

LAFORGE GUIDED HITCH

Active Implement Guidance

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Keywords: **ACTIVE: The action is powered and executed as per Geo-localization signal, IMPLEMENT: The system applies to the implement connected to the tractor, while considering that the tractor has its own solution to be localized in the field, GUIDANCE: This relate to the action to ensure that the implement follow a track defined by the localization signal**

Abstract: **Geo-localization of tractors is well known and application of that technology is expanding rapidly.**
However the implement pulled by the tractor seldom exactly follow the path of the tractor. The reasons are multiples:

- **-Soil variations that tend to create side shift**
- **-Slopes**
- **-Curves**
- **-Implements dynamic behavior variability**

High draft implements trail better but it creates challenge for the tractor to stay where it has to be.
Low draft implements are less challenging for the tractor to maintain localization but are much more unstable.
The Integrated 2 Point Solution further described below has been developed to overcome limitations observed with current solutions .

1.1 INTRODUCTION

Tractor guidance is a solution to maintain a tractor on a set path. However on sloped ground, implements tend to drift downhill resulting in worked area offset error.

According to the investigations conducted by North Carolina State University (Matthew W. Veal § AI) and University of Kentucky (B.K. Koostra §

AI) presented at the AG Eng conference in 2009 the error with low draft implements can be 10 times that of the tractor.

Test results that will be described apply to tractor- planter combination.

Precise and accurate seed placement is crucial as it:

- Prevents crop damage from subsequent operations such as spraying, side-dressing, and harvesting
- Eliminate seedbed compaction

John Deere Active Implement Guidance combined with the Laforge Guided Hitch solves this issue.

1.2 CURRENT MARKET SITUATION

There are several solutions currently offered to locate trailed implements such as:

- installing a receiver on the implement to relocate the tractor so that the implement remains where it has to be.
- having a steerable unit that will move the implement relatively to the tractor so that the implement remains where it has to be, according to signal coming from a receiver installed on the machine, while the tractor follows its own optimized path.
- having a shifting unit installed on the tractor to move the implement relatively to the tractor to achieve similar result.

However each of these solutions have their own limitation:

- Moving the tractor side way does not provide the responsiveness to address high frequency changes associated with soils conditions variations due to non-homogeneous structure.
- Steering the implement is a costly solution and not always practical when it require shifting of discs locked in the ground.
- Shifting implement tongue leads to solutions that are reducing tractor's versatility, and negatively that impacts the weight distribution.

These observations have led to the design of the new 2 point guided hitch from LAFORGE in partnership with John Deere ISG group.

1.3 SYSTEM DESCRIPTION

Laforge has applied its expertise in tractor-implements interface to design and build a Guided Hitch that offers up to 20 inches (50 CM) of implement- hitch movement.

Controlled by Active Implement Guidance, an hydraulic cylinder adjusts implement's position via feedback sensor.

Guided Hitch simply bolts on, replacing existing 2-point hitch

Standard 2 point hitch



2 point Guided hitch



Same relationship between tractor's hook point and planter frame.

- Replaces factory John Deere planter hitch.
- Integrates to planter by retaining same relationship between tractor hook points and planter frame.
- Service: Maintenance free Composite Bushings.

A cylinder provide the power source to shift the planter tongue crosswise.

A sensor provide feedback of the location to the control unit



The 2 point guided hitch is a small portion of the Active implement guidance and act as the enabler to get the desired results.

Active Implement Guidance



2.1 PERFORMANCE TEST CONDUCTED

Laforge Guided Hitch in-field performance has been controlled using John Deere iSteer Application Controller 1100

2.1.1 Project Goal

Determine the capabilities of Laforge Guided Hitch:

- Maximum slope the hitch can be effective.
- Suggested accuracy of the steering system



2.1.2 Equipment Used

- Guided Hitch
- John Deere 1795 Planter (24 rows @ 20" row spacing)
- John Deere Tractor -Active Implement Guidance capable
- StarFire 3000 Receivers with RTK (Tractor and Implement)
- GreenStar 2630 Display: AutoTrac Activation
- Application Controller 1100: Version 2.50A (AIG Controller)
- CAN data collection software

2.1.3 Performance Criteria

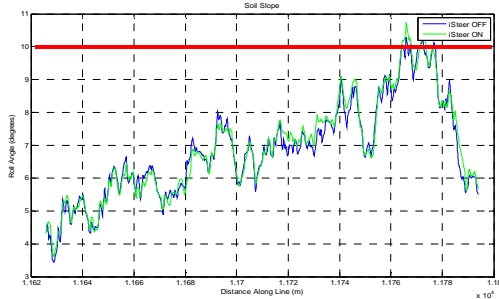
Criteria followed for this implement tracking test:

- Straight Track: 6 mph (9.6kph)
- Active Tracking Status
- 95%: Lateral Error < 4cm (1.57in)
- 95%: Heading Error < 0.8-degrees

Offset Error (lateral error) is the parallel distance from the implement's position to the set AutoTrac AB Line.

2.1.4 Field Conditions

Maximum Slope Encountered: 12.5 degrees (22%)

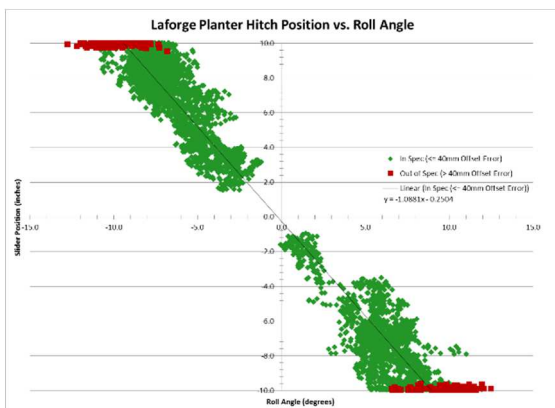


- For comparison the followed paths must be identical.
- Graph show that same path was used for each measurement.
- Soil was tilled between each run to prevent induced distortion

2.2 LAFORGE Guided Hitch performance

Guided hitch carrier position and response due to various ground roll angle.

2.2.1 Graph of Guided Hitch Performance Data

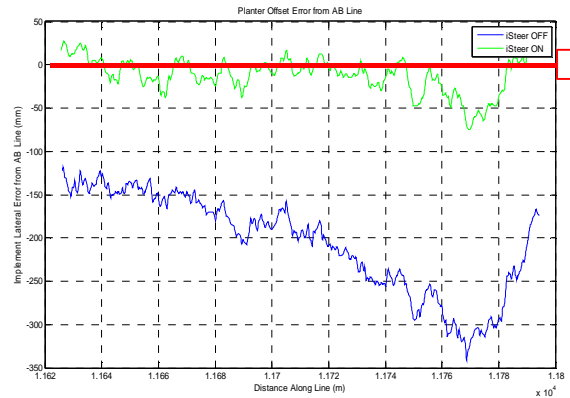


- Guided hitch reached “Max Out” between 8 and 10 degrees.
- Red data represents Out of Spec Data (offset error greater than 40mm.)

2.2.2 iSteer ON versus iSteer OFF

The importance of Active Implement Guidance during planting operation

2.2.2.1 Results



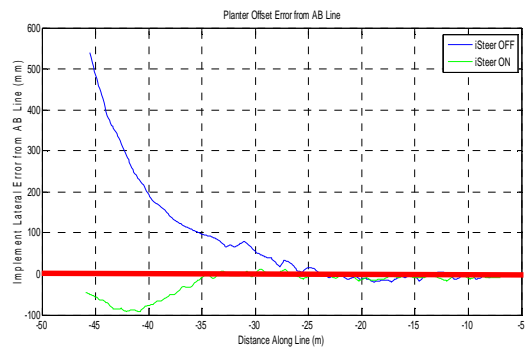
8 degree slope (14%)

- iSteer ON: roughly 3.0cm (1.2 in) offset error
- iSteer OFF: 25.0 cm (9.8 in) offset error

10 degree slope (17.6 %)

- iSteer ON: roughly 6.5cm (2.5 in) offset error
- iSteer OFF: 34.0 cm (13.2 in) offset error

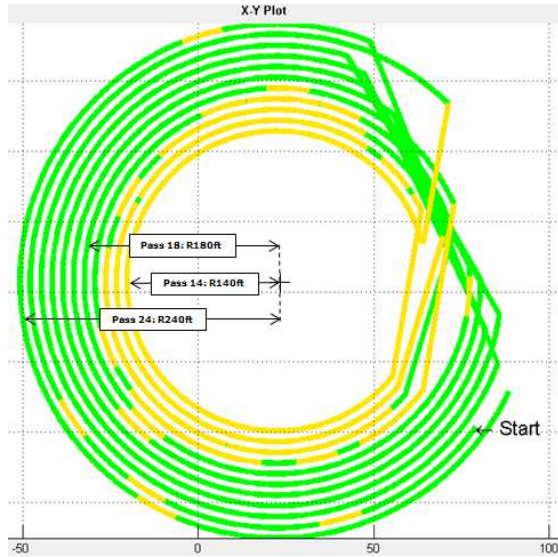
2.2.2.2 AB Line acquisition



Automated out board shift during U turn lead to line acquisition 10 meters sooner with iSteer ON

2.2.2.3 Circle track

Guided Hitch performance in circular path

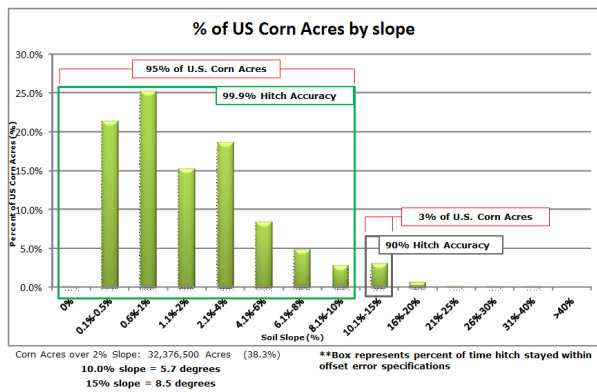


40ft Planter = 320ft diameter of field with offset error > 4.0cm (1.57in)

- Only 1.85 acres of field planted out-of-spec
- Irrigation pivot wheels could track between rows
- Guided Hitch can benefit curve-track and contour farming operations

3.1 AREA OF APPLICATION

Corn acres in US distributed by Slope



USDA data source

4.1 CUSTOMER FEEDBACK

- Did not have to “nudge” or manually steer sprayer on field passes; used same GreenStar™ AB-Line as used for planting.
- Reduced operator fatigue and less crop damage during spraying due to crops being precisely and accurately planted in the fields.
- Can now cover up to 1000 acres per day spraying compared to only 500 acres per day due to confidence in spraying at higher speeds and longer hours.

5.1 CONCLUSIONS

- “Max Out” of hitch; 8°(14%) to 10°(17.6%) roll angle while maintaining offset error within specifications.
- Guided Hitch compensates for uneven implement trailing.
- Great for Circle-Track operation such as irrigated fields, only 1.85 acres planted inaccurate regardless of field size.

6.1 COMMENTS

- Results values varies with soil conditions and equipment setting but overall gain is repeatable
- Having strip till operation performed with the Guided hitch ensure repeatable rows location for subsequent planting operation.
- However slippage associated with high draft makes it challenging for a tractor to stay on its sloped path.
- Active Implement Guidance proved to be a major performance enhancer even on flat ground with less 2% slope

7.1 FUTURE INVESTIGATIONS

7.1.1 Agronomic Practices Optimization

- Determine best range of fertilizer placement relatively to plants to maximize utilization and reduce leaching.
- Review opportunities to secure the potential of high productivity seed by mastering repeatability of optimized relative placement of seed in relation with strip tilled band and in relation with fertilizer applications before and after planting
- Optimize follow up crop localization in relation with localization of former crop debris localization

7.1.2 Mechanical Implications

- Associated Guided hitch correction adds rotation moment to the tractor.
- It is essential to limit slippage to keep this effect under control.
- This opens up opportunities for investigations on correlation between draft load, slip rate, slope angle and ability for the tractor-implement combination to stay on its path.

