 13.** Return:fertilizer cost ratios for individual fertilizer nutrients as well as those for all nutrients and N and P addition only.

## Conclusions

Record energy prices have resulted in higher fertilizer production costs, which in return are having a negative impact on nutrient use by growers. Growers are forced to "sharpen their pencils" when deriving proper fertilization plans for their crops. In doing so, growers should:

1. Select only fertilizer products that result in maximum economic return.

2. Adhere to the same fundamental principles that guided crop fertilization when energy prices were lower and avoid the "search-for-the-silver-lining" mentality. Simply, there is none!

3. Use available tools to assess the necessary adjustments to fertilization rates, so that maximum economic returns are achieved.

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