APPENDICES

APPENDIX 1: Natural regions and farming areas map of Zimbabwe

NR	Description of farming system
I	Specialised and diversified farming region: Rainfall is high (more than 1000 mm per annum in areas lying below 1700 m altitude and more than 900 mm per annum at greater altitudes) normally with some precipitation throughout the year. Temperatures are normally comparatively low and the rainfall is consequently highly effective enabling afforestation, fruit and intensive livestock production to be practised. In frost-free areas, plantation crops such as tea, coffee and macadamia nuts can be grown; where the mean rainfall is below 1400 mm, supplementary irrigation of these plantation crops is required to top yields.
IIa	Intensive farming region: Rainfall is confined to summer and is moderately high (750-1000). Two sub-regions have been defined. Sub-region IIa receives an average of at least 18 rainy pentads per season and normally enjoys reliable conditions, rarely experiencing severe dry spells in summer. The region is suitable for intensive systems of farming based on crop and/or livestock production.
IIb	Sub-region IIb receives an average of 16-18rainy pentads per season and is subject either to rather more severe dry spell during the rainy season or to the occurrence relatively short rainy seasons. In either event, crop yields in certain years will be affected, but not sufficiently frequently to change the overall utilisation from intensive systems of farming.
III	Semi-intensive farming region: Rainfall is moderate, 650-800 mm, accounted for by infrequent heavy falls and temperatures are high. Region is subject to severe mid-season dry spells and is marginal for maize, tobacco and cotton or enterprises based on crop production alone. The suitable farming systems should be based on both livestock (assisted by fodder crops) and cash crops under good management on soils of high available moisture potential.
IV	Semi-extensive farming region: Rainfall is fairly low, 450-650 mm and the region is subjected to periodic seasonal droughts and severe dry spells during the rainy season. Rainfall is low and uncertain for cash cropping except in very favourable localities where drought resistant crops can be grown. The farming system should be based on livestock production but can be intensified by growing drought resistant fodder crops.
V	Extensive farming region: Rainfall is too low and erratic for reliable production of even drought-resistant fodder and grain crops. Farming has to be based on the utilisation of the veld alone. Cattle ranching or game ranching is suitable for this region. The region has areas below 900m altitude and mean rainfall is below 600 mm.

Note: A rainy pentad is defined as the centre one of three five-day periods (pentads) which together receive more than 40 mm of rainfall and two of which receive at least 8 mm of rainfall.

APPENDIX 3: Participatory Rural Appraisal data sheet

1. Name of site/area

Details of site

Date: _____ Location: _____ CARE Group/Non-CARE Group

District: _____ Number of farmers interviewed: _____

Number of females: _____ Number of males: _____

Facilitators: _____

2. Availability of Draught Animal Power (DAP)

Types of draught animals owned/used	
Adequacy of DAP	
Definition of adequate DAP	
Source of draught animals	
Problems with acquiring/sourcing draught animals	

3. Farming systems (crops and livestock)

Major crops grown and varieties	
Inputs used and source(s)	
Farm operations-(Cropping calendar)	
Problems encountered with cropping programmes	
Types of livestock reared and breeds	
Animal grazing	
Animal production constraints	

4. Discussion on Livestock management [Check matrix]

Allocation of grazing area and management. Is it adequate?	
Supplementary feeding	
Animal health and care practices	
Selection and training of animals for DAP	
Uses for DAP	
Roles of men, women, children in the use of DAP	

5. Discussion on Implement management [Check 2 matrices]

Types of animal drawn implements used	
Age range of implements	
Condition of implements	
Field operation for which are implements used	
Skills and knowledge for proper setting and use of identified implements	
Replacement policy on implements? Rate of replacements	
Source of implements	
Back-up support do you get from traders (spares), artisans/blacksmiths (repairs)?	
Problems in sourcing, using, replacing, repairing, and maintaining implements	
Innovators who use special implements	
Training of operators in the use draught animals and implements?	

6. Crop management and productivity

Methods of crop establishment
Number of ploughings
Time of ploughing(s)
Methods of weeding
Number of weedings
Crop maintenance activities
Harvesting methods

Discussion on role of rural blacksmiths and dealers	
Services provided by rural artisans in line with DAP and implements	
Services provided by dealers	

7. Implements matrices

Uses of implements

Field operations	*Types of implements*					
	Plough	Cultivator	Ridger	Ripper tine	Harrow	Scotch cart
Ploughing						
Planting						
Weeding						
Ridging						
Row marking						
Clod breaking						
Soil loosening						
Seed covering						
Transport						

Problems with implements

Problem	*Types of implements*					
	Plough	Cultivator	Ridger	Ripper tine	Harrow	Scotch cart
Parts not available						
Unable to repair						
Too heavy for animals						
Cannot adjust						
Some parts unnecessary						
Weak materials used						
Other						

8. Draught animal use matrix

A calendar for the use of draught animals

Use	*Time of year*											
	O	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
Ploughing												
Planting												
Cultivating												
Carting												
Milk												
Manure												
Meat												
Hides/skins												
Lobola												

The animal type should be indicated and relate this to the cropping calendar

9. Livestock type and use matrix

Use	Cattle		Donkeys		
	Bulls	Oxen	Cows/heifers	Male	Female
Ploughing					
Cultivating					
Carting					
Milk					
Manure					
Meat					
Hides/skins					
Lobola					
Total score					

Factors to ranked by the focus group.
0 =No use 1= low use 2= medium use 3= high use

11. Farmers selected

Resource category 1 (with plough + cultivator + full DAP)
Resource category 2 (with plough only + full DAP)
Resource category 3 (with plough only + inadequate DAP)

APPENDIX 4: Resource categories of households in Masvingo province

Indicator	Well resourced (RG1)	Average (RG2)	Poor (RG3)	Very Poor (RG4)
Livestock	More than 5 cattle and donkeys	At least 2 cattle and donkeys	Possibly a single animal owned	No livestock
Implements	Has full range of implements, often more than one	Plough and possibly one other implement	Hand tools only	No implements Old hoes
Crop Inputs used	Purchases seed Has adequate manure Uses fertiliser regularly	Purchases seed, some manure, occasional fertiliser use	None, some manure	None
Yields achieved (food security)	Sufficient for family Sells surplus most years	Sufficient for household in good years Shortfall in poor seasons	Insufficient for household security	Very low if any
Homestead	Asbestos or tin roof house plus huts Granary Brick toilet	Asbestos or tin roof house plus huts Granary Blair toilet	2-3 huts No toilets No granaries	1-2 huts No toilets No granaries
Education	Complete secondary (“O” levels) Nice schools	Secondary (Form 2-4) May complete “O” levels	Primary Mat attend secondary	Primary only
Sources of income	Many remittances Formal employment (pensions, professions	Occasional remittances Small pension IGAs Some formal employment	Hiring out labour Some IGAs	Hiring out labour for food, seed or cash

RG=Resource Group, IGA=Income generating activity

Source: CARE, 1999

APPENDIX 5: Draught animal power implement survey questionnaire

APPENDIX 7: An illustration of a cluster analysis of one household

(RG1-Farmer 514)

APPENDIX 8: Details of implement parts

Plough and parts

Cultivator and parts

APPENDIX 9: Implement defects and comparisons of new and worn parts

a) A new and a worn plough share: Mutangi-20.05.00	**b) Seriously worn plough body parts: Mutangi-20.05.00**
c) Set of worn plough parts: Gari-09.12.99	**d) Worn wheel and arm assembly, share and landside: Nyimai-15.12.00**
e) A slightly worn duck foot tyne and a new tyne:Chedenje-09.01.00	**f) Plough in poor condition-Note the use of barbed wire for traction/hitching, no drawbar and worn parts: Chedenje-23 10 01**
g) Plough in very poor condition-Note missing wheel and drawbar assemblies: Mutangi-23.10.01	**h) Plough in poor condition-Note broken wheel hub and wire supporting drawbar: Mshagashe-24 10.01**

APPENDIX 10 Frequency of replacement of plough parts

1999-2000 spring season (n=16)

Part	Number of replaced parts	% of farmers
Share	14	88%
Landside	13	81%
Adjusting bar holder with set screw	11	69%
Drawbar assembly	9	56%
King bolt	8	50%
Wheel assembly	8	50%
U-clamp assembly	7	44%
Regulator (hake)	6	38%
Mouldboard bolts	3	19%
Frog	1	6%
Mouldboard	1	6%

1999-2000 winter season (n=7)

Part	Number of replaced parts	% of farmers
Wheel assembly	7	100%
Drawbar assembly	6	86%
Share	5	71%
Adjusting bar holder with set screw	5	71%
Regulator (hake)	5	71%
U-clamp assembly	4	57%
Landside	4	57%
Mouldboard	3	43%
King bolt	2	29%
C2 Cup head bolt	2	29%
Frog	1	14%

2000-2001 spring season (n=18)

Part	Number of replaced parts	% of farmers
Wheel assembly	16	89%
Landside	15	83%
Share	14	78%
Regulator (hake)	10	56%
Adjusting bar holder with set screw	9	50%
C2 Cup head bolt	9	50%
Drawbar assembly	8	44%
King bolt	8	44%
U-clamp assembly	8	44%
Frog	6	33%
Mouldboard	2	11%
Stay bolt	2	11%
Mouldboard bolts	1	6%

2000-2001 winter season (n=12)

Part	Number of replaced parts	% of farmers
Wheel assembly	12	100%
Regulator (hake)	12	100%
Landside	11	92%
Share	11	92%
Adjusting bar holder with set screw	11	92%
Drawbar assembly	11	92%
U-clamp assembly	10	83%
Mouldboard	5	42%
King bolt	4	33%
Stay bolt (beam to mouldboard)	4	33%
Stay bolt (handle to mouldboard)	3	25%
C2 Cup head bolt	3	25%
Mouldboard bolts	3	25%
Frog	6	33%
Spreader bar bolt	1	8%
Handle brace bolts	1	8%

APPENDIX 11: Plough/cultivator performance data sheet

Date:_____ Location: _____ Farmer: _____ Cat:_____

Start:_____
Finish:_____
Total time:_____hr
Weather
T1:_____C
T2:_____C
Stoppages (min)
Turning:____
Adjusting:____
Resting:____
Other:____
Actual time:_____hr
Area:_____m2
No. of people:____
man_hr:____
man_hr/ha:____
Days after planting:__
Row spacing:__mm
plants/m2:_____
plants/ha:_____
plant ht_____mm

PLOT A	Run	Draught	sec/50 m	Depth	Width	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					

Comments on observations

Start:_____
Finish:_____
Total time:_____hr
Weather
T1:_____C
T2:_____C
Stoppages (min)
Turning:____
Adjusting:____
Resting:____
Other:____
Actual time:_____hr
Area:_____m2
No. of people:____
man_hr:____
man_hr/ha:____
Days after planting:__
Row spacing:__mm
plants/m2:_____
plants/ha:_____
plant ht_____mm

PLOT B	Run	Draught	sec/___m	Depth	Width	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					

Comments on observations

APPENDIX 12: Examples of how donkeys were harnessed with yokes

a) Yoked four-donkey draught team : Gari-24.11.00

b) A donkey and cow spanned on the front yoke-Note injury on the donkey's neck caused by the yoke.): Nyimai-12.12 02

c) Two male donkeys lead cows Nyimai-02.12.00

d) Donkey and cow combination on front and rear yokes: Mutangi-16.05 00

APPENDIX 13: GLM procedures-(ANOVA) results

PLOUGHS

Class PLDFTS DEPTH
Dependent Variable: DRAUGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	69	18499713.05809990	268111.78345072	93.01	0.0001
Error	214	616877.37499868	2882.60455607		
Corrected Total	283	19116590.43309850			

R-Square	C.V.	Root MSE	DRAUGHT Mean
0.967731	5.465149	53.68989249	982.40492958

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	0	0.00000000	.	.	.
DEPTH	4	126642.11607149	31660.52901787	10.98	0.0001
SPEED	1	61616.62759514	61616.62759514	21.38	0.0001
PLDFTS*DEPTH	0	0.00000000	.	.	.
SPEED*DEPTH	2	121246.93052649	60623.46526324	21.03	0.0001
MC	1	10302.25470476	10302.25470476	3.86	0.0515

Class TEAM
Dependent Variable: DRAUGHT POTENTIAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	10238821.14027150	2559705.28506788	100.19	0.0001
Error	403	10295920.82051280	25548.19062162		
Corrected Total	407	20534741.96078430			

R-Square	C.V.	Root MSE	DPOT Mean
0.498610	14.59499	159.83801369	1095.15686275

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TEAM	4	10238821.14027140	2559705.28506787	100.19	0.0001

Class WIDTH
Dependent Variable: FIELD EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	81	77195.49336121	953.03078224	9.41	0.0001
Error	334	33814.63782699	101.24143062		
Crrected Total	415	111010.13118821			

R-Square	C.V.	Root MSE	EFFIC Mean
0.695391	11.77471	10.06188007	85.45329327

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WIDTH	80	54315.53743736	678.94421797	6.71	0.0001
SPEED	1	2226.60382889	2226.60382889	21.99	0.0001

Class PLDFTS DEPTH
Dependent Variable: WEEDING EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	98	83103.44761905	847.99436346	210.75	0.0001
Error	321	1291.60000000	4.02367601		
Corrected Total	419	84395.04761905			

R-Square	C.V.	Root MSE	WEEDEFF Mean
0.984696	2.551430	2.00591027	78.61904762

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	6	3535.06666667	589.17777778	146.43	0.0001
DEPTH	84	42815.98974359	509.71416361	126.68	0.0001

Class PLDFTS DPOT DRAUGHT
Dependent Variable: WORK RATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	268	1616.47600216	6.03162687	62.68	0.0001
Error	7	0.67359639	0.09622806		
Corrected Total	275	1617.14959855			

R-Square	C.V.	Root MSE	WRATE Mean
0.999583	2.647582	0.31020647	11.71659420

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	6	8.78221320	1.46370220	15.21	0.0011
DPOT	22	90.21911766	4.10086898	42.62	0.0001
DRAUGHT	224	156.69447399	0.69952890	7.27	0.0047
SPEED	1	0.10156235	0.10156235	1.06	0.3384

Class PLOUGH DEFECTS
Dependent Variable: SPEED

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	44.96420171	2.99761345	10.10	0.0001
Error	384	113.93013429	0.29669306		
Corrected Total	399	158.89433600			

R-Square	C.V.	Root MSE	SPEED Mean
0.282982	13.65014	0.54469538	3.99040000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	13	27.73889267	2.13376097	7.19	0.0001
DEPTH	1	3.03451203	3.03451203	10.23	0.0015
DPOT	1	13.52998385	13.52998385	45.60	0.0001

Class PLOUGH DEFECTS

Dependent Variable: WIDTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	83242.91714432	5202.68232152	3.66	0.0001
Error	307	436107.63775446	1420.54605132		
Corrected Total	323	519350.55489877			

R-Square	C.V.	Root MSE	WIDTH Mean
0.160283	13.74574	37.69013202	274.19493827

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	14	78726.00843696	5623.28631693	3.96	0.0001
SS	1	1362.96131964	1362.96131964	0.96	0.3281
BD	1	424.40198181	424.40198181	0.30	0.5851

Dependent Variable: DEPTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	61	191188.08959617	3134.23097699	24.89	0.0001
Error	262	32993.58478409	125.92971292		
Corrected Total	323	224181.67438026			

R-Square	C.V.	Root MSE	DEPTH Mean
0.852827	9.800713	11.22184089	114.50024691

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	10	31454.28154731	3145.42815473	24.98	0.0001
PLMASS	44	80645.62994317	1832.85522598	14.55	0.0001
MC	1	696.63724811	696.63724811	5.53	0.0194
SS	1	629.66420174	629.66420174	5.00	0.0262
BD	1	1352.24139403	1352.24139403	10.74	0.0012

Dependent Variable: HEART RATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	7102.34166497	1775.58541624	13.19	0.0001
Error	87	11710.52790025	134.60376897		
Corrected Total	91	18812.86956522			

R-Square	C.V.	Root MSE	HR Mean
0.377526	9.110392	11.60188644	127.34782609

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLDFTS	1	2814.91638984	2814.91638984	20.91	0.0001
DEPTH	1	3250.46896878	3250.46896878	24.15	0.0001
EFFIC	1	3316.70127177	3316.70127177	24.64	0.0001
SPEED	1	838.72965435	838.72965435	6.23	0.0144

	T for H0:	Pr > |T|	Std Error of

Dependent Variable: SPECIFIC DRAUGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	73	224.59835000	3.07668973	99999.99	0.0001
Error	214	0.00000000	0.00000000		
Corrected Total	287	224.59835000			

R-Square	C.V.	Root MSE	SPDRGHT Mean
1.000000	0	0	3.62208333

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WIDTH	2	0.00000000	0.00000000	99999.99	0.0001
PLMASS	1	0.00000000	0.00000000	99999.99	0.0001

CULTIVATORS

Dependent Variable: WEEDING EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	12688.82904782	4229.60968261	61.93	0.0001
Error	36	2458.67095218	68.29641534		
Corrected Total	39	15147.50000000			

R-Square	C.V.	Root MSE	WEEDEFF Mean
0.837685	12.38077	8.26416453	66.75000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEPTH	1	389.24253476	389.24253476	5.70	0.0223
WIDTH	1	709.49010911	709.49010911	10.39	0.0027
DEFECT	1	8952.34243061	8952.34243061	131.08	0.0001

Dependent Variable: DRAUGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	64025.38563049	32012.69281525	18.59	0.0001
Error	37	63703.01436951	1721.70309107		
Corrected Total	39	127728.40000000			

R-Square	C.V.	Root MSE	DRAUGHT Mean
0.501262	7.833379	41.49341021	529.70000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEPTH	1	51462.73198761	51462.73198761	29.89	0.0001
SPEED	1	25914.40129870	25914.40129870	15.05	0.0004

Dependent Variable: DRAUGHT POTENTIAL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	0	0.00000000	.	.	.
Error	39	116640.00000000	2990.76923077		
Corrected Total	39	116640.00000000			

R-Square	C.V.	Root MSE	DPOT Mean
0.000000	6.510467	54.68792582	840.00000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TEAM	0	0	.	.	.

Level of TEAM	N	DPOT Mean	DPOT SD
121	40	840.000000	54.6879258

Dependent Variable: WIDTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	125.83877996	125.83877996	0.11	0.7371
Error	38	41813.76122004	1100.36213737		
Corrected Total	39	41939.60000000			

R-Square	C.V.	Root MSE	WIDTH Mean
0.003000	6.059866	33.17170688	547.40000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEFECT	1	125.83877996	125.83877996	0.11	0.7371

Dependent Variable: SPEED

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	16.19323454	8.09661727	272.15	0.0001
Error	37	1.10076546	0.02975042		
Corrected Total	39	17.29400000			

R-Square	C.V.	Root MSE	SPEED Mean
0.936350	4.456927	0.17248309	3.87000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEPTH	1	14.37319968	14.37319968	483.13	0.0001
DEFECT	1	1.80480597	1.80480597	60.66	0.0001

Dependent Variable: FIELD EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	12848.93925110	6424.46962555	52.93	0.0001
Error	37	4491.06074890	121.38002024		
Corrected Total	39	17340.00000000			

R-Square	C.V.	Root MSE	EFF Mean
0.741000	8.957122	11.01726011	123.00000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WIDTH	1	70.28711742	70.28711742	0.58	0.4515
SPEED	1	9356.81238294	9356.81238294	77.09	0.0001

Dependent Variable: WORK RATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	5.07383682	1.69127894	52344.50	0.0001
Error	36	0.00116318	0.00003231		
Corrected Total	39	5.07500000			

R-Square	C.V.	Root MSE	WRATE Mean
0.999771	0.143000	0.00568424	3.97500000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WIDTH	1	0.00017245	0.00017245	5.34	0.0267
SPEED	1	1.13116886	1.13116886	35009.29	0.0001
DEFECT	1	4.46943372	4.46943372	99999.99	0.0001

APPENDIX 14: GLM procedures-oneway anova

PLOUGHS

Dependent Variable: DRAUGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3081226.53051923	3081226.53051923	54.19	0.0001
Error	282	16035363.90257930	56862.99256234		
Corrected Total	283	19116590.43309850			

R-Square	C.V.	Root MSE	DRAUGHT Mean
0.161181	24.27305	238.45962460	982.40492958

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	3081226.53051922	3081226.53051922	54.19	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	671.3599206	15.07	0.0001	44.56110191
PLOT	208.3414683	7.36	0.0001	28.30275826

Dependent Variable: DEPTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	137533.94050346	137533.94050346	266.06	0.0001
Error	418	216079.78540131	516.93728565		
Corrected Total	419	353613.72590477			

R-Square	C.V.	Root MSE	DEPTH Mean
0.388938	20.76867	22.73625487	109.47380952

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	137533.94050345	137533.94050345	266.06	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	55.35598331	15.82	0.0001	3.49840094
PLOT	36.19345065	16.31	0.0001	2.21893191

Dependent Variable: WIDTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	8316.20746690	8316.20746690	5.55	0.0189
Error	418	625963.70262453	1497.52081968		
Corrected Total	419	634279.91009144			

R-Square	C.V.	Root MSE	WIDTH Mean
0.013111	14.17216	38.69781415	273.05514286

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	8316.20746690	8316.20746690	5.55	0.0189

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	259.7475943	43.62	0.0001	5.95438738
PLOT	8.8999528	2.36	0.0189	3.77669125

Dependent Variable: SPEED OF OPERATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	7.19558972	7.19558972	19.42	0.0001
Error	414	153.37419489	0.37046907		
Corrected Total	415	160.56978462			

R-Square	C.V.	Root MSE	SPEED Mean
0.044813	15.24586	0.60866170	3.99230769

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	7.19558972	7.19558972	19.42	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	4.384406215	46.72	0.0001	0.09384033
PLOT	-0.263085461	-4.41	0.0001	0.05969523

Dependent Variable: WORK RATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	14.38137259	14.38137259	2.34	0.1272
Error	418	2573.74828360	6.15729254		
Corrected Total	419	2588.12965619			

R-Square	C.V.	Root MSE	WRATE Mean
0.005557	21.83598	2.48138924	11.36376190

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	14.38137259	14.38137259	2.34	0.1272

Dependent Variable: FIELD EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	98.99775957	98.99775957	0.37	0.5418
Error	418	110966.94561447	265.47116176		
Corrected Total	419	111065.94337404			

R-Square	C.V.	Root MSE	EFFIC Mean
0.000891	19.07487	16.29328579	85.41754762

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	98.99775957	98.99775957	0.37	0.5418

Dependent Variable: WEEDING EFFICIENCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	21624.49056604	21624.49056604	145.36	0.0001
Error	422	62778.11320755	148.76330144		
Corrected Total	423	84402.60377358			

R-Square	C.V.	Root MSE	WEEDEFF Mean
0.256206	15.51130	12.19685621	78.63207547

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	21624.49056604	21624.49056604	145.36	0.0001

Dependent Variable: PLOUGH DEFECTS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	13225.05660376	13225.05660376	1023.30	0.0001
Error	422	5453.88679246	12.92390235		
Corrected Total	423	18678.94339623			

R-Square	C.V.	Root MSE	PLDFTS Mean
0.708020	0.396541	3.59498294	906.58490566

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	13225.05660377	13225.05660377	1023.30	0.0001

Dependent Variable: PLOUGH MASS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1755.71660377	1755.71660377	269.39	0.0001
Error	422	2750.28377358	6.51726013		
Corrected Total	423	4506.00037736			

R-Square	C.V.	Root MSE	PLMASS Mean
0.389640	7.146616	2.55289250	35.72169811

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	1755.71660377	1755.71660377	269.39	0.0001

Dependent Variable: HEART RATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	13.50000000	13.50000000	0.07	0.7956
Error	94	18801.00000000	200.01063830		
Corrected Total	95	18814.50000000			

R-Square	C.V.	Root MSE	HR Mean
0.000718	11.10305	14.14251174	127.37500000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	13.50000000	13.50000000	0.07	0.7956

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	128.5000000	28.15	0.0001	4.56447604
PLOT	-0.7500000	-0.26	0.7956	2.88682812

CULTIVATORS

Dependent Variable: DRAUGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	22090.00000000	22090.00000000	7.95	0.0076
Error	38	105638.40000000	2779.95789474		
Corrected Total	39	127728.40000000			

R-Square	C.V.	Root MSE	DRAUGHT Mean
0.172945	9.953805	52.72530602	529.70000000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PLOT	1	22090.00000000	22090.00000000	7.95	0.0076

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	22090.00000000	22090.00000000	7.95	0.0076

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	459.2000000	17.42	0.0001	26.36265301
PLOT	47.0000000	2.82	0.0076	16.67320573

Dependent Variable: DEPTH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	810.00000000	810.00000000	22.63	0.0001
Error	38	1360.00000000	35.78947368		
Corrected Total	39	2170.00000000			

R-Square	C.V.	Root MSE	DEPTH Mean
0.373272	8.733475	5.98243042	68.50000000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	810.00000000	810.00000000	22.63	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	55.00000000	18.39	0.0001	2.99121521

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PLOT                        9.00000000              4.76        0.0001        1.89181061
_____________________________
Dependent Variable: WIDTH
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1           1299.60000000          1299.60000000     1.22    0.2772
Error                   38          40640.00000000          1069.47368421
Corrected Total         39          41939.60000000
                 R-Square                    C.V.                Root MSE         WIDTH Mean
                 0.030987                5.974207             32.70280851       547.40000000
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
PLOT                     1           1299.60000000          1299.60000000     1.22    0.2772
                                          T for H0:          Pr > |T|       Std Error of
Parameter                     Estimate       Parameter=0                        Estimate
INTERCEPT                  564.5000000             34.52        0.0001        16.35140425
PLOT                       -11.4000000             -1.10        0.2772        10.34153608
_____________________________
Dependent Variable: SPEED
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1              3.72100000             3.72100000    10.42    0.0026
Error                   38             13.57300000             0.35718421
Corrected Total         39             17.29400000
                 R-Square                    C.V.                Root MSE         SPEED Mean
Source                  DF              Type I SS            Mean Square  F Value    Pr > F
PLOT                     1              3.72100000             3.72100000    10.42    0.0026
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
PLOT                     1              3.72100000             3.72100000    10.42    0.0026
                                          T for H0:          Pr > |T|       Std Error of
Parameter                     Estimate       Parameter=0                        Estimate
INTERCEPT                  2.955000000              9.89        0.0001        0.29882445
PLOT                       0.610000000              3.23        0.0026        0.18899318
_____________________________
Dependent Variable: WORK RATE
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1              2.02500000             2.02500000    25.23    0.0001
Error                   38              3.05000000             0.08026316
Corrected Total         39              5.07500000
                 R-Square                    C.V.                Root MSE         WRATE Mean
                 0.399015                7.127234             0.28330753        3.97500000
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
PLOT                     1              2.02500000             2.02500000    25.23    0.0001
                                          T for H0:          Pr > |T|       Std Error of
Parameter                     Estimate       Parameter=0                        Estimate
INTERCEPT                  4.650000000             32.83        0.0001        0.14165377
PLOT                      -0.450000000             -5.02        0.0001        0.08958971
_____________________________
Dependent Variable: FIELD EFFICIENCY
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1             40.00000000            40.00000000     0.09    0.7685
Error                   38          17300.00000000           455.26315789
Corrected Total         39          17340.00000000
                 R-Square                    C.V.                Root MSE           EFF Mean
                 0.002307               17.34707             21.33689663       123.00000000
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
PLOT                     1             40.00000000            40.00000000     0.09    0.7685
                                          T for H0:          Pr > |T|       Std Error of
Parameter                     Estimate       Parameter=0                        Estimate
INTERCEPT                  120.0000000             11.25        0.0001        10.66844832
PLOT                         2.0000000              0.30        0.7685         6.74731916
_____________________________
Dependent Variable: WEEDING EFFICIENCY
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1          14822.50000000         14822.50000000  1733.09    0.0001
Error                   38            325.00000000             8.55263158
Corrected Total         39          15147.50000000
                 R-Square                    C.V.                Root MSE       WEEDEFF Mean
                 0.978544                4.381256             2.92448826        66.75000000
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
PLOT                     1          14822.50000000         14822.50000000  1733.09    0.0001
                                          T for H0:          Pr > |T|       Std Error of
Parameter                     Estimate       Parameter=0                        Estimate
INTERCEPT                   9.00000000              6.15        0.0001        1.46224413
PLOT                       38.50000000             41.63        0.0001        0.92480439


_____________________________
Dependent Variable: DEFECTS
Source                  DF          Sum of Squares            Mean Square  F Value    Pr > F
Model                    1            902.50000000           902.50000000   139.98    0.0001
Error                   38            245.00000000             6.44736842
Corrected Total         39           1147.50000000
                 R-Square                    C.V.                Root MSE        DEFECT Mean
                 0.786492                0.280339             2.53916688       905.75000000
Source                  DF            Type III SS            Mean Square  F Value    Pr > F
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PLOT	1	902.50000000	902.50000000	139.98	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	920.0000000	724.65	0.0001	1.26958344
PLOT	-9.5000000	-11.83	0.0001	0.80295507

Dependent Variable: MASS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	11.02500000	11.02500000	7.32	0.0102
Error	38	57.25000000	1.50657895		
Corrected Total	39	68.27500000			

R-Square	C.V.	Root MSE	MASS Mean
0.161479	3.324110	1.22742778	36.92500000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLOT	1	11.02500000	11.02500000	7.32	0.0102

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	38.50000000	62.73	0.0001	0.61371389
PLOT	-1.05000000	-2.71	0.0102	0.38814674

APPENDIX 15: Implement assessment and evaluation of benefits survey questionnaire

APPENDIX 16: Condition of selected ploughs during implement assessment survey

a) Plough in good condition: Gari-06.08.02

b) Plough in average-poor condition: Mushandike-09.08.02

c) Plough in poor condition (poor plough body): Gari-06.08.02

d) Plough in very poor condition (missing share and mouldboard worn landside and wheel-axle assembly): Mutangi-09.08.02