Demand-Led Plant Breeding

Chapter 5

Variety Development Strategy and Stage Plan

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Chapter 5 Objectives

1. **Variety development strategy and stage plan:**
   - To enable plant breeders to construct a high quality, well-documented demand-led breeding strategy and a development stage plan, to enable good governance, rigorous decision-making and activity planning within a demand-led breeding project.

2. **Stakeholder engagement:** To ensure the variety development strategy and stage plan allow for involvement of stakeholders at key decision points on:
   - The design, development and release of new varieties;
   - Enabling new varieties to reach farmers; and
   - Provide feedback on product performance and farmer adoption.

Contents

1. New variety development strategy
2. Development stage plan
3. Timelines and critical paths
4. Risk management
5. Variety registration

1. Variety Development Strategy

Variety Development Strategy

- A ***development strategy*** defines the core breeding goal and creates a framework for decision-making and investment.

- The strategy analyses the external environment, defines problem and answers key questions on the product being developed: '***what***', '***why***', '***for whom***' and ***'how'?***

- The strategy has a broader scope than a development plan and considers the end product and adoption. It should precede preparing the development stage plan.

Variety Development Strategy

1. Crop supply and demand landscape - ‘the problem’
2. Policy and enabling environment
3. Market analysis
4. Target clients and market segments
5. Variety design and market positioning
6. Intellectual property
7. Development stage and activity plan/timetable
8. Development costs
9. Development investment case
10. Project governance and decision-making
11. Client awareness and raising demand
12. Seed system and delivery to farmers
13. Monitoring post release performance and adoption
14. Performance measures and risk management

Group exercise – Development Strategy

- What should a variety development strategy contain?
- Why does each component matter in a demand-led breeding program?
- What are the benefits of creating a development strategy?

2. Development Stage Plan

Development Stage Plan

- A stage plan is the key tool for supporting timely decision-making and if a new genotype/line is ready for progression to the next stage and further investment.
- It contains all activities needed to deliver a new variety from initial design to use by farmers.
- Activities are mapped onto different stages of progression along the timeline.
- Stages are directly linked and so must communicate with each other.

Development Stage Plan

A Stage Plan includes the following key activities:

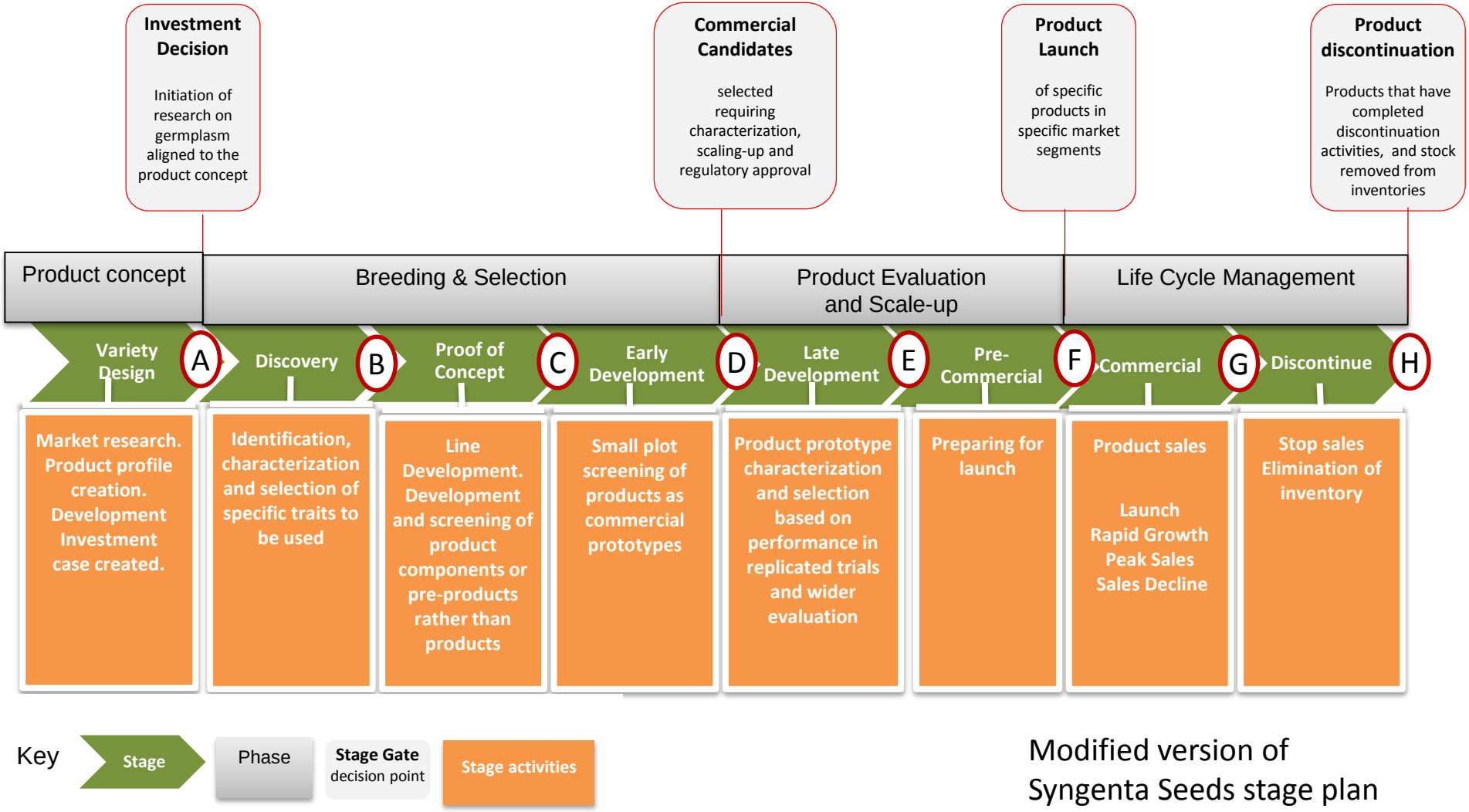
- Development planning
- Variety design
- Breeding, testing and evaluation
- Variety registration and scale up
- Seed production
- Monitoring and evaluation – at all stages of the variety development process

Five key elements of the Stage Plan

1. **Development planning:** Brings in constructive ideas from all key stakeholders.
2. **Variety design:** Makes decisions on the type of a variety to be developed according to the criteria set by clients.
3. **Breeding and evaluation:** Identifying key resources (funds, personnel, facilities and institutions) required to determine a critical path and shortest route to delivery of the variety.
4. **Variety registration and scale-up:** Essential for plant breeders to understand the registration requirements, costs and timelines; and engage with regulatory officials from an early stage.
5. **Seed distribution and farmer access to seed:** Access to high quality, affordable seed to drive adoption and success of variety.

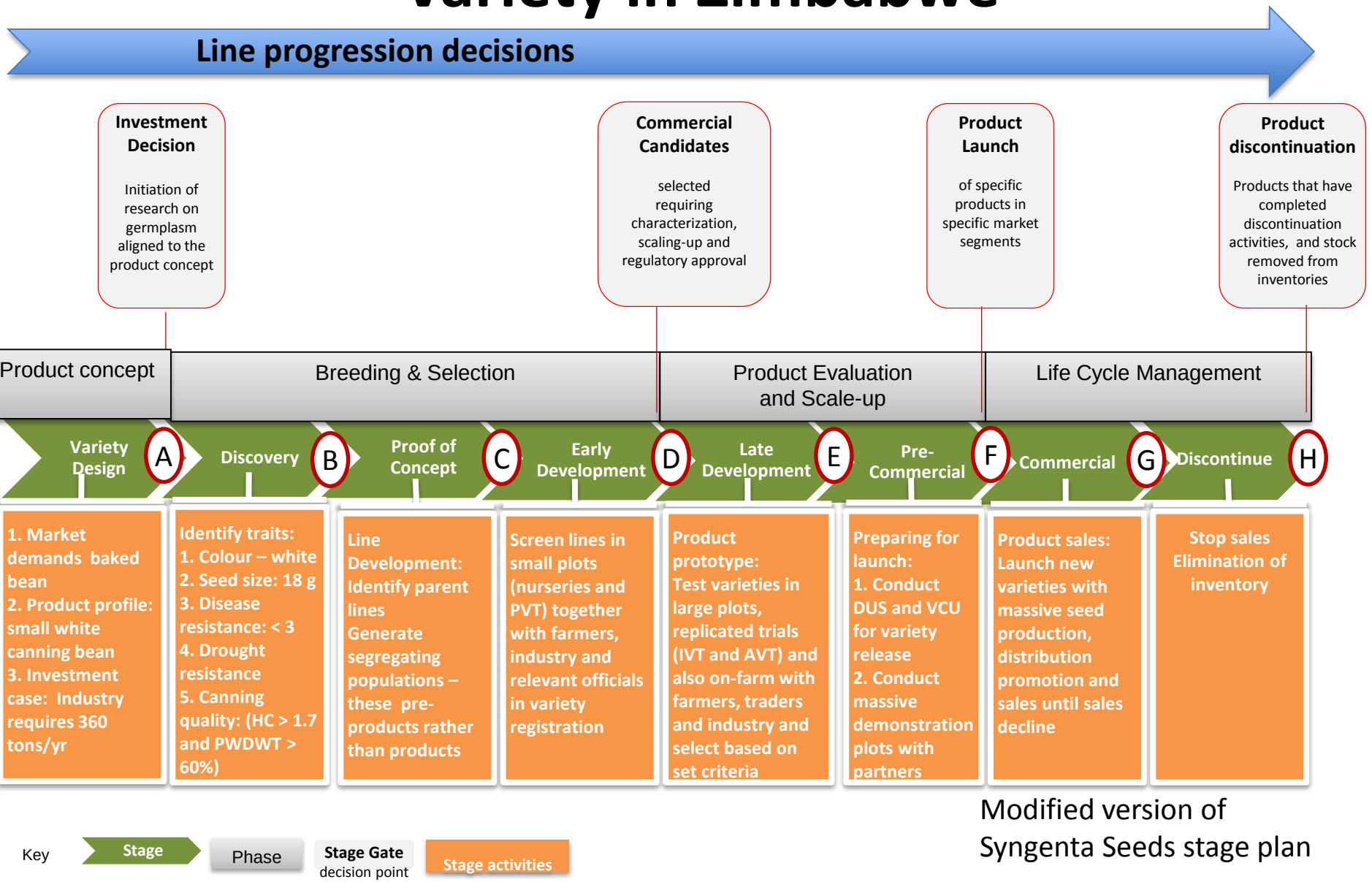
Demand-led Breeding Stage Plan

Line progression decisions



Modified version of
Syngenta Seeds stage plan

Example: Developing a Small White Pea Bean Variety in Zimbabwe



Modified version of Syngenta Seeds stage plan

Benefits of Using a Stage Plan

- **Product adoption:** Higher likelihood of varieties achieving increased farmer adoption by meeting clients' demands.
- **Decision-making:** Enables greater focus on key milestones, generation of quality data and information required for rigorous and informed decisions.
- **Fully integrated plan:** Encourages excellent planning to seek efficiencies and a smooth flow of activities from start to completion of the new variety development.
- **Communications:** Provides a visualisation framework to show progress of many lines under development within a breeding program or institution's new varieity portfolio.

Summary of Development Stage Plan

- Essential planning process for all breeding programs.
- Contains all activities needed to deliver a new variety from initial design to use by farmers - mapped at all the different stages of progression along the timeline.
- Useful not only to organise activities but also to gain inputs, support and “pull through” from clients at critical timings in the variety development process.
- Important for effective communications amongst client groups and experts from different disciplines, both within each stage and across the stages.
- Key tool to support timely decision-making and if a new genotype/line is ready for progression to the next stage and merits further investment.

Group Discussion – Development Stage Plan

- In your breeding program, who makes the decisions and how are the decisions made to progress germplasm - from creating crosses, through varietal release, up to final de-registering the variety from production?
- At which points in the stage plan should clients, management and investors be involved in decision making?

3. Timelines and Critical Paths

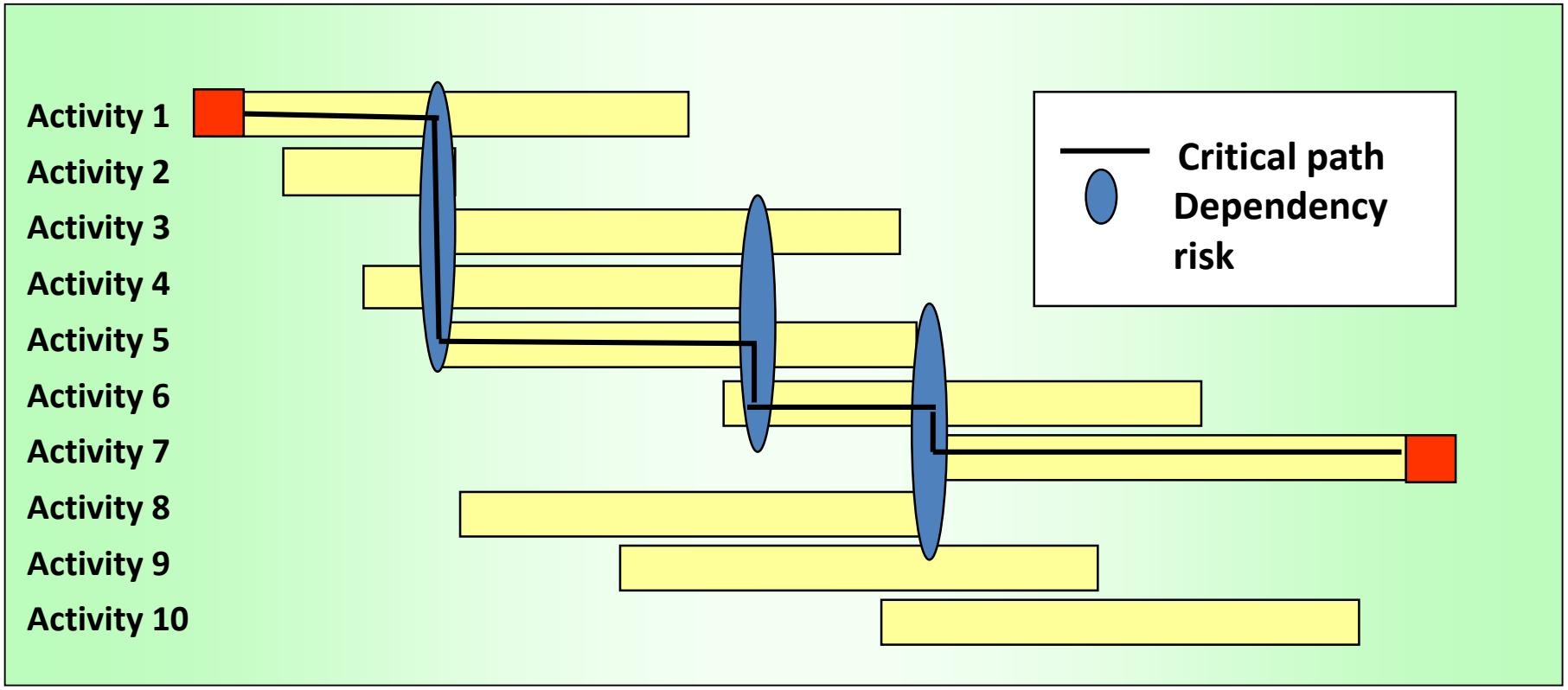
What is a Critical Path?

Definition: The variety development stage plan has a series of steps to design, create and deliver the new variety to farmers. The shortest possible route from design to delivery is called the "***critical path***".

Critical Path Analysis Diagram with Risk Dependencies

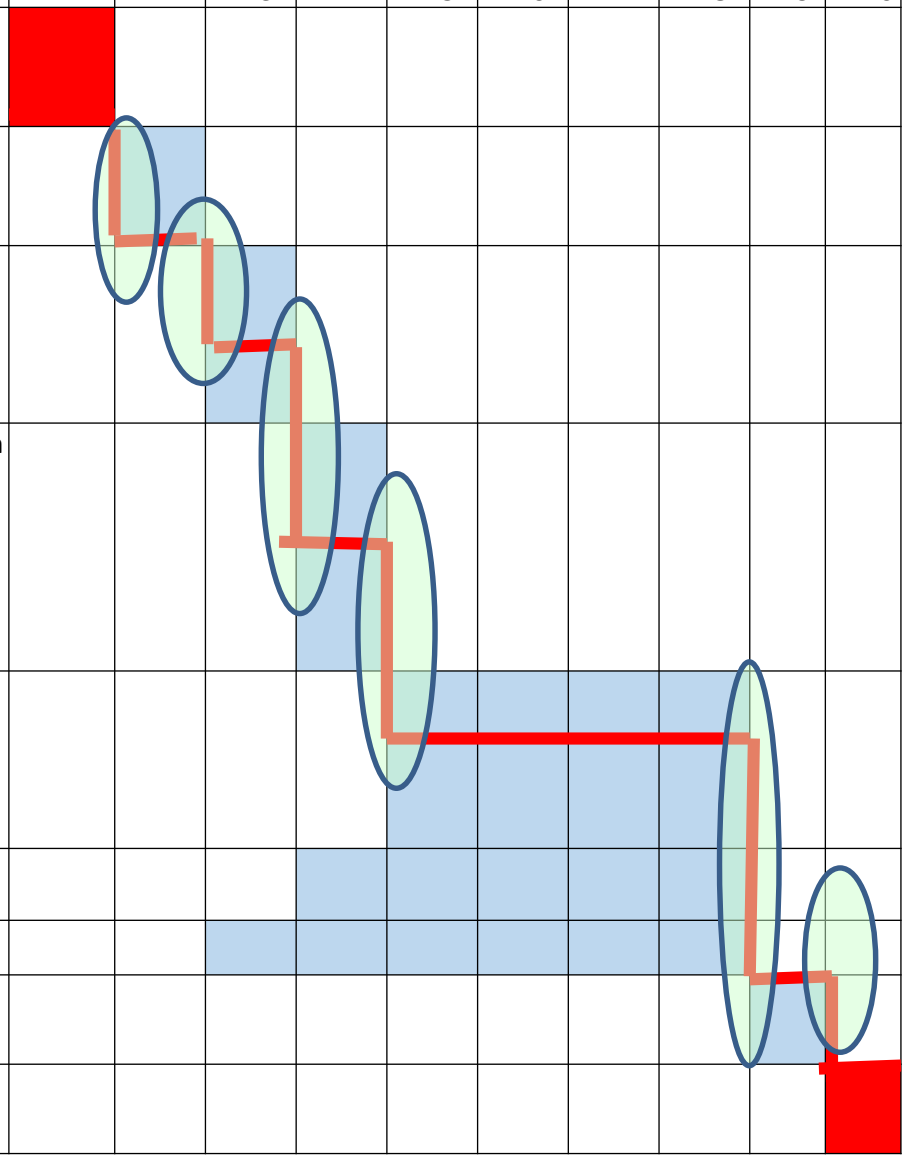
Activity	New variety breeding programme

Years: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+



Timeline and critical path for developing a new drought tolerant and micronutrient dense sugar bean variety with resistance to ALS and BCMV diseases in Zimbabwe

Activity	TIME FRAME (YEARS)									
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
1. Make crosses (parent A -Sugar bean) x (parent B -drought and high Zn); (parent C - ALS) x (parent D - BCMV and high Fe) to get F1 seeds for single and double crosses– in the greenhouse – by the breeder										
2. Plant the 4-way F1 seeds in the field under controlled conditions to generate as much seed as possible at F2 generation under rainfed and generate F3s under irrigation – by the breeder										
3. Plant F3s in a targeted environments for ALS and BCMV screening and select plants with desirable target traits to produce F4 seeds, and plant the F4s under irrigation to get F5 seeds – by the breeder and collaborating partners or stakeholders, depending on the traits of interest										
4. Evaluate F5 lines in a single row nursery, and select best lines for grain type and yield, but also for ALS and BCMV, while increasing seed for the next season, and plant F6s to screen under drought, but also to generate F7 seeds – sample some plants from promising rows and harvest the seeds separately for mineral content analysis - by the breeder and collaborating partners or stakeholders, depending on the traits of interest										
5. Evaluate selected fixed lines from drought screening in multilocation variety trials (PVT for one season, IVT for one season and AVT for two seasons) and select the best lines for yield, diseases resistance and grain type – by the breeder and collaborating partners or stakeholders, depending on the traits of interest										
6. Conduct on-farm trials with stakeholders to capture clients' preferences										
7. Confirm the Fe and Zn content in selected bean lines										
8. Conduct Distinctiveness, Uniformity and Stability (DUS) and Value for Cultivation and Use (VCU) tests – by the designated DUS testing unit										
9. Submit to Variety Release Committee (VRC) for variety release and registration – by the breeder and the variety release committee										



Importance of Timelines and Critical Path

- Understand the timelines and associated costs to develop and register a new variety.
- Clear understanding about critical paths and approaches to risk reduction.
- Develop risk mitigation strategies.
- Understand costs and rewards associated with risks.
- Critical path analysis and pro-active risk management will help breeding team to develop new varieties that meet farmers and value chain needs in a timely and cost-effective manner.

4. Risk Management

Risk Management

- There are many types of hazards, incidences and problems that can occur during varietal development that can cause delays and even through to non-delivery.
- In the case of planning, some scientific activities by their innovative nature may provide unexpected results.
- Where the outcomes of experiments are uncertain and may require repeating, then it is advisable, if possible, to schedule them earlier in the plan and not ‘just-in time’.
- Risk can also be reduced by using parallel approaches to increase the chances of a successful output, if resources permit.

Risk Quantification

Identified risk	Person responsible	Impact	Likelihood	Risk reduction action
New PCR method/lab contamination	Molecular biologist	High	20%	Industrial cleaning lab, restricted access
Field experiment off-site destroyed	Field agronomist	High	20%	Farmer communication , sign boards in field
Lost shipment of seed samples	Seed bank manager	Mod	60%	Send in 2 lots, via specialist shipment company
Delayed recruitment of staff/specialist	Head of breeding team	High	50%	Organise back-up contractor/more $ in budget

Risk Quantification

- Probability theory: Multiply—not add— individual chances of success to see the combined effect of all risks.
- The combined effect of the concurrent major risks with high impact in the example below is much greater than one may think intuitively.
- Combined risk effect: example -

Risk 1 High impact → 60% prob. = chance of success 0.4
Risk 2 High impact → 50% prob. = chance of success 0.5
Risk 3 High impact → 70% prob. = chance of success 0.3

- Total chance of success 0.4 x 0.5 x 0.3=0.06 or only 6%!

- This may affect next decisions and course of action.

Key Messages:
Timelines and Risk Management

- There is need to determine optimal times to integrate requirements, tests/evaluations and data generation for demand-led parameters
- Timescales must be clearly defined
- Find creative ways to not extend and preferably shorten timescales whilst including demand-led components
- Use critical path analysis and risk mitigation
- Use data to make decisions

Group Exercise:
Timelines and Critical Paths

- What are the biggest risks in your breeding program?
- How do you mitigate against these risks?

4. Variety Registration

4. Variety Registration

- Current knowledge of registration system and release requirements is essential, at national and regional levels.
- Timelines and costs.
- Can one help to speed up the registration process by engaging with the regulatory officials?

Demand-led Variety Registration

- Consumer traits and regulatory hurdles.
- Demand-led breeding is complex and can take longer- so a smooth registration process is a key factor.
- Regional harmonization may influence market size and subsequent investment decisions.
- Demand-led variety registration may be influence by international regulations such as UPOV, breeders' rights and national registration agencies.

Demand-led Variety Registration

- In each country, National Variety Registration Committee (NVRC) makes a decision to release or reject a new variety, based on data compiled in the release proposal.
- Some countries charge a fee, others do not, for tests
- Ideally, release is based on merit/uniqueness of variety.
- Uniqueness of a variety that addresses demand-led traits should be considered sufficient to distinguish a new variety from others and give it merit for release.

Demand-led Variety Registration

- Some countries require yield improvement vs benchmark
- Thus the need for *yield gain vs consumer demand-led traits* issues need to be clarified at the variety design stage
- The fact that each country has its own Seed Act makes it costly for seed companies to release and market new varieties in different countries in sub Saharan Africa
- One way to reduce registration costs is to harmonize variety registration regulations across countries, in regional sub groupings (e.g. SADC and COMESA countries).

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