

Kastens Inc., Harrod, Kansas  
30' DPT 2000 Fertilizer Rig

## Variable Rate Application From a Farmers Perspective

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Terry L. Kastens, K-State Ag. Economist  
Dietrich L. Kastens, Farmer/geographer

tkastens@agecon.ksu.edu – 785-532-5866  
dietrich@kastensinc.com – 785-626-4600

## Introduction

- > Located in Rawlins Co. Kansas
- > Silt loam soils, water retention contour terraces
- > WCF rotation
- > 100% no-till starting with 2003 growing season

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## FOR SALE

- 42' Quinstar FallowMaster
- 1991 876 Versatile (4000 hrs)
- 32' HD 4-section Sunflower disk
- 40' 9300 JD drills, 10x12 with transports
- 1975 JD 4630, quad shift, clean tractor

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## Introduction

- > This talk will look at the research and development required to build a no-till fertilizer applicator capable of two-product VRA
- > Many challenges were overcome and the final result was a low-maintenance, two-liquid variable rate, no-till fertilizer rig running straight coulters on 15" centers and direct injection for sub-surface fertilizer delivery
- > Research was begun in 1998, machine running in 2002

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## One Major Assumption

To prevent getting side-tracked lets make this assumption:

- > "Kastens Inc. Farms have developed an agronomically and economically sound system for determining site-specific fertilizer needs"

Specifically, we have identified the building of STP as having the greatest long-run economical potential for our farm

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## System Requirements

- Farm Management Systems
  - Conventional summer fallow
    - August application
    - Typically 20 gpa
  - Chemical summer fallow
  - Wheat and corn stubble
    - Wanted to reduce amount of N placed at planting
    - Typically around 30 gpa
  - Alfalfa
  - Growing wheat
    - Provide minimum disturbance top-dressing in the spring

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### System Requirements

- Fertilizer Machine
  - Fast ground speeds (7 – 10 mph)
  - Large coverage (40' minimum, 250 ac/day minimum)
  - High storage capacity (minimize fill-times)
  - Easy transportation (narrow transport)
  - Low annual maintenance (minimize bearings, other high wear components)
  - Efficient Tendering (fertilizing should be no more than a two person job and we wanted to utilize as much of the existing equipment as we could)

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### System Requirements

- Fertilizer Components
  - Capable of VRA application and rates from 0 – 30 gpa (equivalent)
  - Capable of end-row shutoff
  - As-applied mapping
  - Good technical support

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### System Requirements

- Electronics (Precision Ag equipment)
  - Guidance System
  - User friendly, flexible rate controllers
  - Console able to VRA two products simultaneously and record as-applied maps

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### The Research Process

- Dry Fertilizer, NH3 and liquid
  - Dry
    - Approx. 30% cost adv. over liquid P
    - Requires lots of extra equipment
  - NH3
    - Approx. 30% cost adv. over liquid N
    - Higher safety hazard
    - Logistics problems
    - Delivery and application problems
  - Liquid
    - Best logistics (have semi, trailer, tanks, etc.)
    - Simple to handle, store and transport
    - Optimal for delivery and application

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### The Research Process

- Toolbars and Openers
  - “Ideal” Machine:
    - 54' undercutter frame for size and flexibility running FSO openers to take advantage of deep banding. A VRA system delivering Dry P and NH3 to take advantage of cost differences in fertilizer types
  - Ideals don't match reality
    - The 9x6 FK XL needed lots of modifications, would be cumbersome for transportation (18' width) and had almost zero resale if it didn't work

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### For Sale! FK XL 9x6 Sweep, Good Deal!



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## The Research Process

- Toolbars and Openers
  - Quinstar Ultra-jector (40')
    - Low production (new machine with bugs)
    - Higher cost and less flexible than 9x6
    - Too many unknowns
  - The FSO opener
    - Good seeding opener
    - Capable of dry, liquid or NH3 placement
    - Relatively high cost

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## Quinstar Ultra-Jector



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## Flexicoil FSO opener



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## The Research Process

- Toolbars and Openers
  - DMI 2800 – 16 Nutra-Placer (40')
    - Low cost
    - Straight single coulter, very simple
    - Direct injection (better than broadcast)
    - Adequate toolbar flexibility
    - Maintains constant hydraulic down-pressure
    - High resale value in our area

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## DMI 2800-16 Nutra-Placer



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## The Research Process

- Toolbars and Openers
  - Other machines and openers were evaluated but these most closely matched our needs

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## The Research Process

- Toolbars and Openers
  - Our Machine Decision
    - The 9x6 was a behemoth and required a lot of work
    - However we eliminated the undercutter/FSO option (and consequently dry fert) after we tested and FSO opener in different conditions
    - The FSO opener disturbed far too much growing wheat in a simulated top-dressing operation

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## The Research Process

- Toolbars and Openers
  - Our Machine Decision
    - The DMI 2800-16 was chosen
      - The cost advantages to dry P and NH3 were foregone for the improvements in tending efficiency
      - The DMI worked well in all field management systems
      - Transportation was easy with a 14' width
      - “fill time” was minimized because of the 1300 gallons onboard and the 1000 pulled behind
      - If the machine didn't work, it could be resold easily

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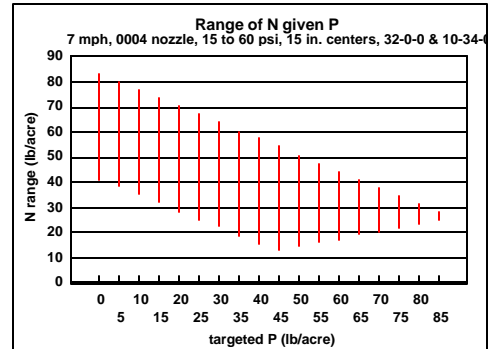
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## The Research Process

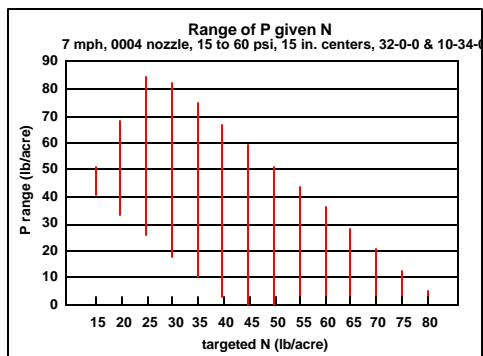
### • Fertilizer hardware

- Lots of thinking with this step
  - Since a 2-fold increase in volume requires a 4-fold increase in pressure, difficulty was had in identifying components that could operate efficiently over a wide range of pressures and provide the needed variability in application rates
- Blending liquids before the nozzles
  - High variability in 1 product if other is held fairly constant

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## The Research Process

### • Fertilizer Hardware

- We worked directly with Brothers Equipment in Friend, Nebraska. Brothers was to set up our machine with two independent fertilizer delivery systems
- Basic items such as valves, fittings, flow meters, etc. were fairly straight forward

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## The Research Process

### • Fertilizer Hardware

- Pumps
  - Initially considered hydraulic centrifugal pumps and butterfly valves
  - Final system used Hypro hydraulic centrifugal pumps whose speed could be changed using a Pulse Width Modulating (PWM) value
  - A simple in-line ball-valve shutoff was plumbed in and used with an implement switch for end-row shutoff

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Hydro Pump



PWM Valve



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## The Research Process

### • Controllers, Consoles and Software

- Controllers
  - Went with Raven 440 controller because of cost, reputation, serial communications and user friendliness



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## The Research Process

### • Controllers, Consoles and Software

- Consoles
  - Looked at commercial multi-rate consoles (Falcon, Raven AMS198)
    - High cost
    - Proprietary input files
    - Couldn't get a handle on all of the costs
  - Opted to use two handheld Ipaq 3630's, each would connect to a separate Raven 440

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## The Research Process

### • Controllers, Consoles and Software

- Software
  - Went with Farmworks SiteMateVRA
    - Single product VRA
    - Good reputation and excellent service
    - Low cost
    - Uses ESRI shapefile standard format for input VRA maps

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## The Research Process

- Lightbar and GPS
  - JD Starfire II receiver provides input to the lightbar and to each of the Ipaq's
  - A Raven LB5 (formally Starlink LB5) is used for navigation
  - When available on 8000 wheel tractors, we will purchase an Auto-trac system

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## Operation

- Troubles
  - Hardware
    - Could only get one side going, hydraulic plumbing problem (series vs. parallel)
    - 3 days and two service trips from Brothers
  - Software
    - A software update was obtained to overcome some communication problems between SiteMateVRA and the 440 controllers

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## Operation

- Testing
  - We have operated this machine for
    - Top-dressing wheat
    - Fertilizing alfalfa
    - Fertilizing conventional summer fallow ground
  - The machine has worked very well so far, with only minor headaches that come along with learning the limitations and problem spots of a new piece of machinery

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## Changes in Technology

- New Stuff
  - This past summer many aftermarket systems were began offering multi-product VRA capabilities using ESRI shapefile format input files. (I.e., Zynx and Raven Viper)
  - Less wiring, less potential problems, less setup time, less training time, higher cost

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## Conclusions

- We are very satisfied with our system in that it:
  1. Delivers accurate rates of fertilizer
  2. Can variably apply two liquids in real-time
  3. Can perform across all of the different field management conditions found on our farm
  4. Minimizes “fill-time” through the use of 2300 gallons of product storage
  5. Minimizes “down-time” through the limitation of moving parts and the use of quality components

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## Conclusions

6. Minimizes tendering costs
  7. Can be transported with ease, even into tight locations
- My only complaint is trying to run this thing at 9mph using just the lightbar. Although, I have not measured it, I feel that my overlap/underlap error is probably around 4%.