Corn Trait Introgression

Prospects and Opportunities

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Trait Introgression program mission

- Deliver high **quality** conversions & enable the trait pipeline… **timely** & **efficiently**

Key Accountabilities

- Hand off events & traits to testing
- Hand off commercial conversions to manufacturing

Right products, right place, right time

Product Concept

What & Why

Trait Value

Breeding germplasm

Market Need

Conversion Process

When, Where, How

Trait Strategy

Conversion Strategy

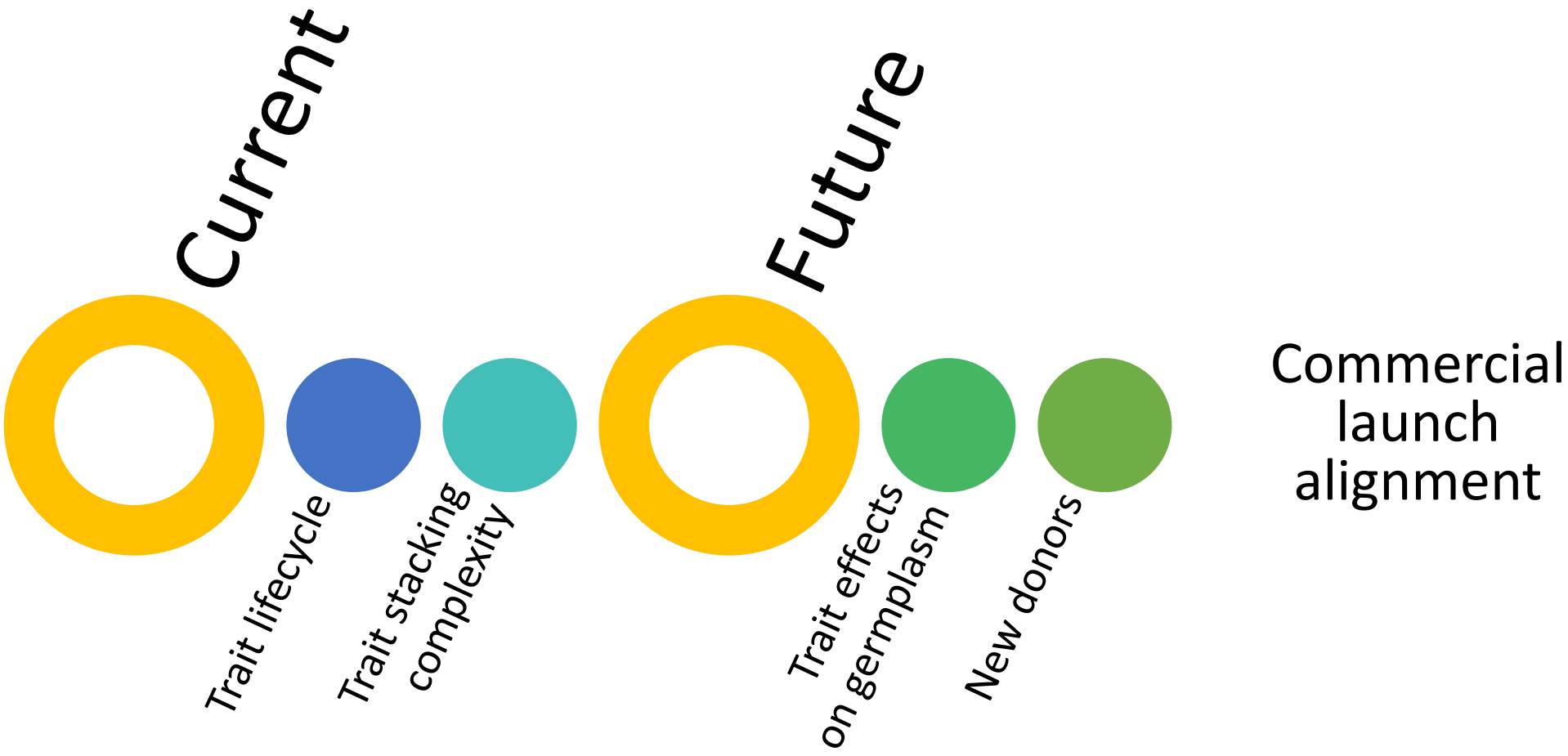
On time Hand-off & Testing

What, When, How much

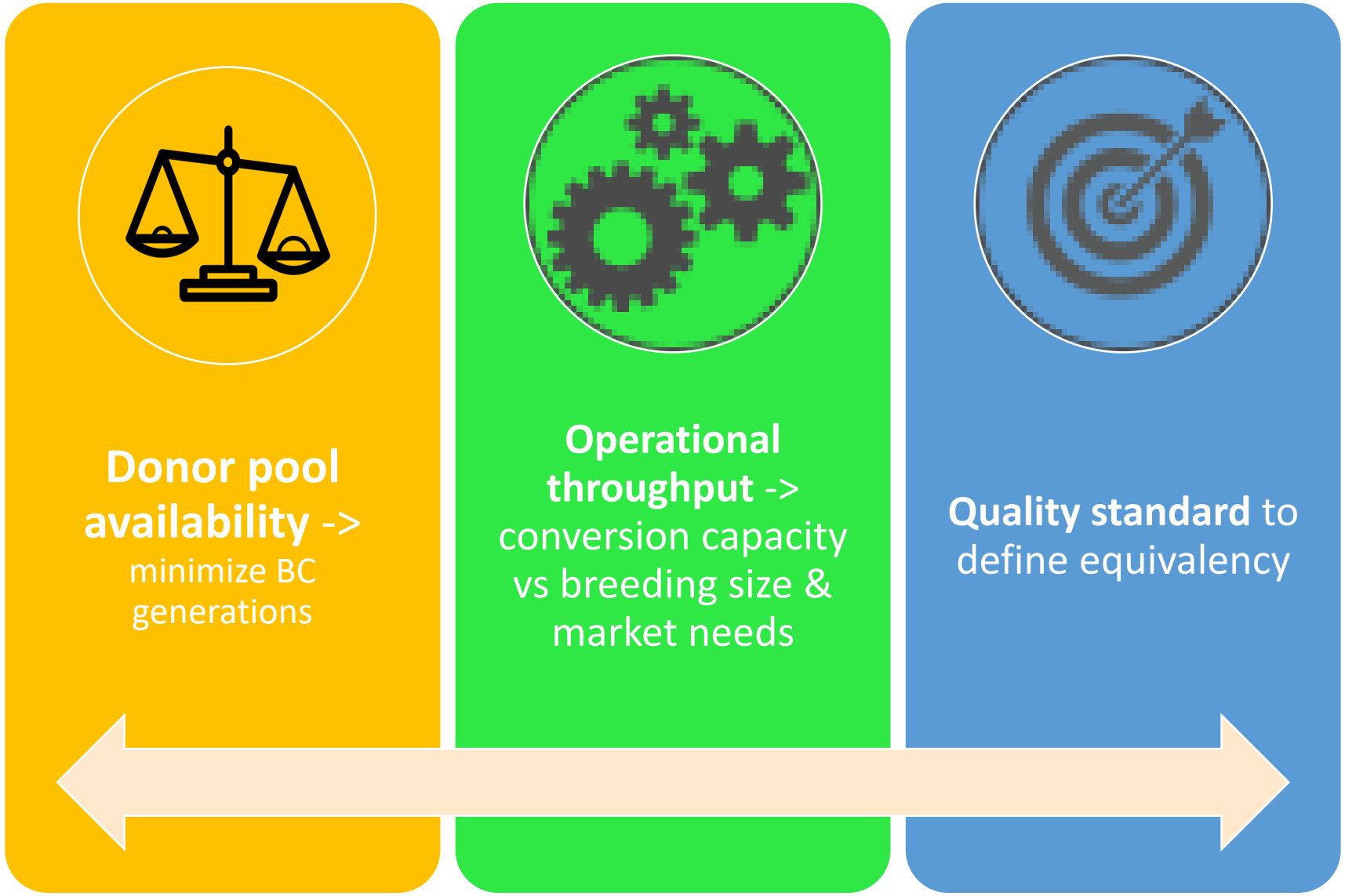
Pipeline integration

Define the key Trait Strategy

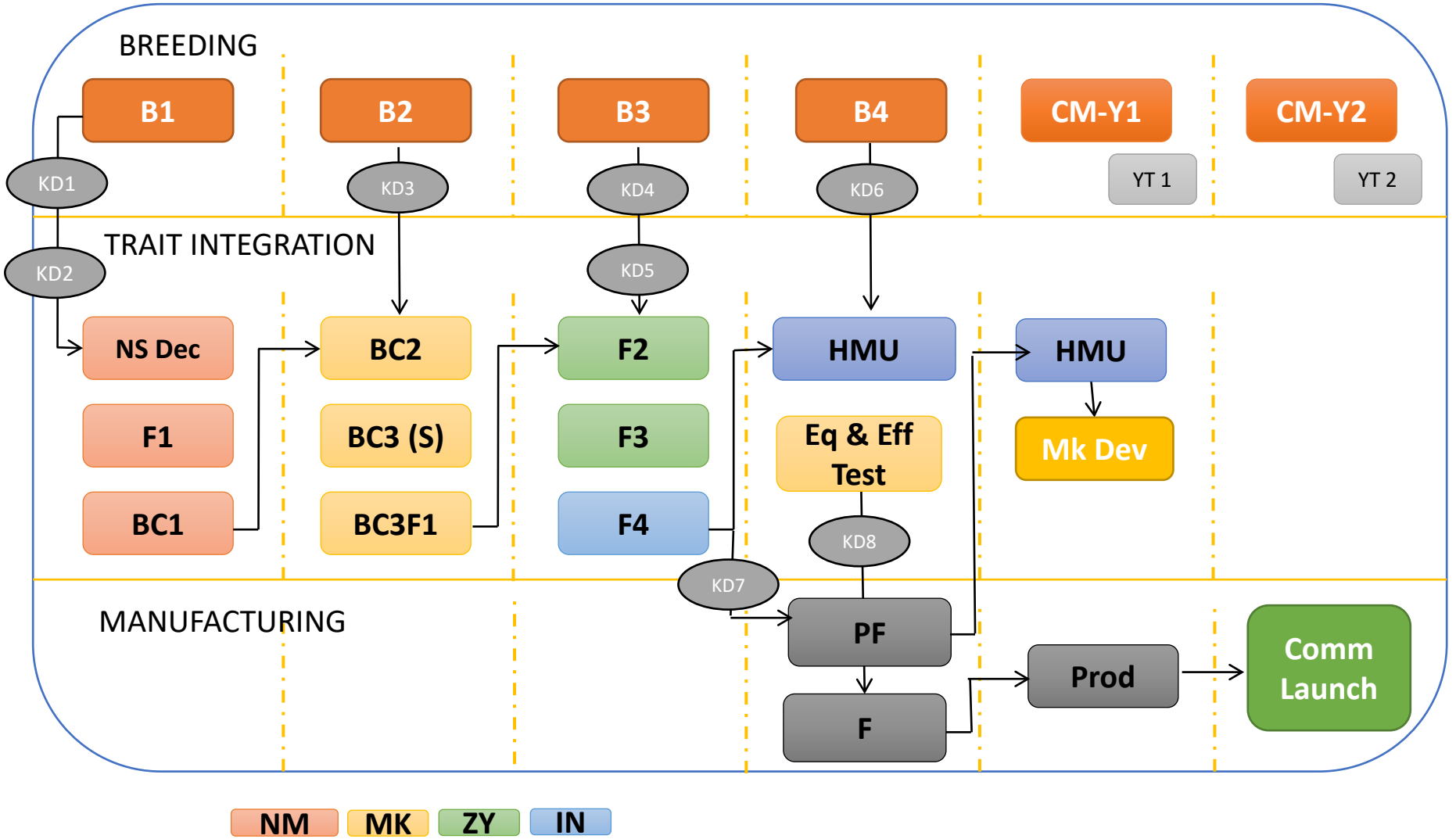
What & When



Conversion strategy – Where & How



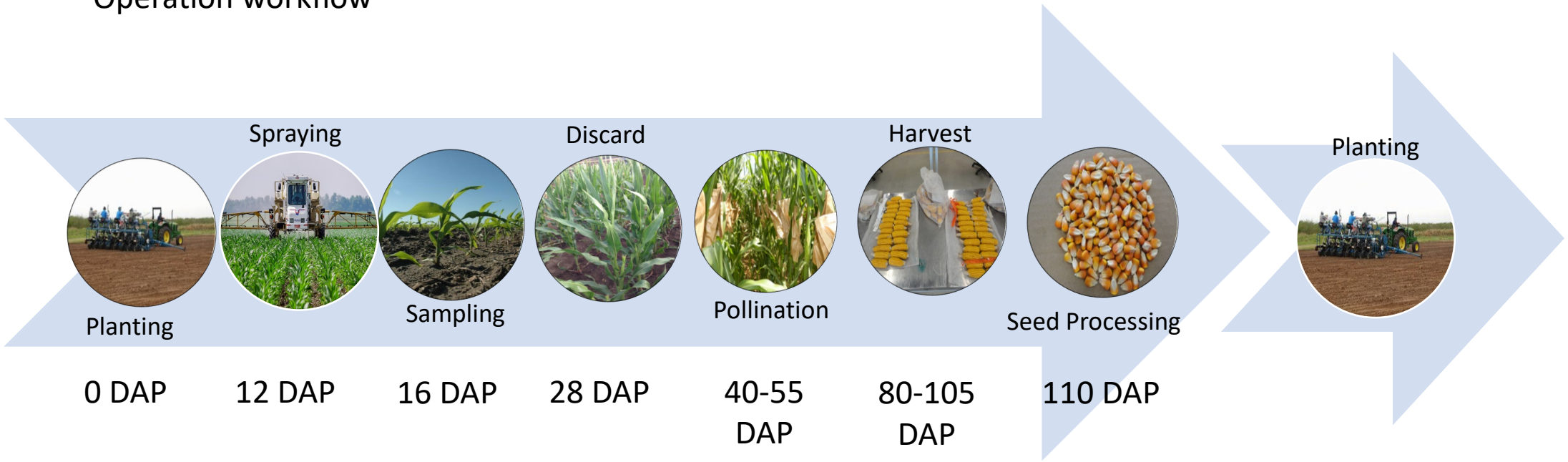
Successful product delivery requires tight coordination



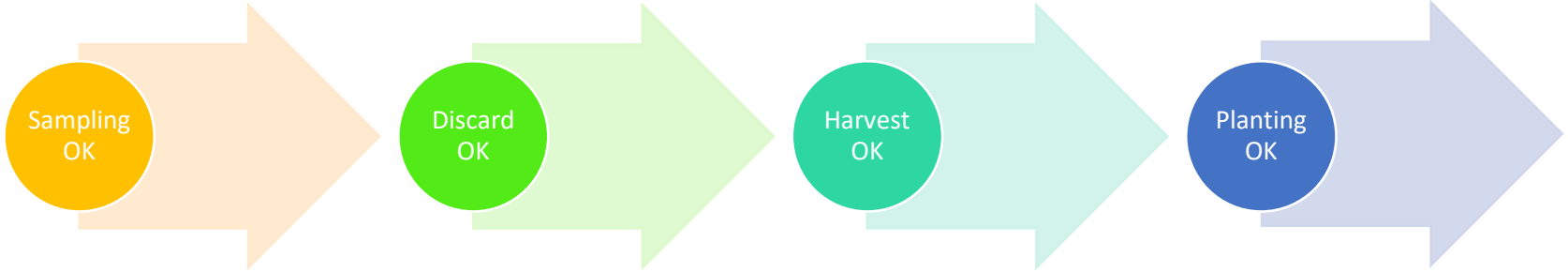
Key Decisions	
KD1	Trait Strategy
KD2	Donor Selection
KD3	Keep List
KD4	Keep List
KD5	Increase List
KD6	Equivalency Testing List
KD7	Pre-Foundation Handoff
KD8	Primary Version Selection/Naming

Operational Integration to drive key decisions

Operation workflow



Key Decision workflow



Case study

- 3 trait stack -> SmartStax female
  - 2T -> 1 Lab (Ins) & 1 Field (RR-Ins) selection
  - 1T -> Field selection (LL-Ins)
- Starting with low quality donors -> 3 MABC generations
  - Panel of 60 markers for background in R2
- Starts in December -> 3 generations per year
- Breeding keep list of 50% every year
- Hand off 2 versions-> 1 per family
- Quality conversion: >95% RP recovery (equivalent to BC4 in conventional BC)
- Germination: 85%
- Selection intensity: ~10%

Non-Marker Generations

- Ensure conversions start clean
  - QC= assay panel for adventitious presence traits on both RP and D
- Fingerprint previous generation to MABC
- Watch for cytoplasm and donor-RP planting split
- Relatively less expensive (~15 to 25% of conversion costs)

	SREs			Lab Data Points				
	2T	1T	Total ($)	HT-2T	HT-1T	PT-2T	PT-1T	Total ($)
NS	200	200	$6,400			2,938*	2,938*	$2,350
F1	200	200	$6,400	9,600*	4,800*			$2,160
BC1	300	200	$8,000	4,800	1,600			$10,960

FP

HT - high throughput lab, PT - proficiency tested, FP - Fingerprint

Marker Generations

- The efficiency of marker-assisted backcrossing depends on the population size of each generation, distance of markers from the target locus, and number of background markers.
  - As a reference to obtain a response to selection of ~10% with 60 markers, a population size of 180 is required in maize, corresponding to ~5400 marker data points
- Resource intensive (~55 to 75% of conversion costs)
  - watch footprint of NRP after selection for best individuals
- Highly dependent on lab performance
  - Particularly turnaround time dictating time of discard -> impact on planting footprint and plant performance

	SREs			Lab Data Points				
	2T	1T	Total ($)	HT-2T	HT-1T	PT-2T	PT-1T	Total ($)
BC2	900	600	$31,500	335,800	294,800			$94,590
BC3 (S)	600	450	$22,050	335,800	294,800			$94,590
BC3F1	1200		$25,200	354,200				$53,130

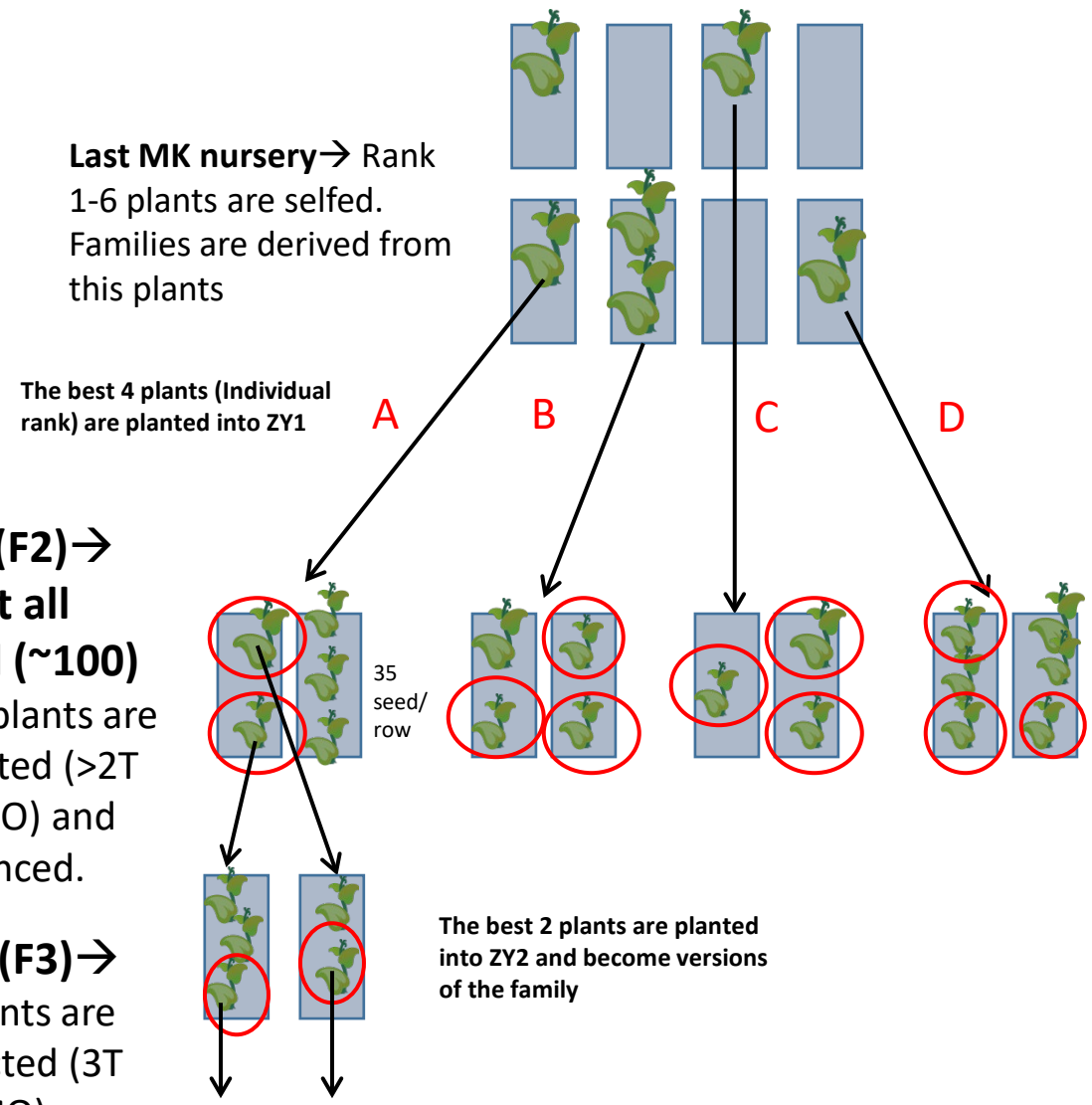
HT - high throughput lab, PT - proficiency tested, FP - Fingerprint

Zigocity workflow

- The goal is to fix the traits (Homo)
- Relatively less resource intense (~10 % of conversion costs)
- Highly dependent on lab performance
  - Turnaround time -> plant performance
  - Lab concordance -> can increase cost up to 30% (re-sampling)
  - Missing data

	SREs		Lab Data Points		
	3T	Total ($)	HT-3T	PT-3T	Total ($)
F2	400	$7,600	28,688	4,200	$5,983
F3	200	$3,800	22,950	1,800	$4,163

HT - high throughput lab, PT - proficiency tested, FP - Fingerprint



2 families and 2 versions/family are advanced to increase

Increase and Hybrid Make-Up

- Final conversion quality check
  - Adventitious presence in all plots
  - Fingerprint by version
  - Event of interest all plants (verify HOMO state)
- Targets driven by testing plans
- Potentially increase could be integrated with zygocity to skip one cycle
- Less intense but larger volumes (<10% of a conversion cost)

	SREs		Lab Data Points		
	3T	Total ($)	HT-3T	PT-3T	Total ($)
F4	200	$3,600		9,100	$8,140
HMU	400	$7,200			

FP

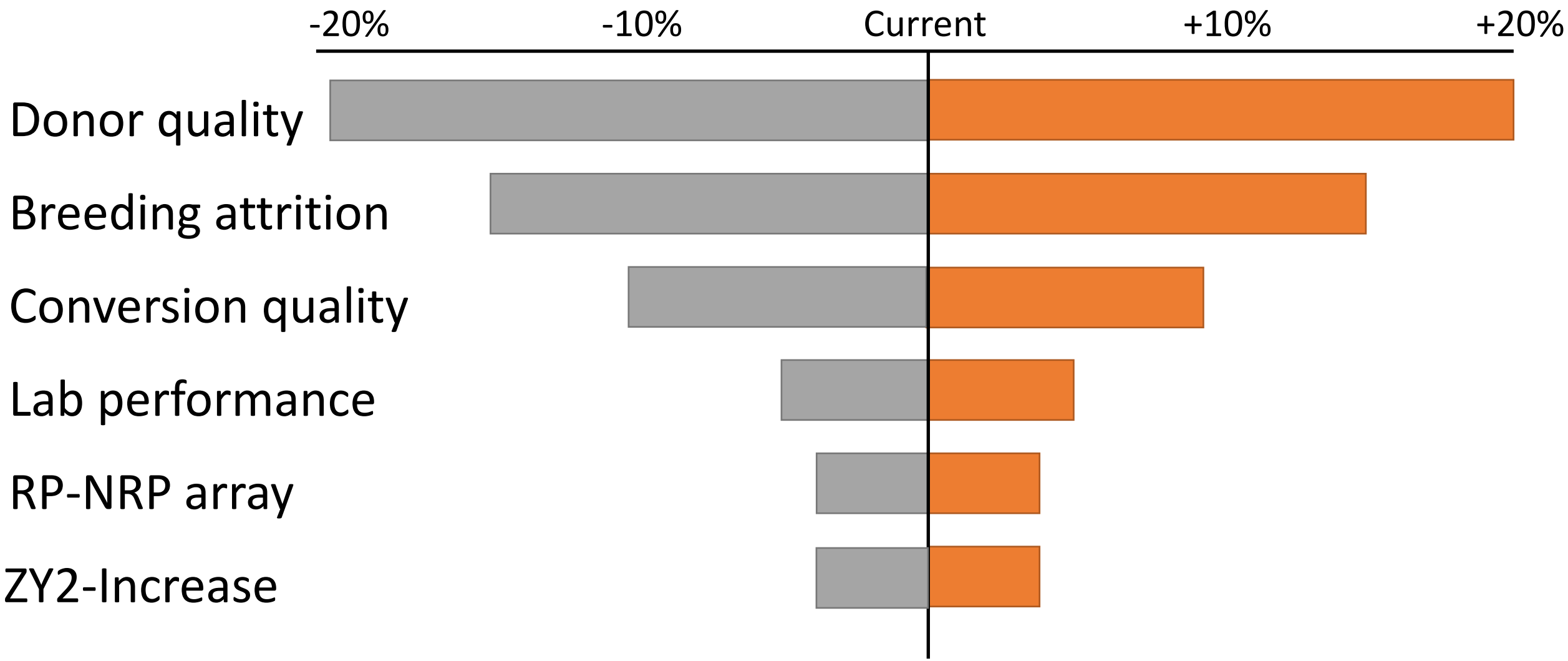
HT - high throughput lab, PT - proficiency tested, FP - Fingerprint

Cost Summary

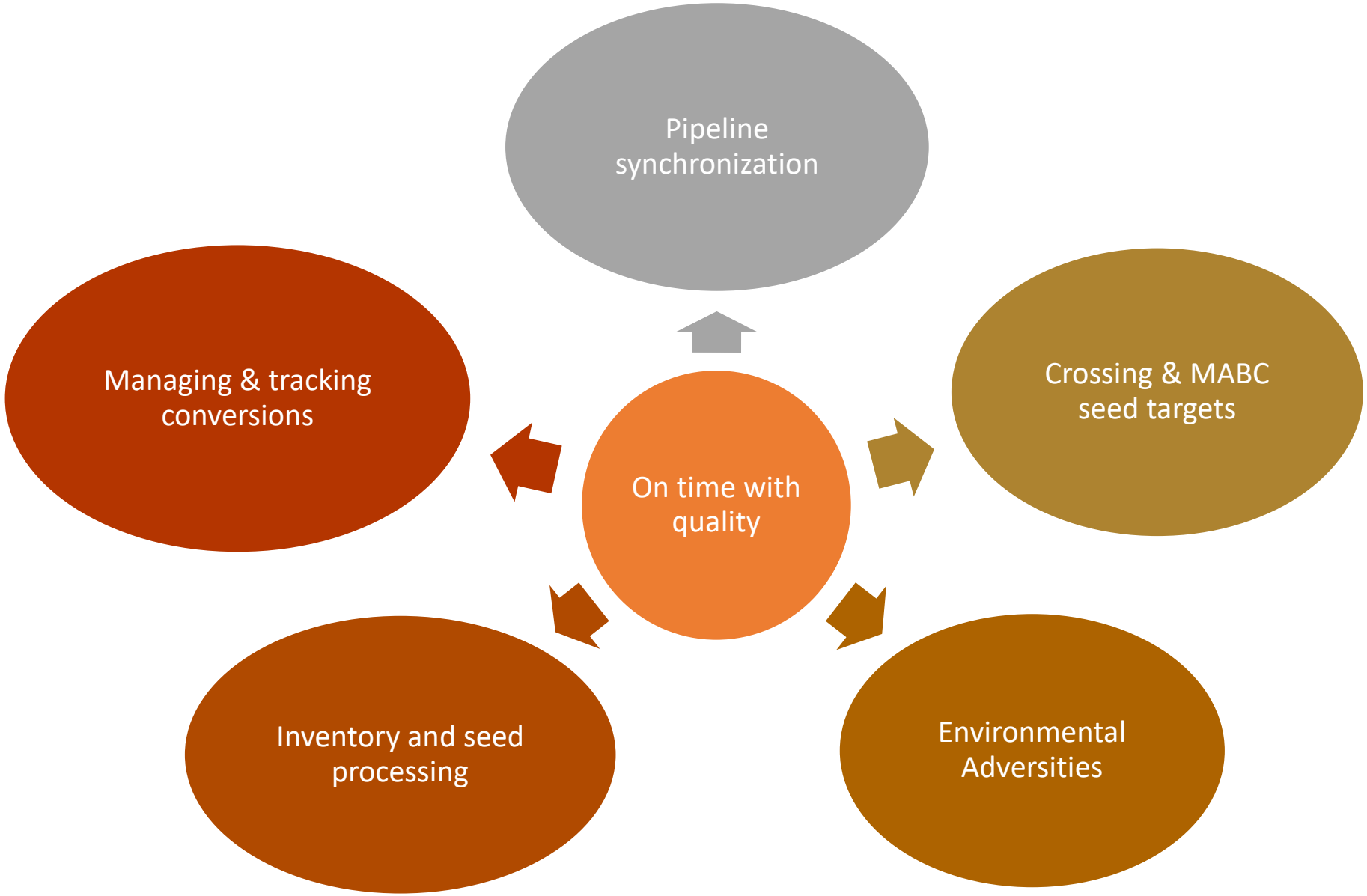
Year	Gen	Trait	Nursery	Start Date	End Date	Ear Target	Cycle	Lines	SRE/conv	DTP	SRE cost	Lab cost	Total cost	Type
1	NS	MON88-MON89	16-NS-2T	12/5/2015	4/3/2016	1	120	100	2	2,938	$ 3,200	$ 1,175	$ 4,375	NS
1	NS	HXCB	16-NS-1T	12/5/2015	4/3/2016	1	120	100	2	2,938	$ 3,200	$ 1,175	$ 4,375	NS
1	F1	MON88-MON89	16-F1-2T	4/3/2016	8/1/2016	2	120	100	2	9,600	$ 3,200	$ 1,440	$ 4,640	MAS
1	F1	HXCB	16-F1-1T	4/3/2016	8/1/2016	2	120	100	2	4,800	$ 3,200	$ 720	$ 3,920	MAS
1	BC1	MON88-MON89	16-BC1-2T	8/1/2016	11/29/2016	6	120	100	3	4,800	$ 4,800	$ 9,720	$ 14,520	MAS
1	BC1	HXCB	16-BC1-1T	8/1/2016	11/29/2016	4	120	100	2	1,600	$ 3,200	$ 9,240	$ 12,440	MAS
2	BC2	MON88-MON89	16-BC2-2T	11/29/2016	3/29/2017	6	120	50	18	335,800	$ 18,900	$ 50,370	$ 69,270	MABC
2	BC2	HXCB	16-BC2-1T	11/29/2016	3/29/2017	4	120	50	12	294,800	$ 12,600	$ 44,220	$ 56,820	MABC
2	BC3	MON88-MON89	16-BC3-2T	3/29/2017	7/27/2017	5	120	50	12	335,800	$ 12,600	$ 50,370	$ 62,970	MABC
2	BC3	HXCB	16-BC3-1T	3/29/2017	7/27/2017	5	120	50	9	294,800	$ 9,450	$ 44,220	$ 53,670	MABC
3	F1	SS	16-F1S-3T	7/27/2017	11/24/2017	4	120	50	24	354,200	$ 25,200	$ 53,130	$ 78,330	MABC
3	F2	SS	16-F2S-3T	11/24/2017	3/24/2018	100pp	120	25	16	32,888	$ 7,600	$ 5,983	$ 13,583	ZYG
3	F3	SS	16-F3S-3T	3/24/2018	7/22/2018	100pp	120	25	8	24,750	$ 3,800	$ 4,163	$ 7,963	ZYG2
3	F4	SS	16-F4S-3T	7/22/2018	11/19/2018	20-25	120	25	8	9,100	$ 3,600	$ 8,140	$ 11,740	INC
3	HMU	SS	HMU	11/19/2018	3/19/2019	20-25	120	25	16		$ 7,200	$ -	$ 7,200	INC
3	F5S	SS	Hand-off	3/19/2019	Apr-19						$ 121,750	$ 284,066	$ 405,816	
											31%	69%	$ 901,813	

Nursery Type	Cost	Percent of Total
NM	$ 44,270	11%
MK	$ 321,060	79%
ZY	$ 21,546	5%
IN	$ 18,940	5%
Cost of conversion	$ 4,055	

Factors that impact the cost of conversion



Opportunities in conversion



Thank you

Questions?