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Session 6: Conservation Agriculture: Producers as Innovators

ORAL ABSTRACTS

“Doubling the Worlds’ Food Production, How New Technology Will help”

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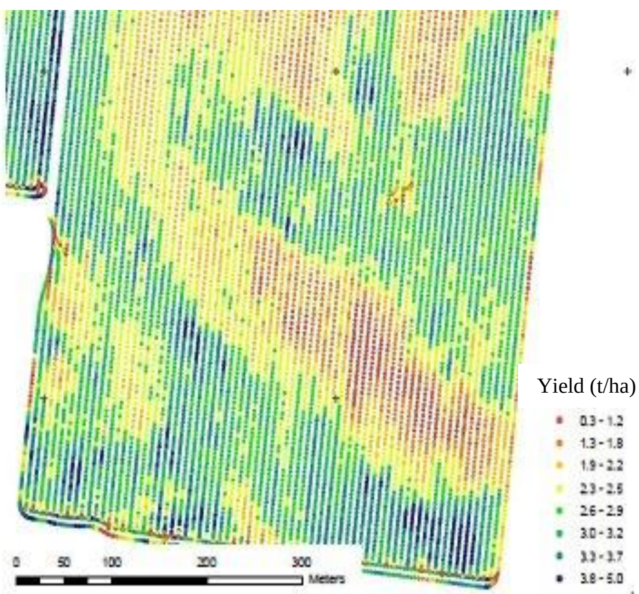
As the talk around feeding an ever increasing population grows by the day, the inevitable question is where is the food going to come from? Many proposals have been discussed, with a number focusing on cultivating new areas of land; about 1.3 Billion Hectares according to McMahon, 2013. However after researching Precision Agriculture and its application for over 15 years, it is becoming increasingly clear that the one answer lies literally right under our noses.

Spatial variability, even in our best soils of Australia (and internationally) and under the best Conservation Agriculture management techniques, is extremely high. It is common to see grain yield three to five times higher in some parts of fields than other parts, and sometimes tenfold (Figure below). This yield map is from a farm with Controlled Traffic Farming (CTF) and has been in no-till for over 10 years, and you can clearly see the considerable yield variation.



Satellite imagery, topographical mapping, soil mapping, and yield mapping are used in Australia to determine the impact of these lower production areas, and also give clues to the causes of these impacts due to the pattern of the effect. The biggest problem comes with agricultures’ generally poor skills in measuring differences, and turning that data into practice change using intelligent solutions. Even in our highly developed conservation agricultural systems of Australia, getting longer-term, good quality data about production differences is challenging. With the advent of Precision Agriculture (PA) technology this is becoming easier to do; with most new machines arriving from the factory fully equipped with the technology.

Causes of yield variation often fall into one (or more) of five main categories:

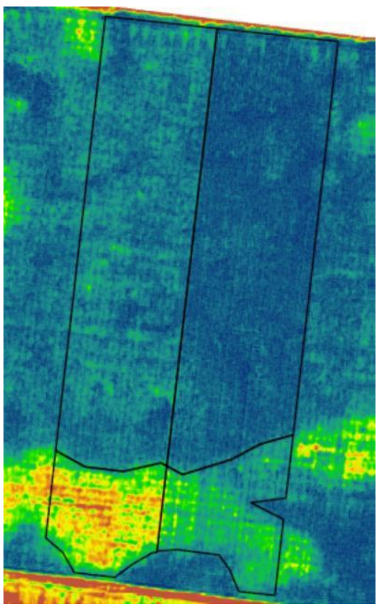
1. soil type differences;
2. water drainage problems/soil erosion;
3. nutrient availability/soil acidification;
4. pests/diseases; and/or
5. man-made factors such as machinery faults, soil compaction, and poor irrigation uniformity.

Many of these can be remediated or managed cost effectively, and often the results can be attained relatively quickly. This is the opportunity where PA technology can help to increase food production. The three case studies below show real life examples how PA can increase production and profitability.

Case study 1: waterlogging remediation

The farm was mapped with high accuracy GPS (Global Positioning Systems) and the data overlaid onto satellite imagery biomass maps during the peak crop growth period. In some fields, waterlogging covered 36% of the field in wet seasons. After reviewing all the data, a drainage plan was implemented using run direction changes and addition of some sub-surface drains. As a result of the drainage work and increase in gross margin was calculated to be $94,480 in 2010 to 2011 (-$52,000 loss to +$42,480 gain) from a $4,000 investment. The photo shows water draining freely from paddocks reducing waterlogging losses.

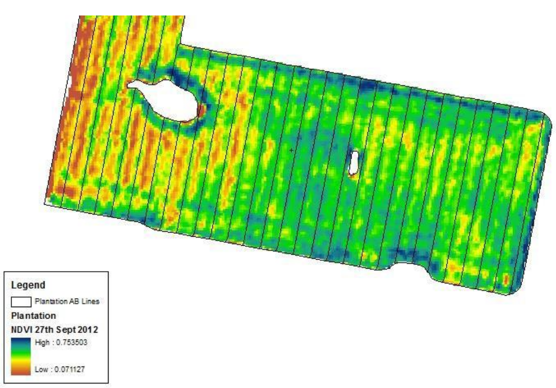
Case study 2: adding organic amendments to acidic sandy soils



This farm had been using lime for acidic/high Aluminum soils for many years, with limited success; and had essentially concluded that the poorer soils were never going to grow high yielding crops. A trial of chicken manure was trialed and the results were starling. The figure (left) shows the trial strips with the manure strip closest. The areas in the bottom part of the field area the poorer soils. From the table below (taken directly from the yield monitor), you can see that the manures allowed the poor soils to match the yield of the good soils. Variable rate manure is now being targeted across all the poorer soil areas.

Soil	Manure	No manure
Good	2.88t/ha	2.54t/ha
Poor	2.89t/ha	2.29t/ha

Case study 3: poor fertilizer spreading



It wasn't until the farmer obtained some high resolution satellite (left) that he realized he had a significant striping problem in the crop (seen here by the red and yellow stripes in between where the spreader ran (black lines). After investigation it was determined that it was caused by poor fertilizer spreading. Hand cuts were taken of yield, which showed a 30% reduction (from 6t/ha down to 4t/ha) in yield where spreading was poorest, which affected about 1/3 of the field costing around $200/ha. Spreader calibration has since corrected the issue.

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The Lessons Learned in the Introduction of Zero Tillage in Dry Conditions of Karakalpakstan Republic

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Background

The main problems of agriculture in Karakalpakstan are soil salinity, drought and lack of organic matter in the soil. All these problems lead to a decrease in productivity, increase in the cost of agricultural production and unprofitable. Farmers in the pursuit of productivity resorted to excessive watering and chemicals, that does not eliminate the causes of the problems, but only aggravates them. In our view, the Conservation Agriculture can address the causes of these problems.

Applications and Implications for Conservation Agriculture

Practical results indicate the possibility of transition to zero tillage . It allows farmers to reduce the cost of production , reduce the risk of non- crop by conserving soil moisture especially in dry years , significantly save water resources of the country , and steadily restore soil fertility .

But , not all cultures are suitable for zero tillage on first time . Our studies have shown that crops such as indigo , fodder beet and some other vegetables and melons can not sow to zero tillage . Particularly well suited for zero tillage crops such as wheat, triticale , maize, sorghum , sunflower, soybean , corn , sesame, and others - well they grow and develop at zero treatment even in the early years of its application.

Further work is needed on the transition of farmers for this technology . But for this we must show all the benefits of technology in the best conditions . Need to demonstrate zero processing on the same field unchallenged for at least five years, that is until soil fertility is restored by natural processes .

Demonstrate the effectiveness of the technology in a stressful environment - in dry years . It is without doubt enhance public confidence in the zero tillage;

Strengthen the technique of farmers and decision-makers - ministries and departments , to improve with the implementation of the method. Also need to continue to work to improve the skills of employees of the agricultural sector , to conduct the training of young scientists in this procedure to review the experiences of other countries in this practice , etc.;

Furthermore, together with the spread of the technology necessary to develop supply zero seeders or establish their local production .

Experimental Approach.

Work carried out in varying degrees of saline lands Republic of Karakalpakstan. Surveys and observations, as well economic assessment carried out by the method of experimental work in field (Nikitenko, Ermakov, Bezuglova, Maslova, Mozgovoy, Saranin, Monakhov, 1982).

The views and opinions of farmers about zero tillage technology studied in the field work, seminars, field days and dialogues with them.

Results and Discussion

An important role plays purely psychological attitude towards the issue of cultivation. After all, not everyone afford to abandon the familiar, used for thousands of years plowing method . Farmers do not just give up the idea that plowing and other tillage may not be the most effective and even detrimental to the soil - so the land is tilled for many centuries. On the shortcomings of mechanical action we discussed a lot. But the facts point to a strengthening of soil degradation , and this suggests that disrupted natural processes. In such cases, the only salvation - is to try to reproduce the laws of nature and natural processes. Zero tillage is primarily based on these natural processes.

There is a risk of yield reduction by 5-10 t / ha during the transition from conventional to zero tillage in the first years of application of technology . This is understandable, because the soil with no-till field has not yet reached the " good " of the soil naturally. As studies scholars and practitioners in many countries , good soil conditions at zero treatment is achieved only after five years of permanent applications. Yield reduction in the first years offset by higher profitability of technology.

At zero field treatment does not always look neat that scares everyone who is not informed of the existence of zero tillage.

In order to successfully implement any method or technology necessary to show the best method or technology for example. Farmers until they see with their own eyes all the benefits of technology, will not risk its use. We had all the time to cultivate the culture during later periods due to the absence of the tractor. Despite these obstacles, we have obtained sufficient experience of cultivation on this technology.

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Evaluating Farmer Adoption of a Set of Precision Nutrient Management Methods

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Background:
The Eastern Panhandle of West Virginia is an area with a large percentage of its highly productive and usable agricultural lands underlain with a limestone or Karsts geology. This geology is well known for underground streams that are fed by sinkholes and fissures that rise to the surface and create open vectors for nutrients and sediments to directly impact groundwater quality. Surface water is vulnerable to surface water runoff which can carry nutrients and sediment, but in this geology it is influenced also by the many springs that are fed by groundwater. The three county region is a part of the Chesapeake Bay Watershed. Through the use of technology and proven conservation practices this vulnerability can be greatly reduced through the measured application, placement and sequestration of free nutrients.

The objective of this USDA NRCS Conservation Innovation Grant project was to demonstrate how a comprehensive program to manage nutrients through financial incentives can impact the proper rate and placement of nutrients on row crop and forage lands. Eleven farmers participated for a 3 year period. Nine practices were offered to the cooperating farmers, including the precision agriculture methods of yield monitoring, grid soil sampling and variable rate application of nutrients. The nitrogen management tools offered to farmers included, split application of nitrogen, pre-sidedress nitrogen test (PSNT), late season corn nitrate test and cover crops to scavenge residual nitrogen from crop fields.

Precision and Nitrogen Management Practices

1) **Yield Monitoring**; to quantify variability of nutrient uptake within a field, to generate GIS based yield maps to improve nutrient allocation within a field.
2) **Manure Relocation**; to improve nutrient distribution, to provide a transportation subsidy to allow dairy liquid manure to travel greater distances
3) **Split Application of Nitrogen**; to reduce early season loss of nitrogen, to improving plant utilization of applied N and have the productivity potential of the crop attained.
4) **Late Season Corn Stalk N Test**; to determine nitrogen levels in the mature crop, evaluate the availability of the at planting applied manure nitrogen, too much, just right or too little.
5) **Cover Crop Planting**; scavenge residual nitrogen within the soil system after crop harvest.
6) **Precision or Grid Soil Sampling**; to determine variability within a field, to generate GIS based field maps demonstrating low or high fertility zones.
7) **Variable Rate P, and K**; the utilization of grid soil sampling generated fertility maps, second step of a precision nutrient management program.
8) **Pre Sidedress Nitrogen Test, PSNT**; utilized with split application of nitrogen, quantifies soil nitrogen levels and allows developing crops to meet their full productivity potential.
9) **Variable Rate Lime**; same concept as #7

Results:

Practice	Grant Acres Allocated	Acres Completed	% of allocated Acres	Producers	% Part.
Yield Monitor	4575 acres	5256 acres	115%	9	82%
Manure Relocation	4000 miles	4164 miles	104%	2	18%
Split Application of Nitrogen	2500 acres	1199 acres	48%	6	55%
Late Season Corn Stalk N Test	60 fields	27 fields	45%	5	45%
Cover Crop Planting	2500 acres	1071 acres	43%	5	45%
Precision or Grid Soil Sampling	2500 acres	794 acres	32%	5	45%
Variable Rate P & K	2500 acres	338 Acres	21%	4	36%
Pre Sidedress Nitrogen Test PSNT	60 fields	11 fields	18%	3	27%
Variable Rate Lime Application	2500	338 acres	14%	2	18%

Conclusions:
Yield Monitoring; highest adoption rate, one cooperator purchased technology and harvested for other farmers, limited by map generation capabilities.
Manure Relocation; 4,164 miles were driven moving 4.6 million gallons of liquid manure off the farmstead. Practice adopted by two dairy farms.
Split Application of Nitrogen with #8 PSNT; A reduction of 28,097 lbs of N resulted from these combined practices. This saved producers over $14,000 in nitrogen costs.
Late Season Corn Stalk N Test with #5 Cover Crop; Both practices were underutilized by the cooperators. An alternative State funded cover crop program that provided higher payments replaced this practice.
Precision or Grid Soil Sampling; Cooperators were interested but limited commercial vendors to carry out this practice inhibited use.
Variable Rate P, K and Lime; Only one commercial vendor (not local) provided this service to a limited number of acres. Cooperators had interest but technology and service providers lagged.

Overall adoption by cooperating farmers was well under the potential for the farming area. A chicken and egg issue, commercial ag. supply vendors need to invest in the variable rate application equipment, offer grid soil sampling services, map generation of yield monitors, variable soil fertility and then farmers will also add Precision Ag equipment to their farm operations. Nitrogen management tools need service providers to collect soil and or tissue samples, analyze and then make a recommendation in a timely manner.

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Innovative Approach to Address Challenges and Opportunities to Conservation Agriculture Adoption in Brazilian Agricultural Frontier

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Background

Brazilian agriculture is facing another expansion cycle to the Cerrado region, more specific in the Northeast. The first agriculture expansion cycle to the Midwest was in seventies encouraged and developed by Brazilian Government with farmers from southern and southeast Brazil, which were traditional small farmers with some experience, low budget and a remarkable determination. All of these efforts after 20 years resulted in an outstanding development of a part of the country with economy based on agribusiness (soybean, corn, cotton, livestock, poultry, swine, etc.). In late nineties, another cycle initiated in the Cerrado Northeastern region known as MATOPIBA (acronyms of Maranhão, Tocantins, Piauí, and Bahia states). Bahia and Maranhão were more pronounced and became very strong over time. Recently, basically in the last 5 years Tocantins and Piauí states started to increase agricultural production in high rates, reaching in Tocantins state a 30% increase of crop area per year and 34 % increase of total grain production per year and soybean is the major crop. Most of technologies developed in other Cerrado regions are not well adapted to MATOPIBA and a technology transfer is necessary to address conservation agriculture principles to farmers, agronomists, consultants and extension agents.

Results

We developed continuous improvement of the methodology of technology transference (TT) through modular training program for extension agents; coordination of a network with more than 100 extension agents, scientists and consultants in Tocantins State; implementation of 41 technological reference properties that adopted conservation agriculture based on low carbon emission; creation and maintenance of an internet blog with information related to project actions and technical support material (http://abc-to.blogspot.com.br/); presentation of 6 field days with focus on conservation agriculture for more than 1000 people; participation on 40 lectures to farmers and advisors; accomplishment of 168 hours of classes during the modular capacity building events; and finally the strengthening of the rural extension and research institutions due the approval of Agenda between the Ministry of Agriculture and the state rural extension service, a Cooperation Agreement between Ministry of Agriculture and Embrapa and the publication of the state bill establishing the State Plan for Mitigation and Adaptation to Climate Change for the Consolidation of an Economy of Low Carbon Emissions in Agriculture.

Applications and Implications for Conservation Agriculture

Most of the recent agricultural area were converted from degraded pasture; however, native Cerrado still been converted into agriculture. According to this scenario, with considerable farmers and companies introducing more land into agricultural production, the challenge is to increase conservation agriculture-based cropping systems adoption by farmers and agronomists. MATOPIBA have been facing great challenges to conservation agriculture adoption due the lack of technologies developed or adapted to regional conditions, which is very warm, low altitude, well-defined dry season (7 months per year), and high daily and nightly temperatures. Rain season is high intensity and varying among locations from 1300 to 2000 mm in 5 months. The agricultural development proposed to this region, must be conservation agriculture-based, and adopting crop and soil management potential resilient to climate change. The experience acquired in the first cycle of Cerrado expansion is important to avoid some inadequate technologies applied in crop production, and to develop a more sustainable crop production. Nowadays, the access to knowledge compared to seventies or even nineties, when the internet and other technologies were incipient in Brazil, make agriculture more dynamic and is necessary very careful in the application of technologies that are not validated to regional conditions.

Experimental approach

In order to begin the research program and also technology transfer to the region, the research team developed an assessment of the agricultural practices used in crop production (Borghi et al., 2012). Results from this report were the baseline about agricultural and livestock systems characterization in the state, and the results were used to support research and agrotechnology transfer to address problems farmers were facing in crop production. Additionally, we developed a approach to share knowledge and enhance practical and theoretical capacity of scientists, agronomists and consultants – which were capable of to transfer low carbon emissions technologies such as no till system, degraded pastures recovery and integrated crop-livestock-forestry systems. The approach was based on Training & Visit (Bennor & Harrison, 1977; Domit, 2007), Farmer Field School Approach (Braun & Duveskog, 2008; Sustainet EA, 2010), Reference Network (Miranda & Doliveira, 2005) and On Farm Approach (USA, 2004), aiming to allow the agronomist a perspective to look at a whole-farm instead of field-scale or one specific agricultural or livestock system and then make a well-designed plan with the farmer to adopt conservation agriculture practices (short and long term). Agronomists enrolled in the training program are encouraged to apply the knowledge learned during the training at a whole-farm level planning and making decisions and interventions in the crop/livestock production systems on their costumers based on several discussions with scientists, growers and others agronomists participants in the training program. All of the interventions in the crop/livestock production systems are intended to enhance the conservation agriculture adoption by farmers mainly those that are low carbon emission based.

Results and Discussion

The results obtained will help Brazil a volunteer compromise to reduce on 36.1 to 38.9% the GHG emission until 2020 established during the COP 15. Brazil create the "Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of an Economy of Low Carbon Emissions in Agriculture" – ABC Plan. This plan has the objective of organize and plan the actions to be performed for the adoption of sustainable production, selected with the objective to achieve the commitment to reduce GHG emissions by the agricultural sector (MAPA, 2012). The ABC Plan is composed of seven programs: 1. Recovery of degraded pastures; 2. Integrated crop-livestock-forestry systems (ICLS); 3. System No-till; 4. Biological nitrogen fixation (BNF); 5. Forestry; 6. Animal waste treatment and 7. Adaptation to climate change. As member of Plan ABC National Executive Comission, the Brazilian Agricultural Research Corporation (Embrapa) has the role of coordination of the actions on research and development (R&D) and technology transference (TT) in national tactical level.

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Improving Livelihood of Resource Poor Farmers Through Conservation Agriculture Based Crop Management Techniques under Rice-Maize Cropping System in Bangladesh

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Introduction:

Recently, rice-maize (R-M) farming systems has well accepted by farmers and has been popular to supply the increasing demand for maize in the local market for poultry feed and human consumption though, R-M production system is a newly emerged cropping system in Bangladesh (Timsina et al., 2011). Therefore, R-M system productivity is below its potential level due to lack of crop management practices on system perspective. Traditionally, most cereal crops such as rice, wheat and maize are planted after excessive amount of tillage, i.e., by tilling the lands 3 to 5 times prior to planting. Such tillage practice requires prolonged use of 2-wheel operated power tiller or 4-wheel tractors and large amount of fuel, labour and water which is resulting the low farm profitability (Johansen et al., 2012). In addition, excessive tillage facilitate for quick soil moisture loss in moisture stressed (rainfed) areas during tillage operations. Keeping the above issues in mind, a Rice-Maize (R-M) project was initiated from 2008-09 rabi season in Bangladesh with the funding support from the Australian Centre for International Agricultural Research (ACIAR). One of the main foci of the project was to introduce, evaluate and disseminate the conservation agriculture (CA)-based tillage and crop establishment technologies for component crops in the R-M systems.

Experimental Approach:

The field activities were conducted during 2009-10 to 2012-13 through several on-farm participatory research trials (81) in two districts (Rajshahi, Rangpur) of Bangladesh in rice-maize rotations. Hence, we tried to introduce mungbean after rabi maize and before aman rice to intensify the system, but it could not harvest economic yield in all trials, so mungbean data were not included in this study. The individual farmer counted as a replication and in each replication the set of treatments was evaluated. The rice and maize crops were grown in sequence and crop and system productivity and profitability were compared between five alternative tillage options (strip tillage, reduced tillage, fresh beds, permanent beds and conventional tillage) in R-M system. Four crop cycles (2009-10 to 2012-13) were evaluated under permanent farmer's field trials keeping same plots for individual tillage option. Data were subjected to analysis of variance (ANOVA) using the mixed covtest model procedures of the Statistical Analysis System (SAS Institute, 2001). Data were either not transformed or transformed using log, square root, or inverse functions as needed to meet the assumptions of normality and equal variance of population distributions. Treatment mean values were separated by Tukey's honest significant difference (HSD) test.

Results and Conclusion:

The average four year crop cycles results shows that there were no significant differences in tillage treatments for rice grain yield and rice net returns but, significance differences were observed in maize and system grain yield and net returns. The permanent raise beds (PB) produced highest maize grain yield (9.07 tha^{-1}) as compared to conventional-till (7.71 tha^{-1}) but at par with rest of tillage treatments i.e. fresh beds (FB), minimum tillage (MT) and strip tillage (ST). The similar trends were also observed as maize grain yield under system grain yield. The CA based tillage treatments (PB, ST and FB) were gave higher net returns 45, 29 and 21 per cent, respectively over CT except MT. The maximum net returns were achieved under PB (1428 US$) followed by MT. The similar trends were observed under system net returns PB(1965 US$)> MT(1842 US$)> FB(1811US$)>ST(1762US$)> CT(1542 US$).The CT gave lower net returns than CA based tillage treatments, except MT. Traditional tillage and planting practices which leads to labor intensive and less profitable of any crops and cropping systems. Similarly, in our study the conventional-till and traditional planting (CT) required more labor as compared to mechanized CA-based treatments. In rice crop cycle, CT required 84 Man-day's ha^{-1} followed by FB (76 Man-day's ha^{-1}) and lowest were needed in PB (54 Man-day's ha^{-1}). Maize crop production with traditional CT involved highest labor (75 Man-day's ha^{-1}) which is significantly higher than CA-based tillage treatments (ST, PB, FB and MT). In overall system, traditional crop production practices were more labor intensive (158 Man-day's ha^{-1} yr^{-1}) than CA-based tillage treatments.

The study concluded that CA-based tillage treatments will be more profitable and facilitate for mechanization options with less labor without any reduction in yield in R-M system of Bangladesh.

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Table 1. Tillage options affect crop performance and profitability (4 yrs mean) under rice--maize cropping system during 2009-12 in North-West districts Bangladesh

Tillage options	Grain yield (t ha^{-1})			Net income (USD ha^{-1})			Labor use (Man-day's ha^{-1})		
	Rice	Maize	System	Rice	Maize	System	Rice	Maize	System
CT (69)	4.71	7.71 b	12.42 b	556	986 b	1542 b	84 a	75 a	158 a
FB (40)	4.75	8.16 ab	12.90 ab	620	1191 a	1811 a	76 ab	41 b	117 b
MT (35)	4.61	8.66 ab	13.27 ab	555	1288 ab	1842 ab	53 c	44 b	97 c
PB (56)	4.83	9.07 a	13.90 a	537	1428 a	1965 a	54 c	47 b	101 c
ST (81)	4.73	8.57 ab	13.30 ab	488	1274 a	1762 a	70 bc	46 b	116 bc
Variance	Probability (0.05)								
Dist	0.3322	0.1324	0.4890	0.3798	0.4944	0.2231	0.2252	0.2521	0.3321
Upzila	0.1312	0.1854	0.1869	0.3589	0.2419	0.2011	0.2057	0.2197	0.1914
Year	0.1612	0.1172	0.0886	0.1511	0.1408	0.2394	0.0987	0.124	0.0985
Farmer	0.0029	0.0185	0.0041	0.0061	0.0160	0.0046	0.3802	0.0085	0.0004
Treatment	0.8714	0.0373	0.0455	0.8123	0.0139	0.0028	0.0004	<.0001	<.0001
Trt*Yr	0.0003	0.0002	0.3833	0.0003	<.0001	0.0080	0.4561	0.1512	0.0002
Far*Trt*Yr	0.4444	0.2986	0.2832	0.0013	0.0021	0.0006	0.3521	0.1511	0.0002

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