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Ethiopian Institute of Agricultural Research (EIAR)



Costing of the EIAR Maize Breeding Program: Procedures and implications

May 2021

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BILL & MELINDA
GATES *foundation*



Introducion – MERCI



- Ethiopian Institute of Agricultural Research (EIAR) received a 4-year-investment from Bill and Melinda Gates Foundation in 2016.
- The investment is called Modernizing EIAR Research in Crop Improvement (MERCi).
- This project aims to modernize the national **sorghum, maize, wheat, chick pea and common bean** breeding programs of EIAR in order to increase rates of genetic gain.
- **University of Queensland (UQ)** was chosen as EIAR's consultant



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- Maize research in EIAR is agro-ecology based:
 - Mid-altitude high-potential (Bako)
 - Highland (Ambo)
 - Dryland and irrigated (Melkassa)

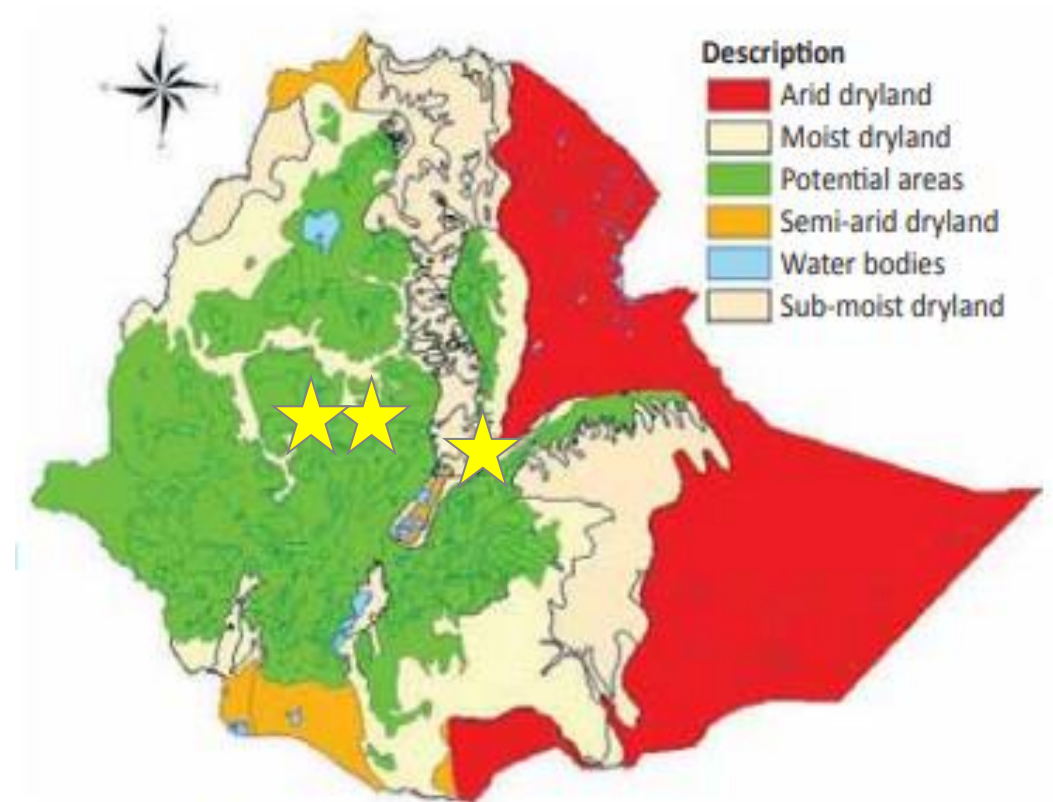


Figure 1. Agro-ecological zones of Ethiopia.



Introduction – Projects (Product concepts)

Melkassa maize breeding (DIME) program has four product concepts

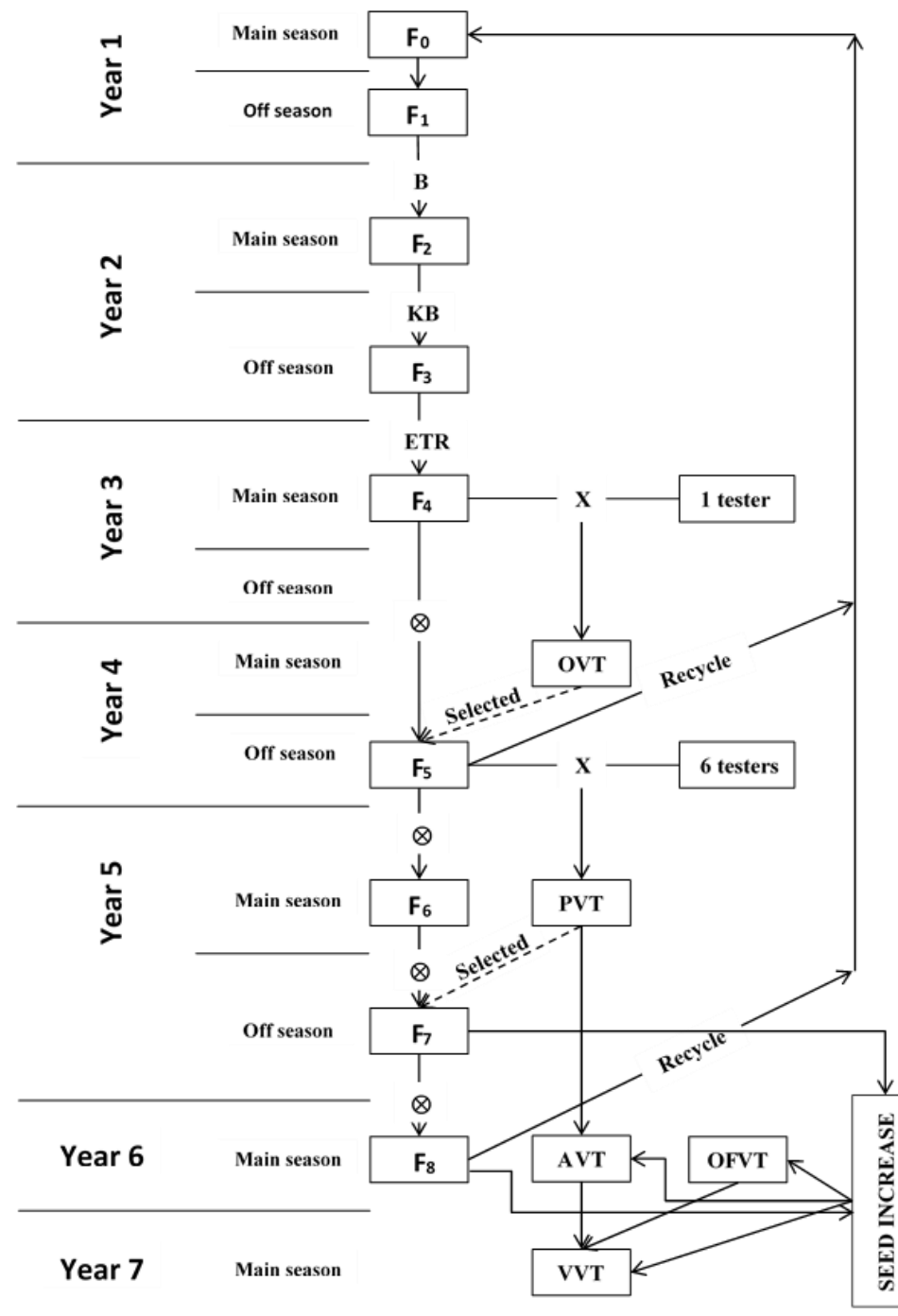
- PC3 = developing **early** maturing maize **hybrids**
- PC4 = developing **early** maturing maize **OPVs**
- PC5 = developing **intermediate** maturing maize **hybrids**
- PC6 = developing **intermediate** maturing maize **OPVs**



Introduction – Pipelines

DIME breeding program

PC5 (Intermediate hybrid)
pipeline





Challenges?

- No knowledge about the cost of an activity
- No knowledge about the cost of a product
- No metrics (genetic gain) relative to \$ or birr spent
- Budgets requested based on mere guess
- Budget allocated to different testing sites (~10) based on mere guess
- No tool to help calculate costs



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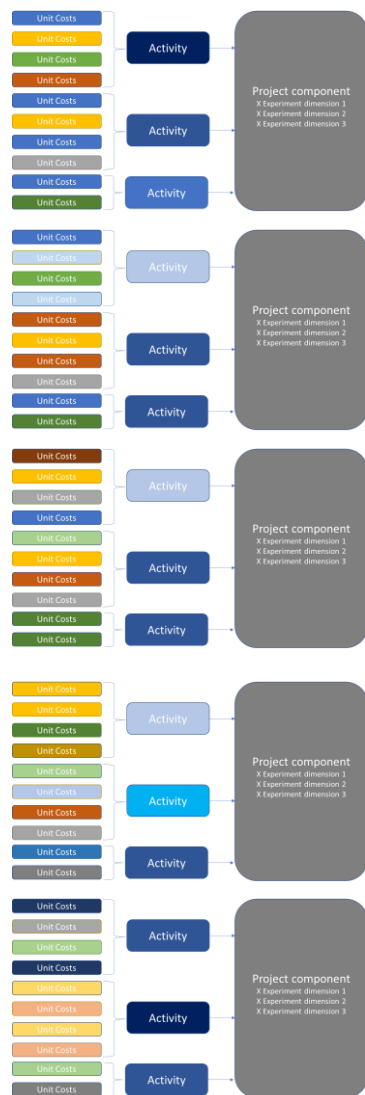


How did we generate costings for our product pipelines?

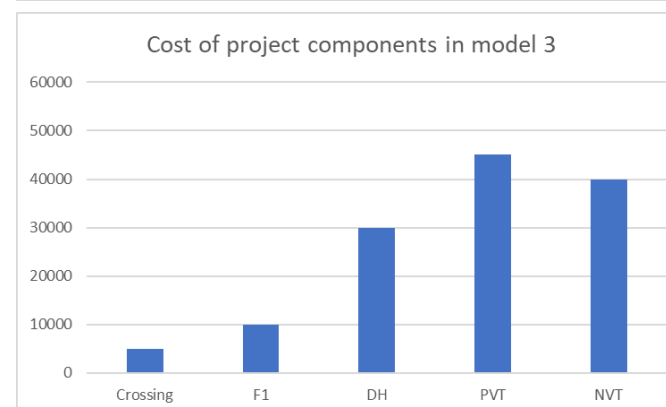
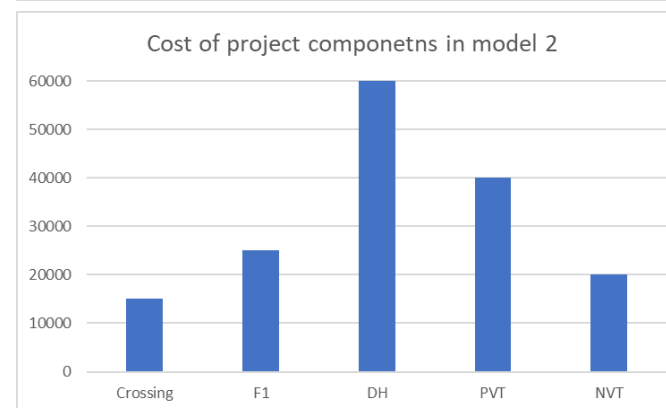
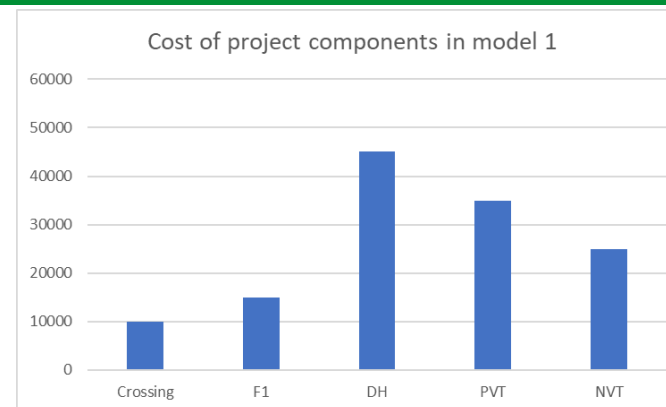
Breeding Costing Tool



Developing scalable financial model of the breeding pipeline



Scalable
experiment
dimensions in order
to understand the
cost impact of
changes to the
pipeline

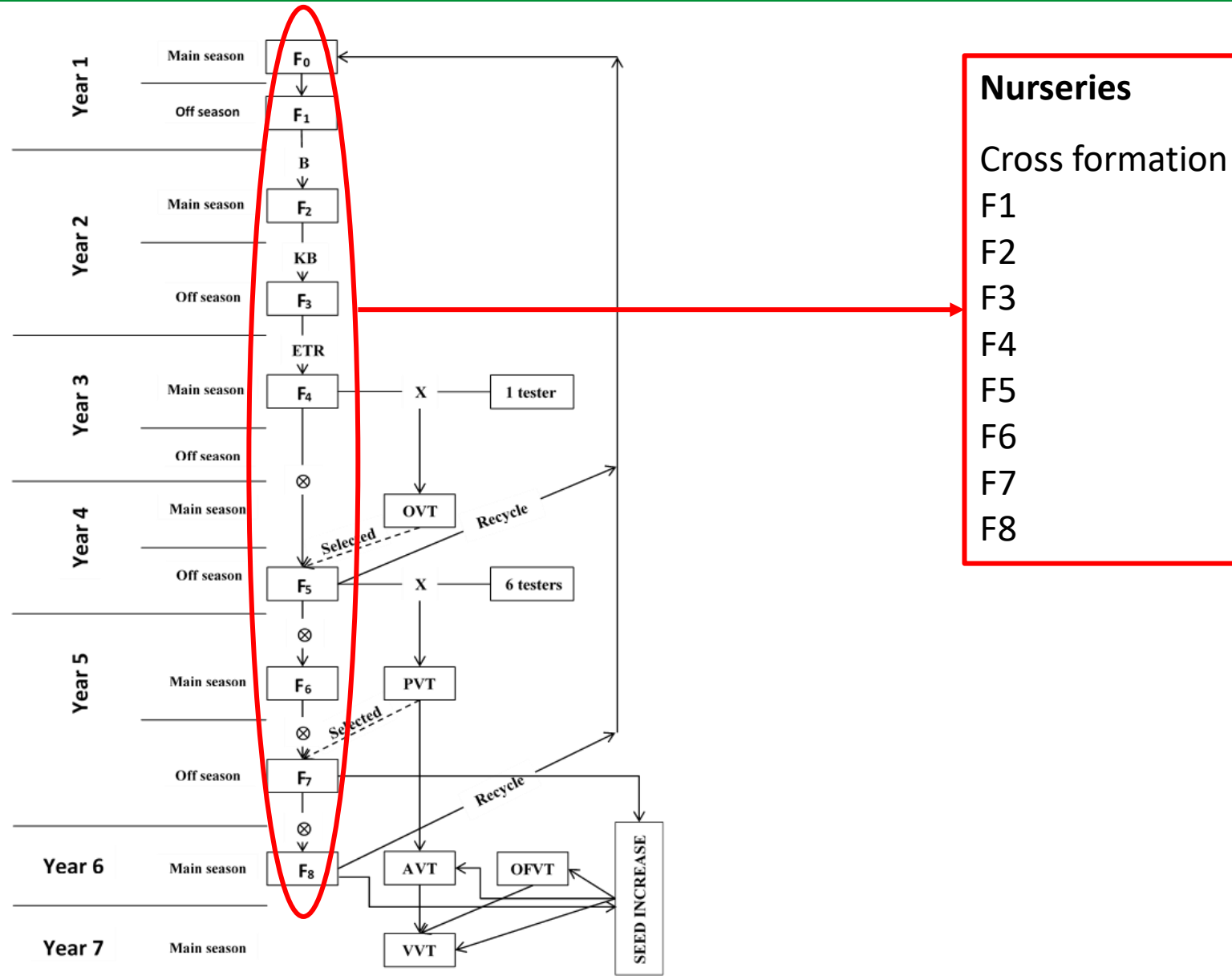




Actions taken

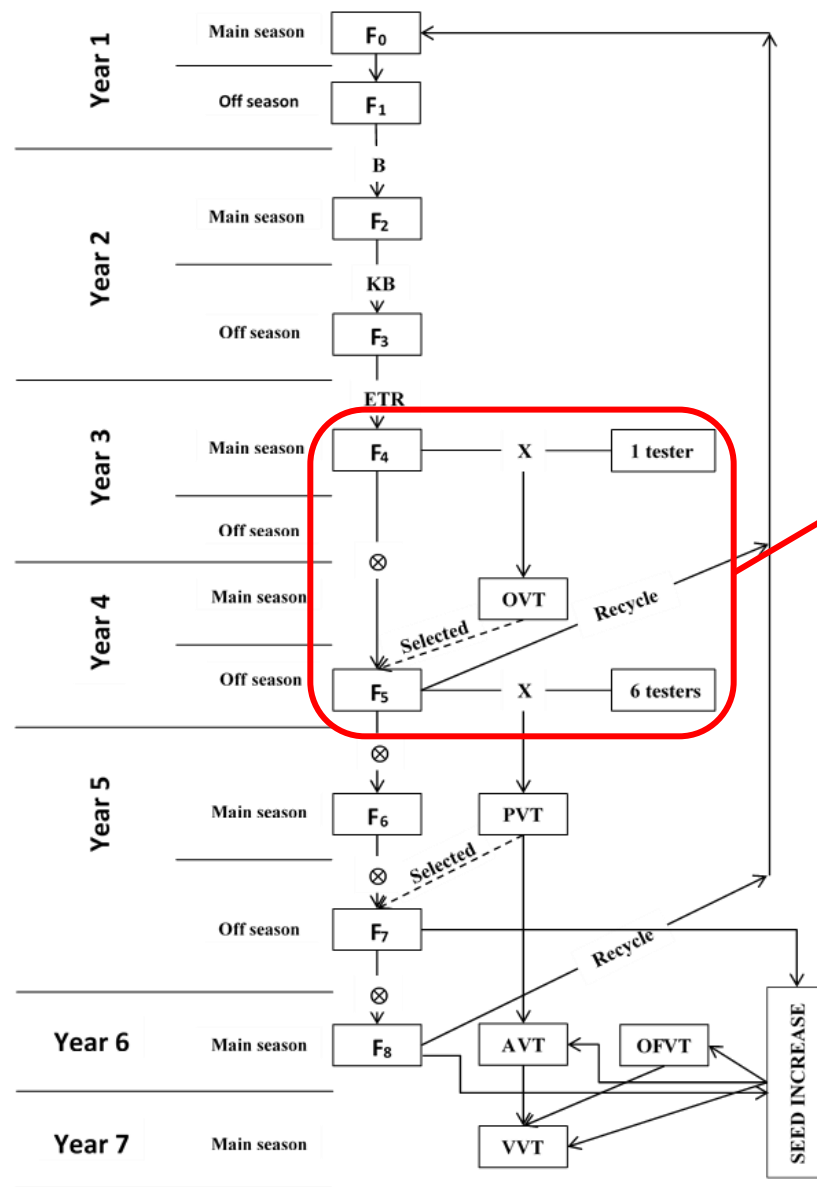
- We sat down with UQ team for 2 day
 - Workshop on calculating unit costs
 - Hands-on training of researchers on the costing tool software
- Champions from the three maize breeding team sat down together for 3 days
 - Listed the project components
 - Agreed on experimental dimensions
 - Standardized the unit costs
- Each champion worked with their team to cost all pipelines for 2 – 3 days

Set-up: Project components





Set-up: Project components



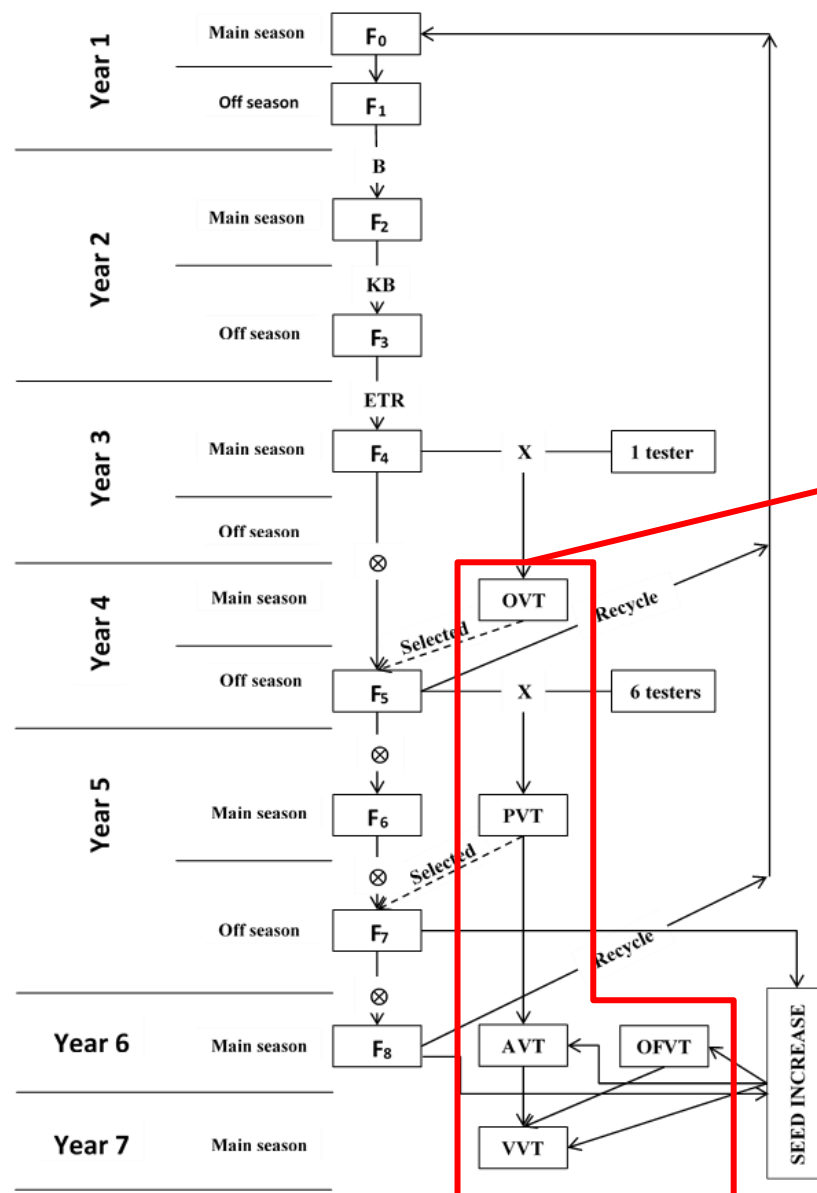
Hybrid formation

Stage I test crossing to
1 tester

Stage II test crossing
to 3 testers



Set-up: Project components



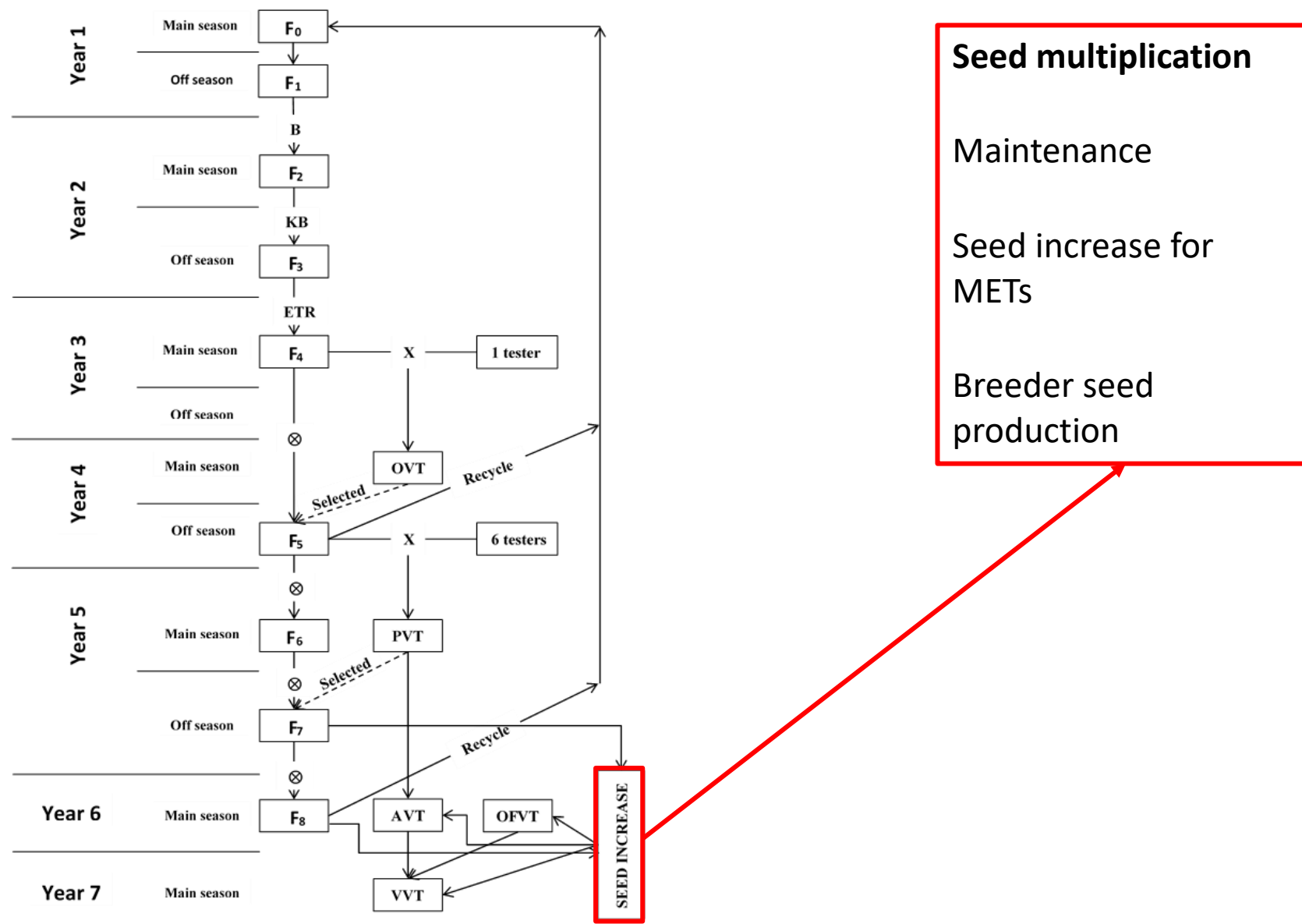
Testing

Sites

Observation variety trial (OVT)	3
Preliminary variety trial (PVT)	6
National variety trial (NVT)	12
On-farm variety trial (OFVT)	33
Variety verification trials (VVT)	16



Set-up: Project components





Set-up: Experiment dimensions

They specify measurements of

- **an experiment** (trial/nursery) **structurally** or
- **the size of tasks** in the experiment

Eg. To calculate the cost of fuel, we measure it by the distance from the main station to experimental site. Therefore, **distance to site** is our dimension.

Dimension	Unit	Comment
Entries	Number	number of test entries without checks
Replicates	Number	number of replicates
Samples	Number	number of samples / plots
Plot length	m	Length of plot in meters (including alleys)
Rows per plot	Number	Number of rows per plot
Row spacing	m	Space between rows in meters
Buffer percentage	Percent	Land area buffer percentage
Land area	m ²	Total area of land required for trial
Row length	m	Length of planting rows in meters (without alleys)
Within row spacing	m	Space between planting stations in meters
Number of crosses	Number	Number of breeding crosses to be made
Number of pollinations	Number	Number of hand pollinations to be made to form breeding crosses/hybrids
Distance to site	km	Distance of testing site from MARC (round trip)
Number of researcher days	Day	Number of days researchers stay in a site/trial/person
Number of plates	Number	Number of plates for genotyping
Land area without buffer	Number	Total area excluding buffer percentage
Number of parents	Number	Total number of parents
Number of pollinations for...	Number	Number of plants to be selfed to advance F4 to F5
Number of support staff d...	Day	Number of days support staff stays in a site/trial/person
Total number of rows	Number	Number of total rows
Number of driver days	Day	Number of days a driver stays in a site/trial/person
Number of 96-well plates	Number	Number of 96-well plates to be genotyped
Number of samples to be ...	Number	Number of samples to be genotyped
Number of checks	Number	Number of checks in the trial
Number of testers	Number	Number of testers for test cross formation
Number of plant	Number	Number of plants (100 inoculum level)
Number of pots	Number	Number of pots in GH

Default dimensions

User generated/added dimensions



Set-up: Item unit cost

Item Unit Cost	Location	Value	Experiment dimension	Unit	Comment
Fertilizer NPS per m2	All Locations	0.17	Land area	Birr	ETB 1700/100 kg with 100 kg/ha
Fertilizer Urea per m2	All Locations	0.15	Land area	Birr	ETB 1500/100 kg with 100 kg/ha
Pollen bag per pollination	All Locations	3.00	Number of po...	Birr	Imported from Kenya; KSH 90000/10000 pcs; Currency ETB 1 = KSH 3
Shoot bag (Polyethylene bag)	All Locations	0.27	Number of po...	Birr	ETB 134/kg; 500 shoot bags/kg
Paper seed packet for seed prep CE 5 101218 (73 mm x 133.4 mm) per plot	All Locations	3.00	Samples	Birr	Imported from Australia; \$42.95 price + \$21.27 transport per 1000 pcs (\$7390/347.5 packs transp...
Sticky label Fomtec GS-1424 per plot	All Lo				
Colored hard paper per plot	All Lo				
Cloth bag per plot	All Lo				
Land preparation @ MK with own tractor per m2	Melka				
Land preparation with tractor rental per m2	All Lo				
Average per diem for a researcher	All Lo				
Average accomodation for a researcher	All Lo				
Average per diem for a support staff	All Lo				
Average accomodation for a support staff	All Lo				
Fuel and service cost for vehicle per km to travel to site	All Locations	5.33	Distance to site	Birr	A vehicle travels 6 km/litre; price of 1litre gasoline = ETB 20; Service cost ETB 10000/5000 km
Chemical application per m2	All Locations	0.25	Land area	Birr	ETB 2500/ha
Paper clips per pollination	Melkasa	0.20	Number of po...	Birr	ETB 200/pack
Torch per m2	All Locations	0.01	Land area	Birr	ETB 55/piece and 2 torches per ha for 5 months
Pollen bag for selfing of F4 rows	Melkasa	3.00	Number of po...	Birr	Imported from Kenya; KSH 90000/10000 pcs; Currency ETB 1 = KSH 3
Shoot bag for selfing of F4 rows	Melkasa	0.27	Number of po...	Birr	ETB 134/kg; 500 shoot bags/kg
Paper clips for selfing of F4 rows per pollination	Melkasa	0.20	Number of po...	Birr	ETB 200/pack

Eg. Blended fertilizer (NPS)

- 100 kg needed for 1 ha = 10,000m²
- Experimental dimension = Land area in m²
- How much birr for 1m²?
- 100 kg costs ETB 1700
- Therefore, $ETB\ 1700/10,000m^2 = ETB\ 0.17\ per\ m^2$



Set-up: Labour unit cost

Labour Unit Cost	Location	Value	Experiment dimension	Permanent Labour	Defined Term Labour	Casual Labour	Unit	Comment
Seed preparation per row: seed counting and packeting	Melkasa	1.95	Total number...	1.76	0.00	0.19	Birr	420 rows/day with a team of 1 researcher, 1 FA and 1 casual
Planting per m2	All Locations	1.18	Land area	0.67	0.00	0.51	Birr	560 rows/day (includes layout, NPS application, planting etc) with a tea...
Manual cultivation per m2	All Locations	0.34	Land area	0.05	0.00	0.29	Birr	70 rows of 4 m length (5.25 m with alleys)/day with a team of 1 FA and 1...
Thinning per m2	All Locations	0.24	Land area	0.11	0.00	0.14	Birr	300 rows of 4 m length (5.25 m with alleys)/day with a team of 1 FA and ...
Weeding per m2	All Locations							ay with a team of 1 FA and ...
Earthing-up per m2	All Locations							y with a team of 1 FA and 1...
Fertilizer (urea) application per m2	All Locations							ay with a team of 1 FA and ...
Pollination	Melkasa							casuals are paid double for p...
Data collection per 2-row plot: Scoring (aspects and diseases)	All Locations							ay by 2 researchers
Data collection per 2-row plot: Counting (Lodging, HC, NP, NE)	All Locations							ay with a team of 1 FA and ...
Data collection per 2-row plot: plant and ear heights	All Locations							ay with a team of 1 FA and ...
Data collection per 2-row plot: GW and MOI measurement	Melkasa							and 5 casuals; machine she...
Harvesting of trials per row	Melkasa							nsportation of ears to store (...)
Harvesting of ears per pollination	Melkasa	1.63	Number of po...	1.06	0.00	0.57	Birr	Includes labeling, harvesting, dehusking, selecting; 700 ears/day with a ...
Seed processing per pollination	Melkasa	0.66	Number of po...	0.09	0.00	0.57	Birr	Includes hand shelling, labeling and packeting; 1400 ears/day with a tea...
detasseling per row	Melkasa	0.93	Total number...	0.13	0.00	0.80	Birr	1000 rows/day (4 plants/min/casual labor) with a team of 1 FA and 10 c...
Guarding per m2	All Locations	3.60	Land area	0.00	0.00	3.60	Birr	1 day time and 2 night time guards per ha for 5 months (150 days)
Irigation application per m2	Melkasa	0.08	Land area	0.01	0.00	0.06	Birr	1 FA + 8 casual/ha/day
Seed packeting for storage per 2-row plot	Melkasa	2.35	Samples	2.35	0.00	0.00	Birr	315 plots/day with a team of 1 researcher and 1 FA
Pollination for selfing of F4 rows	Melkasa	0.66	Number of po...	0.48	0.00	0.18	Birr	1800 pollinations/2FAs and 2 casuals/day (casuals are paid double for p...

Eg. Planting per plot in trials: different tasks

- Clearing the field
- Making field layout
- Applying fertilizer
- Planting
- Covering the seed with soil



Set-up: Labour unit cost

Labour Unit Cost	Location	Value	Experim dimension
Seed preparation per row: seed counting and packeting	Melkasa	1.95	Total number of rows
Planting per m2	All Locations	1.18	Land area
Manual cultivation per m2	All Locations	0.34	Land area
Thinning per m2	All Locations	0.24	Land area
Weeding per m2	All Locations	1.77	Land area
Earthing-up per m2	All Locations	0.79	Land area
Fertilizer (urea) application per m2	All Locations	0.20	Land area
Pollination	Melkasa	0.66	Number of pollinations
Data collection per 2-row plot: Scoring (aspects and diseases)	All Locations	1.46	Samples
Data collection per 2-row plot: Counting (Lodging, HC, NP, NE)	All Locations	0.34	Samples
Data collection per 2-row plot: plant and ear heights	All Locations	0.25	Samples
Data collection per 2-row plot: GW and MOI measurement	Melkasa	1.90	Samples
Harvesting of trials per row	Melkasa	2.32	Total number of rows

Labour costs calculator

LabourCostName	Rate	Unit	Period	Number of people required	Permanent	Defined Term	Casual
Casual	80.0	Birr	Day	14.0	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Researcher	614.0	Birr	Day	2.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field Assistant	127.0	Birr	Day	2.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
*					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The group will perform activity units in one

cost per activity unit Birr

Remove labour cost

OK Cancel

Cost calculation

Team = 2 researchers, 2 technicians and 14 casuals

Team plants 560 5m-long-rows per day = $560 * 5.25 * 0.75 = 2,205 \text{m}^2/\text{day}$

The total cost of labour = $(80 * 14) + (614 * 2) + (127 * 2) = \text{ETB}2,602$

Cost per activity unit = $\text{ETB}2,602 / 2,205 \text{m}^2 = \text{ETB}1.18/\text{m}^2$

800 rows/20 casuals and 2 FAs including transportation of ears to store (...
 des labeling, harvesting, dehusking, selecting; 700 ears/day with a ...
 des hand shelling, labeling and packeting; 1400 ears/day with a tea...
 rows/day (4 plants/min/casual labor) with a team of 1 FA and 10 c...
 time and 2 night time guards per ha for 5 months (150 days)
 + 8 casual/ha/day
 plots/day with a team of 1 researcher and 1 FA
 pollinations/2FAs and 2 casuals/day (casuals are paid double for p...



Set-up: Fixed unit cost

Fixed Cost	Location	Value	Labour Cost	Unit	Comment
Researcher time to prepare fieldscorer file for 1 trial	Melkasa	87.60	<input checked="" type="checkbox"/>	Birr	1 hour of researcher's time to prepare fieldbook in BMS and export it to fieldscorer file format
Statistician time to analyze 1 trait	Melkasa	614.00	<input checked="" type="checkbox"/>	Birr	1 day of researcher's time to do MET analysis of 1 trait taking data from BMS
Researcher time to prepare harvest label for 1 trial	Melkasa	43.80	<input checked="" type="checkbox"/>	Birr	30 minutes of researcher's time (including file preparation and printing)
Researcher time to print packet for 1 trial	Melkasa	43.80	<input checked="" type="checkbox"/>	Birr	30 minutes of researcher's time
Researcher time to prepare tag for 1 trial	Melkasa	43.80	<input checked="" type="checkbox"/>	Birr	30 minutes of researcher's time (including file preparation and printing)
Wheelbarrow	Melkasa	5.30	<input type="checkbox"/>	Birr	2 wheelbarrows per 5 years for ETB 500/piece to be used across 38 components
Rake	Melkasa	15.80	<input type="checkbox"/>	Birr	5 rakes/annum for ETB 120/piece to be used across 38 components
Shovel	Melkasa	20.80	<input type="checkbox"/>	Birr	12 shovels per 3 years for ETB 198/piece to be used across 38 components
hoe	Melkasa	28.90	<input type="checkbox"/>	Birr	20 hoes per 3 years for ETB 164.45/piece to be used across 38 components
hammer	Melkasa	3.20	<input type="checkbox"/>	Birr	2 hammers per 5 years for ETB 300/piece to be used across 38 components
Machete	Melkasa	4.00	<input type="checkbox"/>	Birr	2 machetes per 3 years for ETB 227/piece to be used across 38 components
Axe	Melkasa	3.20	<input type="checkbox"/>	Birr	2 axes per 5 years for ETB 300/piece to be used across 38 components
Knapsac sprayers	Melkasa	73.70	<input type="checkbox"/>	Birr	3 sprayers per 3 years for ETB 2800/piece for chemical spraying and 2 rust screening activities (across 38 components)
Sickle	Melkasa	13.50	<input type="checkbox"/>	Birr	5 sickles per 2 years for ETB 205/piece to be used across 38 components
A4 photocopy paper	Melkasa	126.30	<input type="checkbox"/>	Birr	20 packets/annum for ETB 240/packet to be used across 38 components
Packet printer cartridge	Melkasa	121.10	<input type="checkbox"/>	Birr	2 cartridges/annum for ETB 2300/packet to be used across 38 components
Marker	Melkasa	18.90	<input type="checkbox"/>	Birr	24 marker/annum for ETB 30/piece to be used across 38 components
Pencil	Melkasa	7.90	<input type="checkbox"/>	Birr	60 pencils/annum for ETB 5/piece to be used across 38 components
Pen	Melkasa	12.80	<input type="checkbox"/>	Birr	60 pens/annum for ETB 8.1/piece to be used across 38 components
Plaster	Melkasa	15.80	<input type="checkbox"/>	Birr	5 paster/annum for ETB 120/piece to be used across 38 components
Tablet	Melkasa	884.20	<input type="checkbox"/>	Birr	6 tablets per 5 years for ETB 28000/piece to be used across 38 components
Stapler	Melkasa	32.90	<input type="checkbox"/>	Birr	5 staplers/annum for ETB 250/piece to be used across 38 components



Set-up: Activity

Activities

Activity	Location
▶ Nursery implementation	Melkasa
Trial implementation excluding land preparation and harvesting	All Locations
Purchase of fixed farm and office supplies	Melkasa
Irrigation of off-season activities	Melkasa

Unit Cost Location	Value	Unit	Comment
Fertilizer NPS per m2 - All Locations	0.17	Birr	ETB 17...
Fertilizer Urea per m2 - All Locations	0.15	Birr	ETB 15...
Pollen bag per pollination - All Locations	3	Birr	Importe...
Shoot bag (Polyethylene bag) - All Locations	0.27	Birr	ETB 13...
Paper seed packet for seed prep CE 5 101218 (73 mm x 133.4 mm) per plot - All Locations	3	Birr	Importe...
Sticky label Fomtec GS-1424 per plot - All Locations	0.17	Birr	ETB 40...
Colored hard paper per plot - All Locations	0.21	Birr	ETB 25...
Cloth bag per plot - All Locations	15	Birr	ETB 75...
Land preparation @ MK with own tractor per m2 - Melkasa	0.5	Birr	ETB 50...
Chemical application per m2 - All Locations	0.25	Birr	ETB 25...
Seed preparation per row: seed counting and packeting - Melkasa	1.95	Birr	420 row...
Planting per m2 - All Locations	1.18	Birr	560 row...
Manual cultivation per m2 - All Locations	0.34	Birr	70 rows...



Set-up: Activity

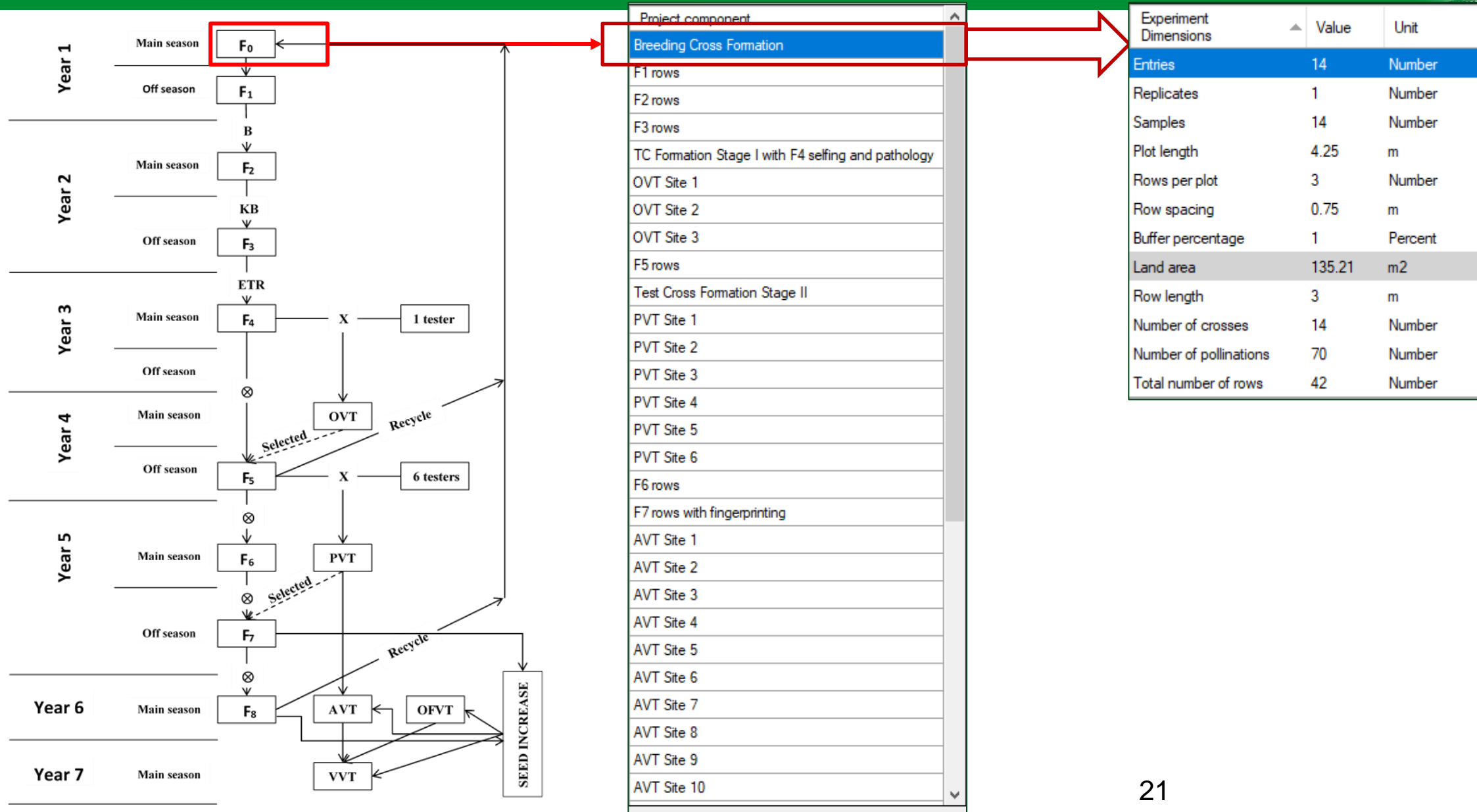
Activities

Activity	Location
Nursery implementation	Melkasa
Trial implementation excluding land preparation and harvesting	All Locations
Purchase of fixed farm and office supplies	Melkasa
Irrigation of off-season activities	Melkasa

Unit Cost Location	Value	Unit	Comment
Fertilizer NPS per m2 - All Locations	0.17	Birr	ETB 17...
Fertilizer Urea per m2 - All Locations	0.15	Birr	ETB 15...
Paper seed packet for seed prep CE 5 101218 (73 mm x 133.4 mm) per plot - All Locations	3	Birr	Importe...
Colored hard paper per plot - All Locations	0.21	Birr	ETB 25...
Cloth bag per plot - All Locations	15	Birr	ETB 75...
Chemical application per m2 - All Locations	0.25	Birr	ETB 25...
Seed preparation per row: seed counting and packeting - Melkasa	1.95	Birr	420 row...
Planting per m2 - All Locations	1.18	Birr	560 row...
Manual cultivation per m2 - All Locations	0.34	Birr	70 rows...
Thinning per m2 - All Locations	0.24	Birr	300 row...
Weeding per m2 - All Locations	1.77	Birr	400 row...
Earthing-up per m2 - All Locations	0.79	Birr	30 rows...
Fertilizer (urea) application per m2 - All Locations	0.199176954732...	Birr	120 row...



Experimental dimensions for each component





Activities for each component

Project component
Breeding Cross Formation
F1 rows
F2 rows
F3 rows
TC Formation Stage I with F4 selfing and pathology
OVT Site 1
OVT Site 2
OVT Site 3
F5 rows
Test Cross Formation Stage II
PVT Site 1
PVT Site 2
PVT Site 3
PVT Site 4
PVT Site 5
PVT Site 6
F6 rows
F7 rows with fingerprinting
AVT Site 1
AVT Site 2
AVT Site 3
AVT Site 4
AVT Site 5
AVT Site 6
AVT Site 7
AVT Site 8
AVT Site 9
AVT Site 10

Activity	Location	Non Labour	Permanent Labour	Casual Labour	Total Cost
Nursery implementation at Melkasa	Melkasa	1,288.55	434.11	1,036.25	2,758.92
Purchase of fixed farm and office supplies at Melkasa	Melkasa	3,980.90			3,980.90

Experiment Dimension		X	Unit costs	X	#	=	Cost
Land area	X		Chemical application per m2 at All Locations	X	1	=	33.80
Samples	X		Cloth bag per plot at All Locations	X	1	=	210.00
Samples	X		Colored hard paper per plot at All Locations	X	1	=	2.94
Land area	X		Dursban per m2 at Melkasa	X	1	=	16.23
Land area	X		Fertilizer NPS per m2 at All Locations	X	1	=	22.99
Land area	X		Fertilizer Urea per m2 at All Locations	X	1	=	20.28
Land area	X		Land preparation @ MK with own tractor per m2 at Melkasa	X	1	=	67.61
			Paper clips per pollination at Melkasa	X	1	=	14.00
Samples	X		Paper seed packet for seed prep CE 5 101218 (73 mm x 133.4 mm) per plot at All Locations	X	1	=	42.00
Number of pollinations	X		Pollen bag per pollination at All Locations	X	1	=	210.00
Land area	X		Pre-emergence herbicide (premagram gold) per m2 at Melkasa	X	1	=	20.28
Land area	X		Radiant per m2 at Melkasa	X	1	=	43.27
Number of pollinations	X		Shoot bag (Polyethylene bag) at All Locations	X	1	=	18.90



Activities for each component

Project component
Breeding Cross Formation
F1 rows
F2 rows
F3 rows
TC Formation Stage I with F4 selfing and pathology
OVT Site 1
OVT Site 2
OVT Site 3
F5 rows
Test Cross Formation Stage II
PVT Site 1
PVT Site 2
PVT Site 3
PVT Site 4
PVT Site 5
PVT Site 6
F6 rows
F7 rows with fingerprinting
AVT Site 1
AVT Site 2
AVT Site 3
AVT Site 4
AVT Site 5
AVT Site 6
AVT Site 7
AVT Site 8
AVT Site 9
AVT Site 10

Activity	Location	Non Labour	Permanent Labour	Casual Labour	Total Cost
Nursery implementation at Melkasa	Melkasa	1,288.55	434.11	1,036.25	2,758.92
Purchase of fixed farm and office supplies at Melkasa	Melkasa	3,980.90			3,980.90

Experiment Dimension		X	Unit costs	X	#	=	Cost
Land area	X		Torch per m2 at All Locations	X	1	=	1.49
Land area	X		Tracer per m2 at Melkasa	X	1	=	79.77
Samples	X		Cutting harvest labels per plot at All Locations	X	1	=	0.28
Samples	X		Cutting tags and tagging per plot at All Locations	X	1	=	4.90
Land area	X		Earthing-up per m2 at All Locations	X	1	=	106.82
Number of pollinations	X		Evaluation and selection in nurseries per row at Melkasa	X	1	=	46.20
Land area	X		Fertilizer (urea) application per m2 at All Locations	X	1	=	26.93
Number of pollinations	X		Harvesting of ears per pollination at Melkasa	X	1	=	114.10
Land area	X		Manual cultivation per m2 at All Locations	X	1	=	45.97
Land area	X		Planting per m2 at All Locations	X	1	=	159.55
Number of pollinations	X		Pollination at Melkasa	X	1	=	46.20
	X		Researcher time for breeding plan preparation at Melkasa	X	1	=	233.91
	X		Researcher time to prepare fieldscorer file for 1 trial at Melkasa	X	1	=	87.60

Labour costs



Activities for each component

Project component
Breeding Cross Formation
F1 rows
F2 rows
F3 rows
TC Formation Stage I with F4 selfing and pathology
OVT Site 1
OVT Site 2
OVT Site 3
F5 rows
Test Cross Formation Stage II
PVT Site 1
PVT Site 2
PVT Site 3
PVT Site 4
PVT Site 5
PVT Site 6
F6 rows
F7 rows with fingerprinting
AVT Site 1
AVT Site 2
AVT Site 3
AVT Site 4
AVT Site 5
AVT Site 6
AVT Site 7
AVT Site 8
AVT Site 9
AVT Site 10

Activity	Location	Non Labour	Permanent Labour	Casual Labour	Total Cost
Nursery implementation at Melkasa	Melkasa	1,288.55	434.11	1,036.25	2,758.92
Purchase of fixed farm and office supplies at Melkasa	Melkasa	3,980.90			3,980.90

Experiment Dimension		X	Unit costs	X	#	=	Cost
Land area	X		Planting per m2 at All Locations	X	1	=	159.55
Number of pollinations	X		Pollination at Melkasa	X	1	=	46.20
	X		Researcher time for breeding plan preparation at Melkasa	X	1	=	233.91
	X		Researcher time to prepare fieldscorer file for 1 trial at Melkasa	X	1	=	87.60
	X		Researcher time to prepare harvest label for 1 trial at Melkasa	X	1	=	43.80
	X		Researcher time to prepare tag for 1 trial at Melkasa	X	1	=	43.80
	X		Researcher time to print packet for 1 trial at Melkasa	X	1	=	43.80
Samples	X		Seed packeting for storage per 2-row plot at Melkasa	X	1	=	32.93
Number of rows	X		Seed preparation per row: seed counting and packeting at Melkasa	X	1	=	81.90
Number of pollinations	X		Seed processing per pollination at Melkasa	X	1	=	46.20
Land area	X		Thinning per m2 at All Locations	X	1	=	32.45
Land area	X		Weeding per m2 at All Locations	X	1	=	239.32
Land area	X		Guarding per m2 at All Locations	X	1	=	486.76



Final Output: Cost of Projects (Product concepts)

Projects

Project Name	Non Labour	Undefined Labour	Permanent Labour	Casual Labour	TotalCost	Description
PC3 (Future)	954,836.61	64,491.28	170,625....	428,530....	1,618,483.95	Early maturing maize hybrid
PC5 (Future)	1,260,543.05	64,008.80	277,231....	779,384....	2,381,167.52	Intermediate maturing maize hybrid

Currency ETB 1 = \$42.00

Cost of PC3 = ETB 1,618,483.95 = \$38,535.33

Cost of PC5 = ETB 2,381,167.52 = \$56,694.46



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Ethiopian Institute of Agricultural Research (EIAR)



How did we benefit from the costing tool?



Questions answered by the costing tool

- How much does developing a product cost?
- How much does each project component cost?
- What are the most expensive components in the pipeline?
- Which activity unit costs make the largest contribution to the component cost?
- How can we change our operations to be more cost-effective?
- How can we learn from each other to improve operational efficiency?
- How many resources are needed?
- How can we fit in the available budget?



How much does developing a product cost?

Breeding program costing tool

Setup Export Reports Tools About

Crop Name: Project: **PC3** Component: **Breeding C**

Project overview Projects Experiment Dimensions Activities

Projects

Project Name	Non Labour	Undefined Labour	Permanent Labour	Casual Labour	TotalCost	Description
PC3	954,836.61	64,491.28	170,625....	428,530....	1,618,483.95	Early maturing maize hybrid
PC5	1,260,543.05	64,008.80	277,231....	779,384....	2,381,167.52	Intermediate maturing maize hybrid

Update all projects

Add project

Delete project

Save project

It has helped us know how much running the product pipeline costs starting from breeding cross formation up to release of a variety and breeder seed production.

- That means
 - We can evaluate whether the cost is according to the **market size** (PC3 : PC5 = 40% : 60%)



How much does each project component cost?

Component	Location	Number Of Sites	Cost Per Site	Total Non Labour	Total Undefined Labour	Total Permanent Labour	Total Casual Labour	Total Cost	Comment
Breeding Cross Formation	Melkasa	1	6,485.02	4,532.17	482.48	434.11	1,036.25	6,485.02	
F1 rows	Melkasa	1	5,320.24	4,235.71	482.48	203.78	398.27	5,320.24	
F2 rows	Melkasa	1	26,689.63	13,957.84	482.48	5,285.11	6,964.20	26,689.63	
F3 rows	Melkasa	1	12,956.84	6,904.13	482.48	1,854.40	3,715.84	12,956.84	
TC Formation Stage I with F4 selfing and pathology	Melkasa	1	134,032.41	82,471.30	9,712.00	18,832.20	23,016.91	134,032.41	
OVT Site 1	Melkasa	1	82,411.30	28,090.44	1,096.48	11,894.24	41,330.14	82,411.30	
OVT Site 2	Dhera	1	90,145.00	36,048.54	1,096.48	11,795.24	41,204.74	90,145.00	
OVT Site 3	Miesso	1	83,040.44	28,625.52	1,096.48	11,585.69	41,732.74	83,040.44	
F5 rows	Melkasa	1	11,126.96	6,976.66	482.48	1,336.53	2,331.29	11,126.96	
Test Cross Formation Stage II	Melkasa	1	44,715.78	20,675.74	482.48	8,935.85	14,621.72	44,715.78	
PVT Site 1	Melkasa	1	41,214.31	15,067.87	1,096.48	5,504.39	19,545.58	41,214.31	
PVT Site 2	Dhera	1	49,172.41	23,025.97	1,096.48	5,504.39	19,545.58	49,172.41	
PVT Site 3	Miesso	1	41,608.29	15,317.10	1,096.48	5,409.14	19,785.58	41,608.29	
PVT Site 4	Mehoni	1	50,208.34	23,917.15	1,096.48	5,409.14	19,785.58	50,208.34	

It has helped us know how much it costs to conduct each nursery and trial.

That means

- We know the estimated cost of **each activity**
- We can send adequate resources esp. budget to **other testing sites**
- We can request appropriate resources for **collaborative activities** with seed companies, CIMMYT and other research centers.



Example

- We received 361 hybrids organized in 8 trials from CIMMYT-Zimbabwe in 2018. Each entry was planted on 2-row-plots in 3 replications at 2 locations. Therefore, they had 2,166 plots in total.
- The approved small grant budget for all the trials was \$7,500 (equivalent to ETB 202,500).
- Using the costing tool, we found that the total cost was ETB 333,831.
- This means the contribution of CIMMYT was 61% while that of Ethiopian government was 39%.

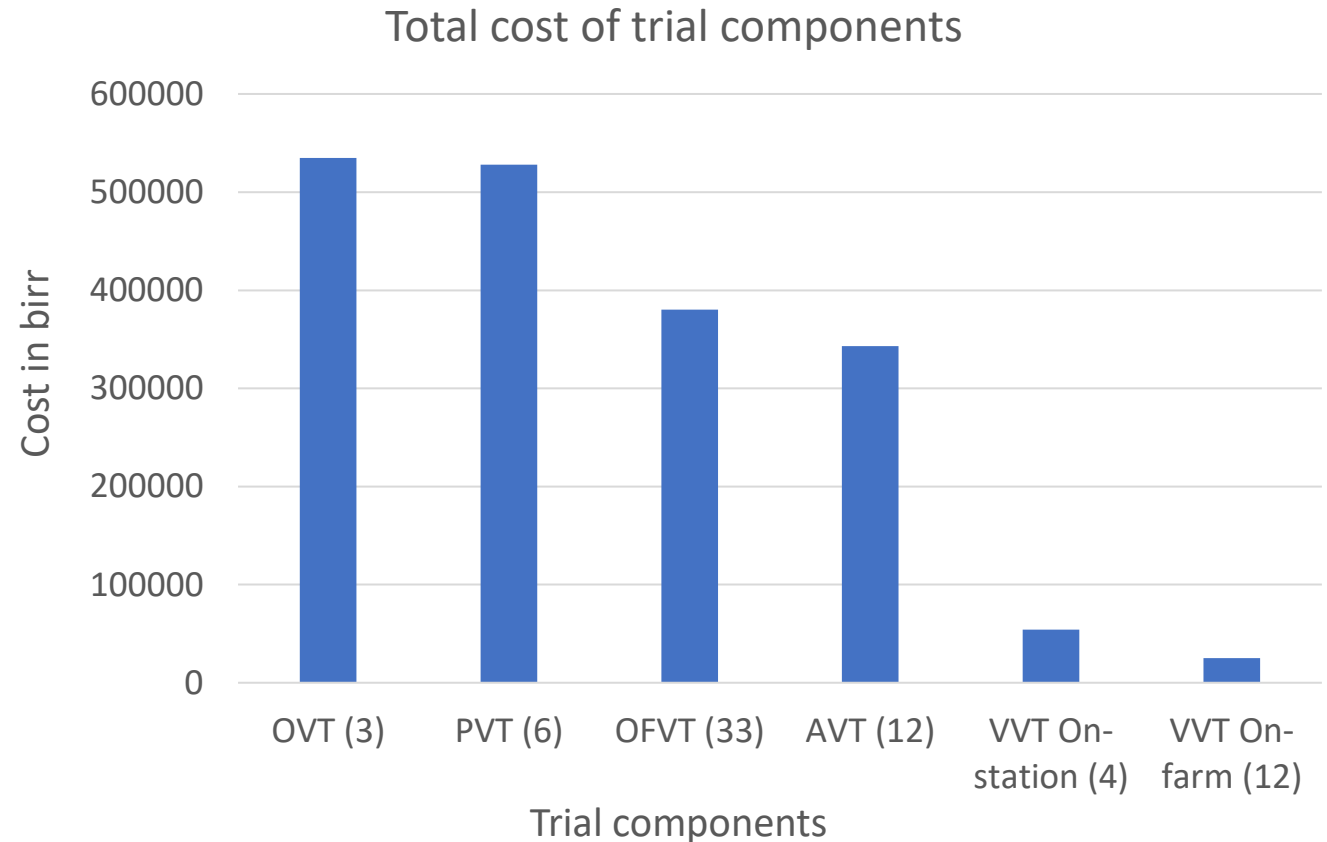


What are the most expensive components in the pipeline?

It has helped us **compare different components** and identify the one with the **most expensive cost**. It shows where we should be the **most efficient**.

It is **OVT** among the trials.

The next question is which of those **activity unit costs** is contributing to the highest cost?



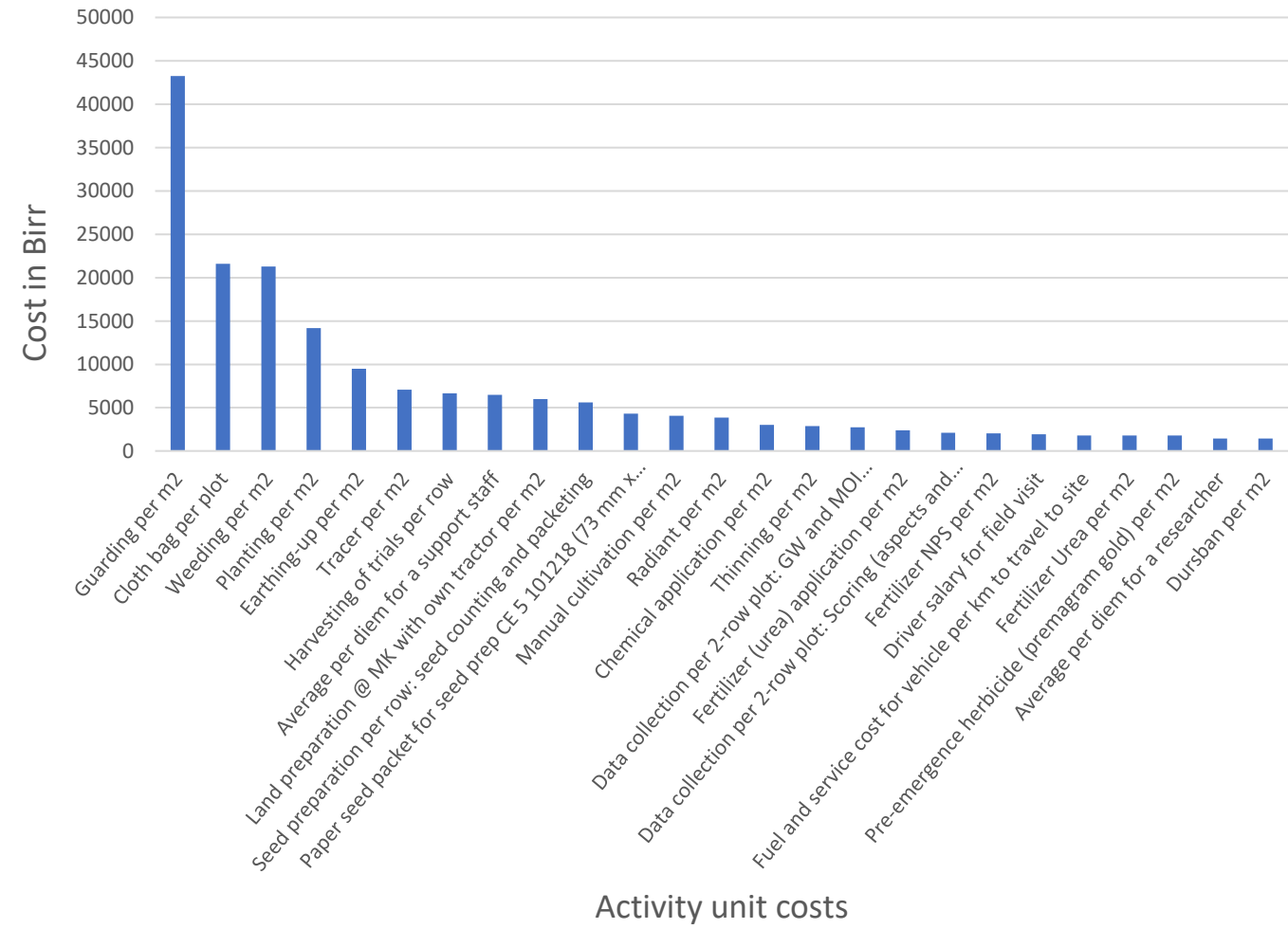


Which activity unit costs make the largest contribution to the component cost?

It has helped us identify tasks and items that make the largest contribution to the cost of a breeding component.

Eg. **Guarding** is the most expensive cost in OVT. Therefore, **Fencing** of trial fields can reduce the cost considerably.

Activity unit costs for OVT at Dhera





How can we change our operations to be more cost-effective?

It has helped us be cost-conscious so that we generate new ideas to do some activities

- Do **stage I test crossing** with two testers in **two isolation blocks** compared to hand-crossing. In doing so we reduced cost of **hand pollination** while incurring detasseling cost.
- **Superimpose stage I test crossing** with **F4 selfing** and **disease screening**. In doing so, we reduced cost of **land preparation, planting, nursery management (weeding, manual cultivation etc.), etc.** for each component separately.



How can we learn from each other to improve operational efficiency?



It has helped us learn from other programs to think how efficiently we can do each task.

Eg. **Cost of harvesting** a trial row

- At Bako = 2.32 birr
- At Melkassa = 3.09 birr

What makes the difference in the cost?

- **Through-put** per unit of labor
(57 vs 42 rows/casual/day)

What makes the difference in through-put?

- **Operational efficiency**
 - Shift work
 - Task specialization





How many resources are needed?

It has helped us plan how many resources (like land, consumables etc.) are needed.

Experiment Dimensions

Experiment Dimensions	Value	Unit
Entries	1100	Number
Replicates	1.3	Number
Samples	1440	Number
Plot length	5.25	m
Rows per plot	2	Number
Row spacing	0.75	m
Buffer percentage	6	Percent
Land area	12020.4	m ²
Row length	4	m
Total number of rows	2880	Number

Experiment Dimensions

Experiment Dimensions	Value	Unit
Entries	14	Number
Replicates	1	Number
Samples	14	Number
Plot length	4.25	m
Rows per plot	3	Number
Row spacing	0.75	m
Buffer percentage	1	Percent
Land area	135.21	m ²
Row length	3	m
Number of crosses	14	Number
Number of pollinations	70	Number
Total number of rows	42	Number

Eg. Land for OVT = 12020.4m² (1.2 ha)

Number of pollen bags needed for breeding cross formation = 70 pollen bags to make 70 pollinations



How can we fit in the available budget?

It has helped us fit our pipeline to available/approved budget to maximize genetic gain per \$.

There are many options:

- Alternative technology
- Smaller population size
- Reduce number of replications
- Reduce number of rows per plot
- Reduce data collection at some locations
- Reduce number of locations
- Postponing some components to the next year, etc.

It has helped us check how much each change can reduce the cost.

Crop Name: Maize

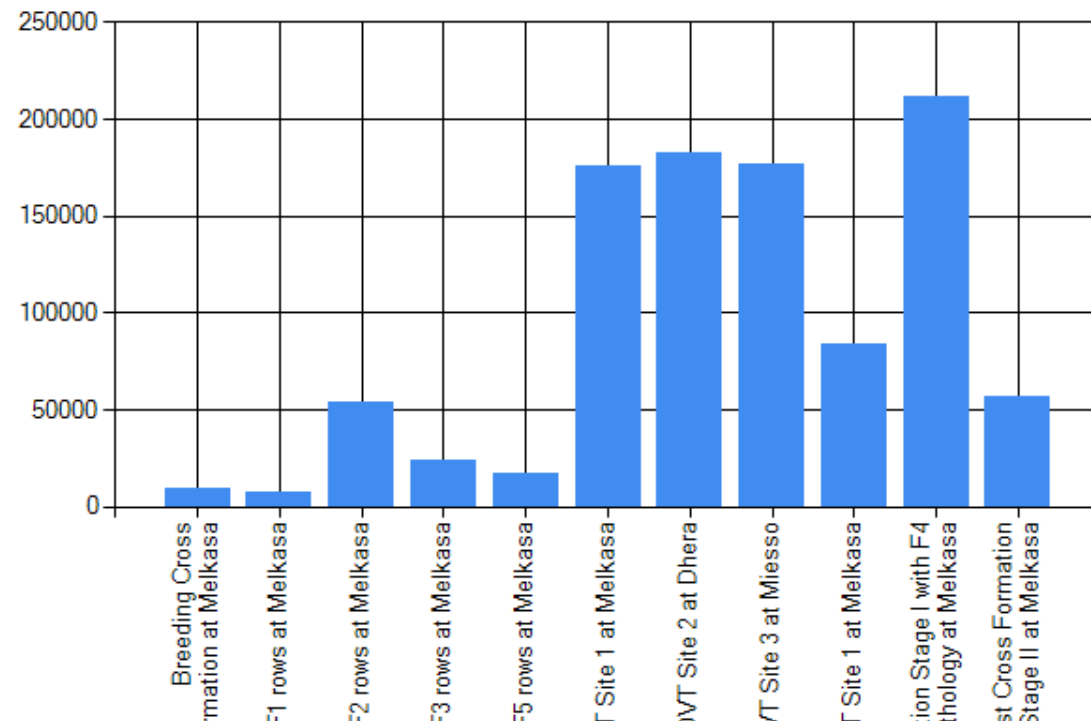
Project: PC5 (without DH)

Component: Seed increase for VVT

Project overview Projects Experiment Dimensions Activities

Component	Sites	Entries	Reps	Samples	Value	Reload	Save
Breeding Cross Formation at Melkasa	1	32	1	32	9,666.75	Reload	Save
F1 rows at Melkasa	1	32	1	32	7,004.36	Reload	Save
F2 rows at Melkasa	1	22	1	22	53,921.70	Reload	Save
F3 rows at Melkasa	1	22	1	22	23,709.49	Reload	Save
TC Formation Stage I with F4 s	1	1100	1	1100	212,063.14	Reload	Save
OVT Site 1 at Melkasa	1	1100	1.3	1440	175,538.86	Reload	Save
OVT Site 2 at Dhera	1	1100	1.3	1440	182,752.56	Reload	Save
OVT Site 3 at Mieso	1	1100	1.3	1440	176,680.65	Reload	Save
F5 rows at Melkasa	1	165	1	165	16,698.63	Reload	Save
Test Cross Formation Stage II a	1	165	1	165	56,599.91	Reload	Save

■ PC5 (without DH)



The interactive project overview function has helped us modify the scale of elements of an existing pipeline and conduct “what if” scenarios to explore the consequences of changing particular elements of the breeding activity or project

Selected Components Activity Costs for selected component Bar chart Pie chart

Close

Crop Name: Project: **PC5 (without DH)**Component: **Seed increase for VVT**

Project overview Projects Experiment Dimensions Activities

 Exclude
 Permanent Labour
 Defined term Labour
 Casual Labour

Component	Sites	Entries	Reps	Samples	Value	Reload	Save
Breeding Cross Formation at Melkasa	1	32	1	32	9,666.75	Reload	Save
F1 rows at Melkasa	1	32	1	32	7,004.36	Reload	Save
F2 rows at Melkasa	1	22	1	22	53,921.70	Reload	Save
F3 rows at Melkasa	1	22	1	22	23,709.49	Reload	Save
TC Formation Stage I with F4 selection and pathology at Melkasa	1	1100	1	1100	212,063.14	Reload	Save
OVT Site 1 at Melkasa	1	1100	1.3	1440	175,538.86	Reload	Save
OVT Site 2 at Dhera	1	1100	1.3	1440	182,752.56	Reload	Save
OVT Site 3 at Mieso	1	1100	1.3	1440	176,680.65	Reload	Save
F5 rows at Melkasa	1	165	1	165	16,698.63	Reload	Save
Test Cross Formation Stage II at Melkasa	1	165	1	165	56,599.91	Reload	Save



What if I reduce the number of entries for the highest costing component?

Project Total:

Chart by:

 Selected Components Activity Costs for selected component Bar chart Pie chart

Close

Crop Name: Project: **PC5 (without DH)**Component: **Seed increase for VVT**Project overview **Projects** Experiment Dimensions Activities
 Exclude
 Permanent Labour
 Defined term Labour
 Casual Labour

Component	Sites	Entries	Reps	Samples	Value	Reload	Save
Breeding Cross Formation at Melkasa	1	32	1	32	9,666.75	Reload	Save
F1 rows at Melkasa	1	32	1	32	7,004.36	Reload	Save
F2 rows at Melkasa	1	22	1	22	53,921.70	Reload	Save
F3 rows at Melkasa	1	22	1	22	23,709.49	Reload	Save
TC Formation Stage I with F4 selfing and pathology at Melkasa	1	700	1	700	179,946.46	Reload	Save
OVT Site 1 at Melkasa	1	1100	1.3	1440	175,538.86	Reload	Save
OVT Site 2 at Dhera	1	1100	1.3	1440	182,752.56	Reload	Save
OVT Site 3 at Mieso	1	1100	1.3	1440	176,680.65	Reload	Save
F5 rows at Melkasa	1	165	1	165	16,698.63	Reload	Save
Test Cross Formation Stage II at Melkasa	1	165	1	165	56,599.91	Reload	Save
PVT Site 1 at Melkasa	1	495	1.3	650	83,926.19	Reload	Save
						Reload	Save

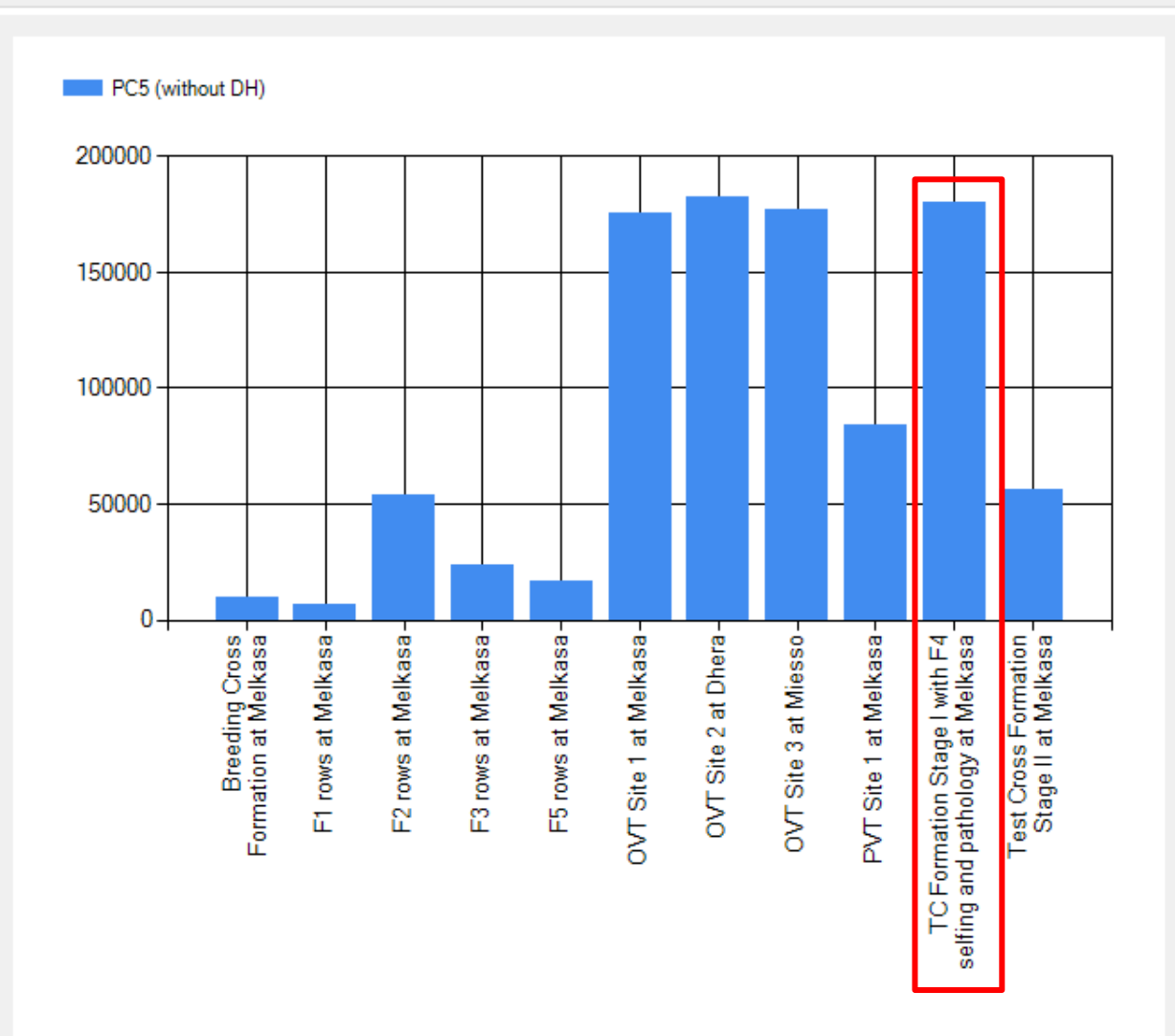
Project Total: **966,445.56**

Chart by:

 Selected Components Activity Costs for selected component Bar chart Pie chart

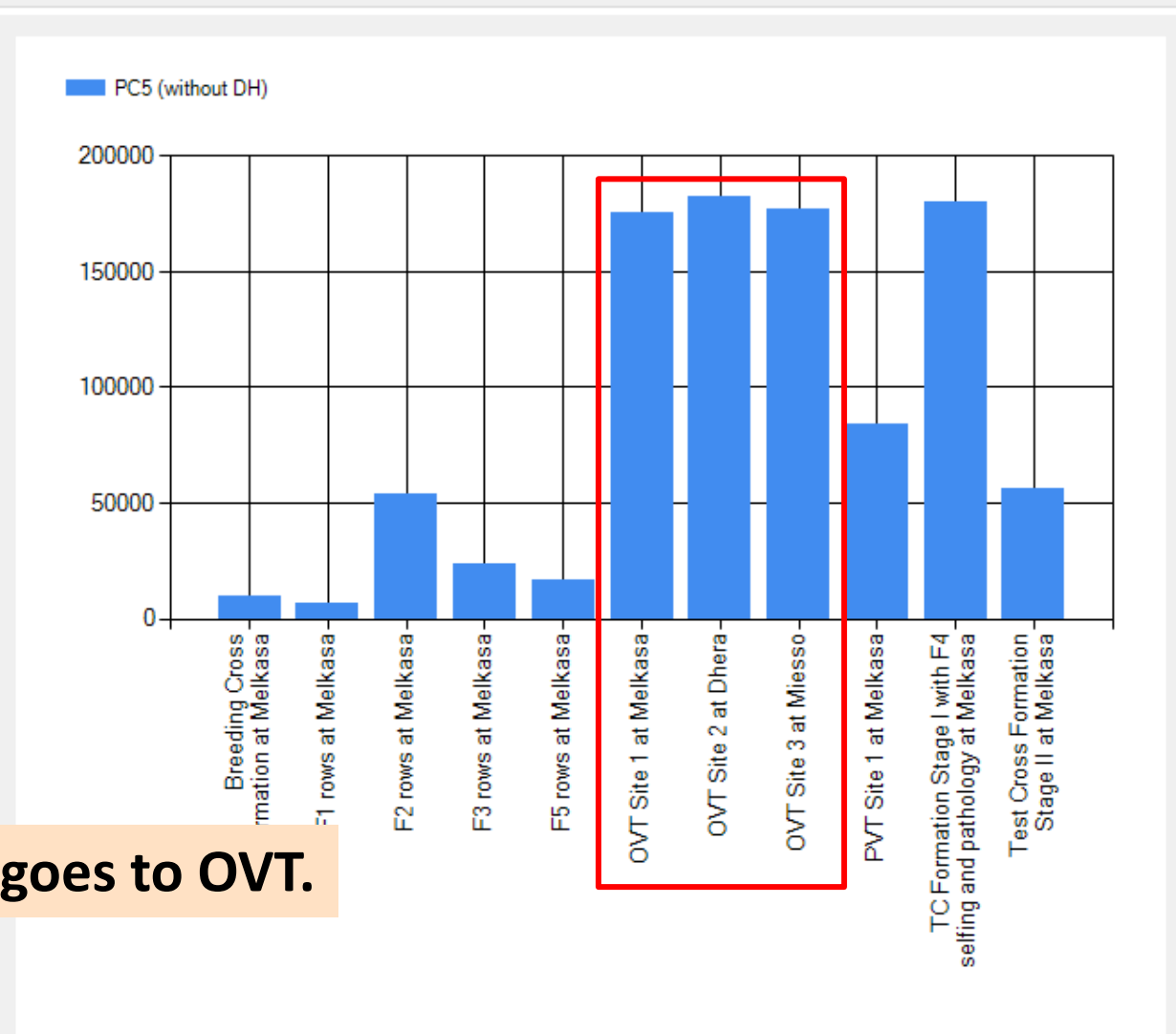
Close

Crop Name: Project: **PC5 (without DH)**Component: **Seed increase for VVT**

Project overview Projects Experiment Dimensions Activities

> Exclude Permanent Labour Defined term Labour Casual Labour

Component	Sites	Entries	Reps	Samples	Value	Reload	Save
Breeding Cross Formation at Melkasa	1	32	1	32	9,666.75	Reload	Save
F1 rows at Melkasa	1	32	1	32	7,004.36	Reload	Save
F2 rows at Melkasa	1	22	1	22	53,921.70	Reload	Save
F3 rows at Melkasa	1	22	1	22	23,709.49	Reload	Save
TC Formation Stage I with F4 selection	1	700	1	700	179,946.46	Reload	Save
OVT Site 1 at Melkasa	1	1100	1.3	1440	175,538.86	Reload	Save
OVT Site 2 at Dhera	1	1100	1.3	1440	182,752.56	Reload	Save
OVT Site 3 at Mieso	1	1100	1.3	1440	176,680.65	Reload	Save
F5 rows at Melkasa	1	165	1	165	16,698.63	Reload	Save
Test Cross Formation Stage II at Melkasa	1	165	1	165	56,599.91	Reload	Save



This reduces the number of entries that goes to OVT.

Project Total: **966,445.56**

Chart by:

 Selected Components Activity Costs for selected component Bar chart Pie chart

Close

Crop Name: Project: **PC5 (without DH)**Component: **Seed increase for VVT**

Project overview Projects Experiment Dimensions Activities

> Exclude Permanent Labour Defined term Labour Casual Labour

Component	Sites	Entries	Reps	Samples	Value	Reload	Save
Breeding Cross Formation at Melkasa	1	32	1	32	9,666.75	Reload	Save
F1 rows at Melkasa	1	32	1	32	7,004.36	Reload	Save
F2 rows at Melkasa	1	22	1	22	53,921.70	Reload	Save
F3 rows at Melkasa	1	22	1	22	23,709.49	Reload	Save
TC Formation Stage I with F4 selection	1	700	1	700	179,946.46	Reload	Save
OVT Site 1 at Melkasa	1	700	1.3	910	117,323.11	Reload	Save
OVT Site 2 at Dhera	1	700	1.3	910	124,717.01	Reload	Save
OVT Site 3 at Miesso	1	700	1.3	910	117,946.96	Reload	Save
F5 rows at Melkasa	1	165	1	165	16,698.63	Reload	Save
Test Cross Formation Stage II at Melkasa	1	165	1	165	56,599.91	Reload	Save

What if the number of reps increased?

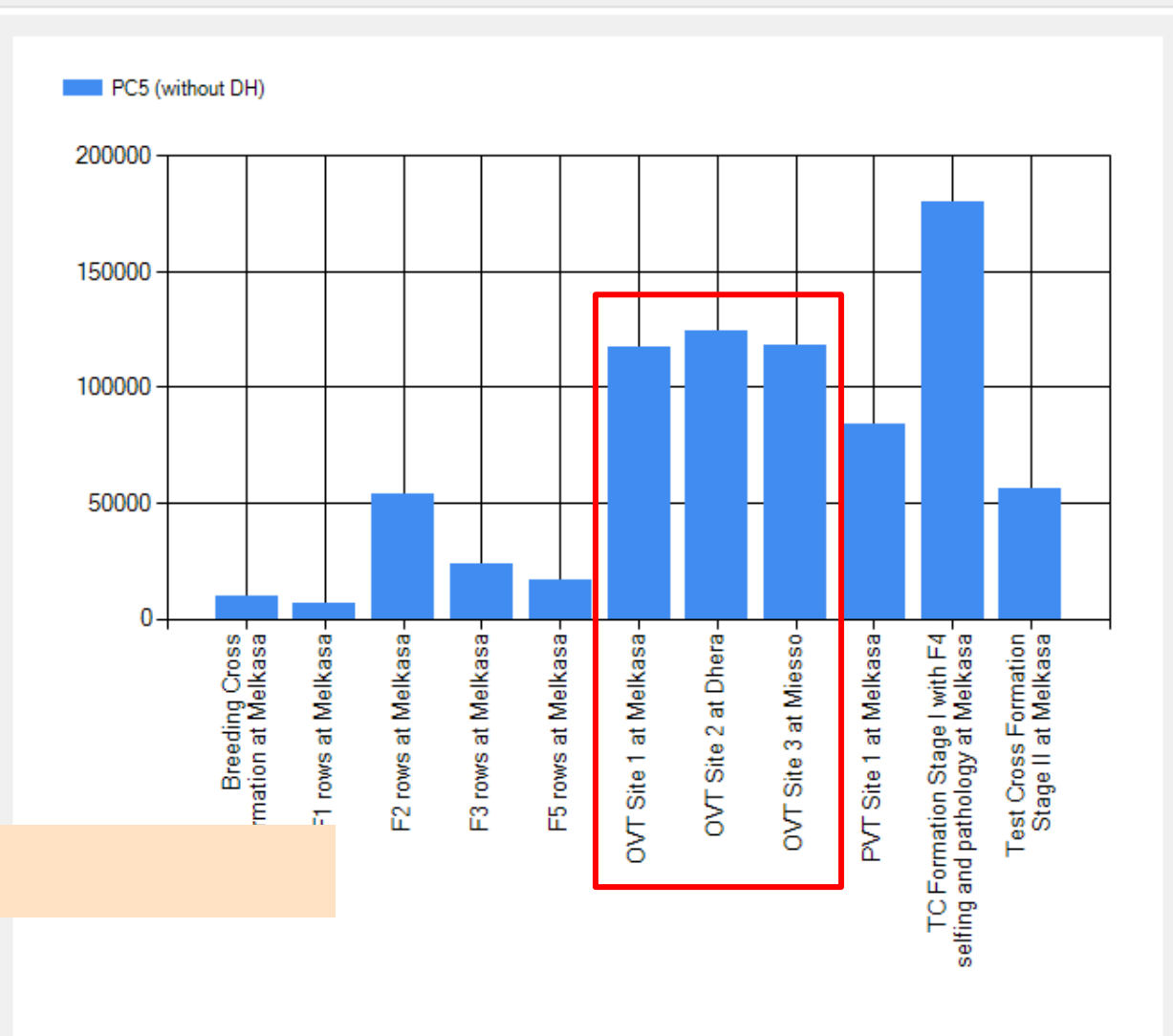
Project Total: **791,460.57**

Chart by:

 Selected Components Activity Costs for selected component Bar chart Pie chart

Close

Trade-offs

- Including more genotypes in a partially-replicated design vs a small number of genotypes in a 2 replicated column-row design
- Increasing entry number at a limited number of sites versus reduced entries at more locations

TC Formation Stage I with F4 s	1	700	1	700	179946.46	Reload	Save
OVT Site 1 at Melkasa	1	700	2	1400	171145.22	Reload	Save
OVT Site 2 at Dhera	1	700	2	1400	178372.52	Reload	Save
OVT Site 3 at Miesso	1	700	2	1400	172247.92	Reload	Save

We decided finally to have more genotypes (1100 entries) with partially-replicated design (1.3 replications)!

						Reload	Save
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Project Total: 953,239.15

and increase for VVT

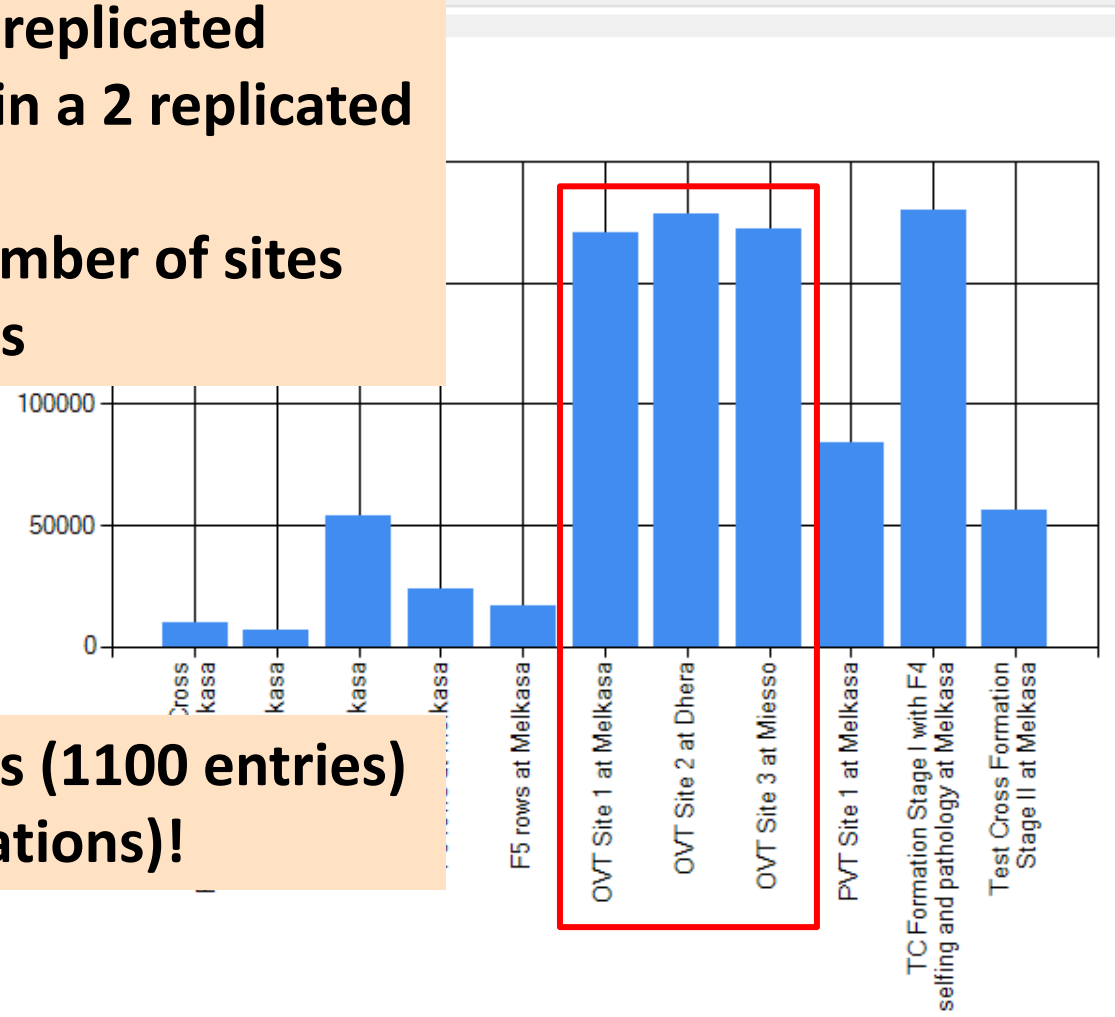


Chart by: Selected Components Activity Costs for selected component Bar chart Pie chart

Close

Projects

Project Name	Undefined Labour	Permanent Labour	Casual Labour	TotalCost	Description	Non Labour
PC3 (without DH)	64,491.28	170,625.59	428,530.47	1,618,483.95	Early maturing maize hybrid	954,836.61
PC5 (without DH)	65,339.07	278,210.99	780,174.68	2,389,915.22	Intermediate maturing maize hybrid	1,266,190.48
PC5 (DH only)	48,245.00	254,844.13	742,994.69	3,549,894.35	Intermediate maturing maize hybrid	2,503,810.53
PC5 (Conventional + DH)	52,373.88	272,801.66	773,033.47	2,643,712.89	Intermediate maturing maize hybrid	1,545,503.88

- Update all projects
- Add project
- Delete project
- Save project

Components

Component	Location	Number Of Sites	Cost Per Site	Total Non Labour	Total Undefined Labour	Total Permanent Labour	Total Casual Labour	Total Cost	Comment
Breeding Cross Formation	Melkasa	1	9,666.75	5,823.36	482.48	992.27	2,368.64	9,666.75	
F1 rows	Melkasa	1	7,004.36	5,145.73	482.48	465.79	910.36	7,004.36	
F2 rows	Melkasa	1	53,921.70	26,490.73	482.48	11,627.25	15,321.24	53,921.70	
F3 rows	Melkasa	1	23,709.49	10,972.54	482.48	4,079.67	8,174.80	23,709.49	
TC Formation S									
OVT Site 1									
OVT Site 2									
OVT Site 3									
F5 rows									
Test Cross Form									
PVT Site 1	Melkasa	1	83,926.19	28,554.75	1,096.48	11,926.18	42,348.78	83,926.19	
PVT Site 2	Dhera	1	91,629.49	36,258.05	1,096.48	11,926.18	42,348.78	91,629.49	

By default 7 working hours per day and 255 working days per year are assumed for labour unit cost calculations. These values can be changed under Setup->Settings or Tools->Settings.

- Add component
- Delete component
- Save component

Close

It has helped us compare the costs of two alternative breeding pipelines

- We compared conventional line development vs DH vs both pipelines using the duplicated function for project and project components**



Thank you