

Table 1: Plant breeding pipelines - Issues and opportunities – Version 8 June 2015

General step in the breeding program	General issues	Issues related to agro-ecological intensification (AEI)	Opportunities
<p>1a-Clarifying goals of the breeding program</p>	<ul style="list-style-type: none"> • What are the overarching goals of the program? Do they include beyond Increasing productivity/or revenue other goals such as: • Benefits for specific types of farmers • Capacity building of farmers • Improving health and nutritional status • Influence policies/policy makers 	<ul style="list-style-type: none"> • Importance of biodiversity conservation – conservation of specific types of material • Improving resilience of a production system 	<ul style="list-style-type: none"> • Clarification of roles and responsibilities of specific program/project partners • Clarifying socio-economic context • Some of these goals will influence breeding objective and selection criteria
<p>1b-Establishment of breeding objectives</p>	<ul style="list-style-type: none"> • What are the key constraints to crop productivity? • Are the overall target environment and the target contexts within that environment well defined (based on careful analysis of stakeholders and their realities (e.g. farmer typology), needs, preferences, and the role of the crop for them?) • Who participates/do farmers and other users participate in the priority setting for the breeding program? • If there are options for different variety types for the target crop available (e.g. line or population versus hybrid varieties) – who participates in the decision making about the variety type to go for? • Key elements of the traditional seed system – who does what, what is a variety, rules for exchange.... 	<ul style="list-style-type: none"> • How much diversity will be produced (are we looking for a “best” product, or a suite of materials?) • Do the defined target contexts include those of vulnerable and poor? • Does the breeding material include specifically chosen germplasm – germplasm base for the program • Is the variety’s fit into the production system considered an explicit objective (includes e.g., breeding for intercrop performance?) • Do the breeding objectives <i>include AEI -relevant traits such as: phosphorus and nitrogen use efficiency, N fixation capacity in case of legumes, other eco-system services, disease and pest resistance, dual purpose use (fodder and grain) for better crop-livestock integration, weed suppression, intercropping ability, nutritional quality and food yield</i> (all work within CCRP should be at least nutritional-quality-informed). • Have gender-specific breeding /production priorities been assessed and are they taken into 	<ul style="list-style-type: none"> • Solving particular problems/ constraints by matching varieties to specific contexts • Breeding progress targeting specific use groups • What is the desired product of the breeding process? Sometimes the default is to seek a single superior variety; should it be larger suites of diverse options; e.g. should the target be to offer diversity to the diversity of farmers and enabling farmers to choose what fits best into their context.

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	<ul style="list-style-type: none"> • Is there meaningful regional cooperation in germplasm exchange? • Short-term versus long-term goals considered when creating diversified populations? • Methods and skills for crossing? Sometimes there is a need for innovation for efficiency • Seed storage: maintaining an available pool of crop genetic diversity for use by the breeding program 		
<p>3-Development of experimental varieties</p>	<ul style="list-style-type: none"> • Direct selection in the target environment(s) (e.g., on-farm, stress environment,...) <i>versus</i> indirect selection (on-station, non-stress...) • If indirect selection (on-station, in a different country, pot trial, laboratory assay): is the genetic correlation to performance under field conditions in the target environment / context known? • Achieve detectable, heritable variation for traits of interest among progeny generated • Is the breeding program optimally designed (N of locations & years <i>versus</i> replications, based on quantitative-genetic parameters, heterogeneity of target environment, extent of GxE interactions, and available budget)? • Availability and use of modern tools (such as marker-assisted or genomic selection) to accelerate breeding progress? • Need to attain homozygosity (for inbreeding crops)? 	<ul style="list-style-type: none"> • Population-based approaches that lead to plant populations that maintain diversity • Direct selection in the target environment favored • Do farmers participate in the selection process? Are farmers’ priority selection criteria used during selection? Are women included? • Are major issues related to nutritional quality taken into account (mycotoxines, Fe/Zn, ProVitamin A density, phytates) • Is interannual rainfall (and other climate elements) variability being taken into account in the selection process (are one-year results put into longer term climatic context (and possibly weighted accordingly)? • What about other sources of interannual variation (pest and disease levels, farm-management quality in farmer trials, etc) • Are options to enhance yield stability considered / fully exploited (e.g. consideration of traits that enhance individual and/or population buffering)? • In case of high inter-annual rainfall variability: can modeling help to enhance selection efficiency (“breeding <i>in silico</i>”) 	<ul style="list-style-type: none"> • Participatory breeding options • Need to develop / disseminate /provide respective tools for experimental designs that enable testing of large numbers of early-generation progenies (with little seed availability) on-farm, in order to adequately sample the target environment. • Likewise, develop and disseminate effective analysis methods for data coming from such trials. These can build on the latest relevant developments standard breeding (eg spatial analysis).

General step in the breeding program	General issues	Issues related to agro-ecological intensification (AEI)	Opportunities
<p>4-Testing experimental varieties</p>	<ul style="list-style-type: none"> • Need to identify a relevant “target population of environments” in which to trial the material and to appropriately sample that target environment • Sufficient & appropriate testing effort, and statistical analysis to achieve acceptable heritability and progress • Has the variety testing strategy been optimized (N of locations, reps, years...)? • Are the data being collected in a data base that could be assessed by other stakeholders and inform variety recommendations? • Is inter-annual climate and other variability being taken into account during testing? 	<ul style="list-style-type: none"> • Meaningful characterisation of environments, including the social environment • Who will trial the material, under what conditions? • MET designs that consider socio-ecological diversity of target farmers/environments • Increasing farmer participation in variety tests farmer-managed trials • Enabling partner farmer organizations to exploit on-farm variety testing data for specific variety recommendations • Evaluation of AEI-relevant traits, including “food yield” and tradeoffs between multiple functions. • Putting 1-year results into long-term climate context; assessing yield stability at one location over years 	<ul style="list-style-type: none"> • Simple yet meaningful measurements that get at mutual interest of farmers and formal scientists • Large-N trials through farmer research networks • Use of modeling to determine expectations and thus to identify superior and inferior performance?
<p>5-Variety release and dissemination</p>	<ul style="list-style-type: none"> • Variety release: are there clear rules for variety release in the target country/countries? • Availability of seed: is seed being produced, stored and sold in adequate quantity? • Access to seed : Do (all) people have the means to buy or acquire seed, and is the seed sold/distributed in a way that (all) people can access it, physically and economically? • Quality of seed: technical quality (e.g. germination, purity) and quality related to utilization, i.e., whether and to which extent the seed meets people’s multiple needs, including it being adapted to the existing farming systems and agro-ecological conditions, but also its processing quality, nutritional value and requirements of market partners. 	<ul style="list-style-type: none"> • Do the variety release regulations enable release of varieties that show adaptation to specific niches/varieties that are of use in very specific situations? • Roles of farmers and other stakeholders in seed production and dissemination? Consider community-based system v. commercially-based, or combination of both? • Decentralization of seed production and marketing • Strengthening of farmers’ seed cooperatives • Building on traditional seed security measures and networks. 	<ul style="list-style-type: none"> • ICT for gathering and sharing info about seeds (Amazon.com-type system with user ratings, but with user typology?) • Farmer seed cooperatives to become part of the private sector for seed • Circumventing restrictive regulations