

# Product Concept Notes of GLDC Crops

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## Product Concept Notes of GLDC Crops

### Chickpea

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Short- to medium-duration varieties with resistance to root diseases and tolerance to drought and heat stresses	8.0	80	<p><b>Target:</b> Central India, Eastern India, Western India, Southern India and Myanmar</p> <p><b>Spillover:</b> Bangladesh, Nepal, Tanzania, Malawi, Mozambique and Uganda</p>	90-120	<p><b>Abiotic stresses:</b> Drought and heat</p> <p><b>Biotic stresses:</b> Fusarium wilt (FW), dry root rot (DRR), pod borer, Botrytis grey mold (BGM) (for Eastern India)</p>	<p><b>Must have traits:</b> Seed size (100-seed weight): 20-25 g (desi), 35-45 g (large kabuli), &gt;45 g (extra-large kabuli); seed color: light brown to brown for desi, creamy white/beige for kabuli; suitability for machine harvesting</p> <p><b>Nice to have traits:</b> Herbicide tolerance, high BNF efficiency, fast cooking time, high protein (25%), Fe (60 ppm) and Zn (40 ppm)</p>	<p><b>Yield:</b> At least 5% increase over checks (JG 11, JAKI 9218, NBeG 47, Phule Vikram, RVG 204, Yezin 12, BARI Chola 10, JGK 1, Vihar, JGK 5)</p> <p><b>Resistance levels:</b> FW: &lt;10% mortality DRR: Disease score ≤ 3 BGM: Disease score ≤ 3</p>
(2) Medium- to long-duration varieties with resistance to Ascochyta blight	1.0	20	<p><b>Target:</b> Northern India and Ethiopia</p> <p><b>Spillover:</b> Pakistan, Kenya and Sudan</p>	120-140	<p><b>Abiotic stresses:</b> Drought, cold and heat</p> <p><b>Biotic stresses:</b> Ascochyta blight (AB), Fusarium wilt, pod borer, Botrytis grey mold (for Uttarakhand state of India)</p>	<p><b>Must have traits:</b> Seed size (100-seed weight): 20-25 g (desi), 35-45 g (large kabuli), &gt;45 g (extra-large kabuli); seed color: light brown to brown for desi, creamy white/beige for kabuli; suitability for machine harvesting</p> <p><b>Nice to have traits:</b> Herbicide tolerance, cold tolerance, high BNF efficiency, fast cooking time, high protein (25%), Fe (60 ppm) and Zn (40 ppm)</p>	<p><b>Yield:</b> At least 5% increase over checks (GCP 106, KWR 108, KPG 59, DCP 92-3, GNG 1958, GNG 1969, HK 4, GLK 28127, HC 5, CSJ 515, GNG 1581, Tara, Arerti, Minjar).</p> <p><b>Resistance levels:</b> FW: &lt;10% mortality; AB: Disease score ≤ 3</p>

## Cowpea

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Extra-early to early varieties with resistance to stem rot diseases, Striga/Alectra and tolerance to drought and low soil fertility	7.5	50	<p><b>Target:</b> Burkina Faso, Mali, Niger and Nigeria</p> <p><b>Spillover:</b> Ghana, Senegal Benin, Cameroon, Kenya, Tanzania, Uganda, Namibia, Malawi and Mozambique</p>	50-75	<p><b>Biotic stresses:</b> Aphid, bacterial blight, bean common mosaic virus, Striga/Alectra, stem rot diseases (macrophomina, fusarium)</p> <p><b>Abiotic stresses:</b> Seedling, mid-season and terminal drought, heat, low soil fertility</p>	<p><b>Must have traits:</b> Seed size: &gt;18 g per 100 grains; seed color: white or brown Rough seed coat</p> <p><b>Nice to have traits:</b> High protein (&gt;25%), Fe (50 ppm) and Zn (40 ppm), fast cooking</p>	<p><b>Yield:</b> At least 5% increase over checks (most recently released varieties fall in this maturity group).</p> <p><b>Resistance levels</b> Resistant to Striga/Alectra Tolerant to aphid, thrips Tolerant to bacterial blight, viral diseases</p>
(2) Medium-maturing varieties with resistance to stem rot diseases, Striga/Alectra and tolerance to drought and low soil fertility	5.0	33	<p><b>Target:</b> Burkina Faso, Mali, Niger and Nigeria</p> <p><b>Spillover:</b> Cameroon, Ghana, Senegal, Tanzania, Kenya, Benin, Uganda, Malawi, Zambia and Mozambique</p>	76-85	<p><b>Biotic stresses:</b> Aphid, flower thrips, bacterial blight, viral diseases, stem rot diseases, Striga/Alectra</p> <p><b>Abiotic stresses:</b> Seedling and terminal drought, heat, low soil fertility</p>	<p><b>Must have traits:</b> Seed size: &gt;18 g per 100 grains; Seed color: White or brown Rough seed coat</p> <p><b>Nice to have traits:</b> High protein (&gt;25%), Fe (50 ppm) and Zn (40 ppm), fast cooking, dual purpose (grain, leaves and fodder)</p>	<p><b>Yield:</b> At least 5% increase over checks (most recently released varieties fall in this maturity group)</p> <p><b>Resistance levels</b> Resistant to Striga/Alectra Tolerant to flower thrips Tolerant to bacterial blight, viral diseases, stem rot diseases</p>
(3) Late-maturing varieties with resistance to stem rot diseases and Striga/Alectra and tolerance to drought and low soil fertility	2.5	17	<p><b>Target:</b> Burkina Faso, Mali, Niger and Nigeria</p> <p><b>Spillover:</b> Cameroon, DRC, Ghana, Senegal, Kenya, Tanzania, Uganda, Malawi, Zambia and Mozambique</p>	85-95	<p><b>Biotic stresses:</b> Flower thrips, viral diseases, stem rot, foliar diseases, Striga/Alectra</p> <p><b>Abiotic stresses:</b> Terminal drought, low soil fertility</p>	<p><b>Must have traits:</b> Seed size: &gt;18 g per 100 grains, seed Seed color: White or brown Rough seed coat</p> <p><b>Nice to have traits:</b> High protein (&gt;25%), Fe (50 ppm) and Zn (40 ppm), fast cooking, dual purpose (grain, leaves and fodder)</p>	<p><b>Yield:</b> At least 5% increase over checks (most recently released varieties fall in this maturity group)</p> <p><b>Resistance levels</b> Resistant to Striga/Alectra Tolerant to thrips Tolerant to stem rot, foliar diseases, viral diseases</p>

## Groundnut

Product concept	Estimated area (m ha)	% area/effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Short-duration and climate resilient varieties with resistance to foliar fungal and virus diseases for oil, food and dual purposes	5.0	45	<p><b>Target:</b> Homogenous Zone 9 (Southern India, Eastern India, Myanmar, Malawi, Sudan, Tanzania, Burkina Faso, Mali, Ghana, Nigeria and Senegal)</p> <p><b>Spillover:</b> Vietnam, Bangladesh, Niger, Chad, Kenya, Uganda, Mozambique and Zambia</p>	85-100	<p><b>Biotic stresses:</b> Foliar fungal and soil borne diseases. Groundnut rosette disease (GRD) for ESA and WCA and Peanut Bud Necrosis Disease (PBND) in SA.</p> <p><b>Abiotic stresses:</b> Water deficit stress, heat stress.</p>	<p><b>Must have traits:</b> Fresh seed dormancy of 2-3 weeks; shelling % 65-75; erect and bunch growth habit; kernel quality both normal and high oleic (&gt;70%); 100-kernel mass: 30-45; seed coat color: tan or red; suitable for the (a) food processing industry, and confectionery (50%) with low oil content of 46-50% and (b) industrial processing of oil (50%) with high oil content of 52-55%.</p> <p><b>Nice to have traits:</b> Low P tolerance, haulm yield and quality, high oleic acid (&gt;70%)</p>	<p><b>Yield:</b> At least 5% higher than the standard check cultivars: SA - ICGV 91114, ICGV 14421, ICGV 13189 and ICGV 13207; WCA – ICGV 86124, ICGV 80015, Fleur 11, Samnut 24, Samnut 25, Samnut 26; ESA-ICGV-SM 99551, 99556, 01514, Naliendele 09, Serenut 14R</p> <p><b>Resistance level:</b> Early Leaf Spot (ELS), Late Leaf Spot (LLS); rust score: 2-3 GRD incidence: &lt;10% and score of 1-2 Stem rot mortality: &lt;10% PBND incidence: &lt;10%</p>
(2) Medium-duration varieties with resistance to foliar fungal and soil borne diseases for oil, food and confectionery, and dual purposes	6.0	40	<p><b>Target:</b> Homogenous Zone 10 (Northern India, Western India, Southern India, Myanmar, Malawi Tanzania, Sudan, Burkina Faso, Mali, Ghana, Nigeria and Senegal)</p> <p><b>Spillover:</b> Vietnam, Sri Lanka, Philippines, Indonesia, Niger, Kenya, Mozambique, Zambia, Haiti, and other countries in S. America</p>	100- 120	<p><b>Biotic stresses:</b> Foliar fungal and soil borne diseases. (GRD) for ESA and WCA.</p> <p><b>Abiotic stresses:</b> Water deficit stress</p>	<p><b>Must have traits:</b> Shelling %: 68-80; kernel quality both normal and high oleic (&gt;70%); 100-kernel mass: 45-70 g; seed coat color: tan or red; fresh seed dormancy of 2-3 weeks Suitable for (a) food processing industry and confectionery (60%) and (b) industrial processing of oil (40%)</p> <p><b>Nice to have traits:</b> Low P tolerance, haulm yield and quality; round seed shape</p>	<p><b>Yield:</b> At least 5% higher than the standard check cultivars: SA-ICGS 44, GG 20, Kancil, L 23, ICGV 02266; WCA-Samnut 22, Samnut 23, ICG 7878; ESA – ICGV-SM 08501, 08503, 01731, 01724, Nsingiro, CG7</p> <p><b>Quality:</b> High oleic. Resistance level: ELS, LLS, Rust score of 2-3 GRD incidence: &lt;10% and score of 1-2 Stem rot mortality: &lt;10% Collar rot mortality: &lt;10%</p>

<p>(3) Long-duration varieties with large seed size, resistance to foliar fungal and soil borne diseases for food and confectionery purposes</p>	<p>2.0</p>	<p>15</p>	<p><b>Target:</b> Homogenous Zone 11, 12 and 13 (India, Myanmar, Malawi, Tanzania, Mali, Nigeria, Senegal and Ghana) <b>Spillover:</b> Homogenous Zone 11, 12 and 13 of SA, ESA and WCA (Philippines, Sri Lanka, Vietnam, Uganda and Kenya)</p>	<p>120-150</p>	<p><b>Biotic stresses:</b> Soil borne and foliar fungal diseases GRD for ESA and WCA</p>	<p><b>Must have traits:</b> Shelling outturn of 68-80%; High oleic acid (&gt;70%); kernel mass: 60-100 g per 100 kernels; fresh seed dormancy: 2-3 weeks; low oil content: 46-50% <b>Nice to have traits:</b> High water-use efficiency and tolerance to heat stress</p>	<p><b>Yield:</b> At least 5% higher than the standard check cultivars (ICGV 87546, ICGV 12218 and ICGV 12266) <b>Quality:</b> High oleic or normal Resistance level: ELS, LLS, rust score of 2-3 GRD incidence: &lt;10% and score of 1-2 Stem rot mortality: &lt;20% Collar rot mortality: &lt; 0%</p>
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## Lentil

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/ tolerance required	Other criteria	Product development goals
(1) Extra-short to short-duration varieties with resistance to Fusarium wilt and rust, and tolerance to drought and heat stresses	1.5	60	<b>Target:</b> Eastern India <b>Spillover:</b> Nepal and Bangladesh	80-110	<b>Abiotic stresses:</b> Drought and heat <b>Biotic stresses:</b> Fusarium wilt, rust, Stemphylium blight	<b>Must have traits:</b> Seed size (100-seed wt): 2.0 - 3.5, seed color: Red <b>Nice to have traits:</b> Root rot resistance, herbicide tolerance, high protein (30%), high biomass for dry fodder purpose	<b>Yield:</b> At least 10% increase over checks (BARI Masoor7, JL3, Moitree, Sagun) <b>Resistance levels</b> FW: <10% mortality Rust: Disease score 1 Stemphylium blight: Disease score ≤3
(2) Biofortified large seeded varieties with resistance to rust and Stemphylium blight	0.8	30	<b>Target:</b> Eastern and Central India <b>Spillover:</b> Bangladesh Pakistan and Nepal	90-130	<b>Abiotic stresses:</b> Drought and heat <b>Biotic stresses:</b> Fusarium wilt, rust, Stemphylium blight	<b>Must have traits:</b> Seed size (100-seed wt): >3.5 g Iron content (80 ppm), Zinc (50 ppm) Seed color: Red <b>Nice to have traits:</b> Root rot resistance, herbicide tolerance, machine harvestability, high protein (30%), Bruchid resistance, high biomass for dry fodder purpose	<b>Yield:</b> At least 10% increase over checks (BARI Massor7, L4717, JL3, IPL406) <b>Resistance levels</b> FW: <10% mortality Rust: Disease score 1 Stemphylium blight: Disease score ≤ 3
(3) Biofortified varieties with resistance to rust, Fusarium wilt and Ascochyta blight	0.1	10	<b>Target:</b> Ethiopia <b>Spillover:</b> Sudan	100-120	<b>Abiotic stresses:</b> Drought and heat, water logging <b>Biotic stresses:</b> Ascochyta blight, Fusarium wilt, rust	<b>Must have traits:</b> Seed size (100-seed wt): >2 g; Fe (80 ppm) and Zn (50 ppm) content; seed color: red <b>Nice to have traits:</b> Herbicide tolerance, water logging tolerance, root rot resistance, aphid tolerance; input use efficiency, high protein (30%)	<b>Yield:</b> At least 10% increase over checks (Alemaya, Darash) <b>Resistance levels</b> FW: <10% mortality; AB: Disease score ≤3 Rust: Disease score 1

## Pigeonpea

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/ tolerance required	Other criteria	Product development goals
(1) Medium-duration climate resilient varieties, parental lines and hybrids with resistance to diseases and pests	5.66	79	<p><b>Target:</b> Eastern Kenya, Eastern and Southern Tanzania, Northern Uganda, Central and Northern Malawi, Central and Southern Zones of India and Myanmar</p> <p><b>Spillover:</b> Mozambique, Zambia, Nepal, Nigeria, Ghana, Mali, Southern Ethiopia, Sudan and Zimbabwe</p>	130-180	<p><b>Biotic stresses:</b> Fusarium wilt, sterility mosaic, Phytophthora, pod borers, pod fly, Cercospora leaf spot, pod sucking bugs</p> <p><b>Abiotic stresses:</b> Intermittent and terminal drought, water logging</p>	<p><b>Must have traits:</b> Photoperiod insensitivity; intercropping compatibility; plant height: 150-160 cm; seed size &gt;10 -12 g (&gt;15 g for ESA); seed colour: brown and cream; &gt;75 % shelling recovery and dehulling recovery</p> <p><b>Nice to have traits:</b> High protein (25%), Fe (50 ppm) and Zn (40 ppm), green vegetable quality, fast cooking</p>	<p><b>Yield:</b> At least 5% increase over checks or similar yields with special attributes</p> <p><b>Resistance levels</b> FW: &lt;5 % mortality SMD: &lt;5 % mortality Phytophthora blight: &lt;10% mortality</p>
(2) Long-duration varieties with resistance to Fusarium wilt and pests	0.5	7	<p><b>Target:</b> Eastern Kenya and Rift Valley, Northern Tanzania, Southern Malawi and North Eastern plain zones of India (Bihar, Eastern Uttar Pradesh)</p> <p><b>Spillover:</b> Mozambique, Zambia, Ethiopian highlands and Southern highlands in Tanzania</p>	160-270	<p><b>Biotic stresses:</b> Fusarium wilt, Cercospora leaf spot, pod borers, pod fly, pod sucking bugs</p> <p><b>Abiotic stresses:</b> Intermittent and terminal drought</p>	<p><b>Must have traits:</b> Photoperiod and thermo-period insensitivity; intercropping compatibility; seed size: &gt;10 -12 g (&gt;18 g for ESA); seed colour: brown and cream; &gt;75 % shelling recovery and dehulling recovery, high fuel wood</p> <p><b>Nice to have traits:</b> High protein (25%), green vegetable quality, fast cooking</p>	<p><b>Yield:</b> At least 5% increase over recently released varieties or similar yield with special attributes</p> <p><b>Resistance levels</b> FW: &lt;5 %</p>
(3) Early-duration varieties, parental lines and hybrids with resistance to diseases	1.0	14	<p><b>Target:</b> Eastern Kenya, Eastern Tanzania, Central Malawi, Eastern Uganda, Northwestern plain zone of India (Rajasthan, Punjab, Haryana), Central and southern zones of India (Maharashtra, Karnataka, Telangana State, Andhra Pradesh, Madhya Pradesh, Gujarat, Uttar Pradesh, Odisha and Tamil Nadu) and Myanmar</p> <p><b>Spillover:</b> Mozambique, Zambia, Nigeria, Ghana, Zimbabwe, Mali, Nepal, Central Ethiopia and Sudan</p>	100 -120	<p><b>Biotic stresses:</b> Fusarium wilt, sterility mosaic, Phytophthora, pod borers, pod fly</p> <p><b>Abiotic stresses:</b> Terminal drought, water logging</p>	<p><b>Must have traits:</b> Indeterminate growth habit, plant height: 120 -130 cm; seed size: &gt;10 g (&gt;12 g for ESA); seed colour: brown and cream; &gt;75 % shelling recovery</p> <p><b>Nice to have traits:</b> High protein (25%), Fe (50 ppm) and Zn (40 ppm), green vegetable quality, fast cooking</p>	<p><b>Yield:</b> At least 5% increase over checks or similar yield with special attributes</p> <p><b>Resistance levels</b> FW: &lt;5 % mortality SMD: &lt;5% mortality Phytophthora blight: &lt;10% mortality</p>

## Soybean

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Early- to medium-maturing varieties with resistance to rust, escapes/tolerance to drought and promiscuous nodulating	1.0	60	<b>Target:</b> Nigeria and Malawi  <b>Spillover:</b> Ghana, Zambia Mozambique, Cameroon, Kenya, Tanzania, Uganda, Democratic Republic of Congo, Rwanda, Zimbabwe, South Africa, Angola, Mali, Ethiopia and South Sudan	90-105	<b>Biotic stresses:</b> Rust, leaf blight, frogeye, shattering, lodging  <b>Abiotic stresses:</b> drought, heat, low P	<b>Must have traits:</b> Seed size: >16 g per 100 grains; high protein >38%, oil >20%, high biomass for West Africa, medium tall: >50 cm <70 cm  <b>Nice to have traits:</b> Herbicide tolerant, high oleic acid content, high biomass for Southern Africa	<b>Yield:</b> At least 5% increase over checks (TGx1740-2F, Jenguma, and/or recently released varieties fall in the maturity group). <b>Maturity:</b> ±3days check <b>Resistance levels</b> Resistant to rust, frogeye, leaf blight, shattering, Lodging scores: <2
(2) Medium late-maturing varieties with resistance to rust, tolerance to drought and promiscuous nodulating	0.8	40	<b>Target:</b> Nigeria, Malawi,  <b>Spillover:</b> Ghana, Mozambique, Zambia Cameroon, Kenya, Tanzania, Uganda, Democratic Republic of Congo, Rwanda, Zimbabwe, South Africa, Angola, Mali, Ethiopia, South Sudan and Cote d'Ivoire	110-120	<b>Biotic stresses:</b> Rust, leaf blight, frogeye , shattering, lodging  <b>Abiotic stresses:</b> drought, heat, low P	<b>Must have traits:</b> Seed size: >16 g per 100 grains high protein >38%, oil >20%, high biomass for West Africa Height: >60 <90 cm, good pod clearance  <b>Nice to have traits:</b> Herbicide tolerant, high oleic acid content, high biomass for Southern Africa	<b>Yield:</b> At least 5% increase over checks (SC Saga, Safari, Square, Dina, Makwacha, TGx1951-3F and/or recently released varieties fall in this maturity group). <b>Maturity:</b> ±3 days check <b>Resistance levels</b> Resistant to rust, frogeye, leaf blight,shattering Lodging scores <2

## Finger millet

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Short-duration varieties for semi-arid areas	1.0	40	<p><b>Target:</b> Semi-arid areas of Ethiopia and India</p> <p><b>Spillover:</b> Semi-arid areas of Uganda, Tanzania, Kenya, Zimbabwe, Malawi and Zambia</p>	80-100	<p><b>Biotic stresses:</b> Blast, Striga</p> <p><b>Abiotic stresses:</b> Terminal drought (ESA, India), heat stress (India)</p>	<p><b>Must have traits:</b> Yield: High (&gt;1.0 t/ha), seed color: brown;, big heads, high tillering (&gt;6 productive tillers), synchrony of tillers, resistance to lodging, good threshability</p> <p><b>Nice to have traits:</b> High Fe, Zn and Ca contents in grain; snapping trait for ease of harvesting</p>	At least 5% higher yield than the standard check cultivars
(2) Medium- to long-duration varieties for sub-humid areas	1.5	60	<p><b>Target:</b> Sub-humid areas of Ethiopia and India</p> <p><b>Spillover:</b> Sub-humid areas of Uganda, Tanzania, Kenya, Zimbabwe, Malawi and Zambia</p>	105-130	<p><b>Biotic stresses:</b> Blast, Striga</p> <p><b>Abiotic stresses:</b> Terminal drought (ESA, India), heat stress (India)</p>	<p><b>Must have traits:</b> High yield (&gt;1.0 t/ha), seed color: brown, big heads, high tillering (&gt;3 productive tillers), synchrony of tillers, resistance to lodging, good threshability</p> <p><b>Nice to have traits:</b> High Fe, Zn and Ca contents in grain; snapping trait for ease of harvesting</p>	At least 5% higher yield than the standard check cultivars (e.g. U15)

## Sorghum

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Extra-early to early-maturing dual-purpose rainy season sorghum (OPV/hybrids) for food and feed	10.4	30	<b>Target:</b> India, Mali, Nigeria, Niger, Burkina Faso, Ethiopia, Sudan, Uganda and Tanzania  <b>Spillover:</b> Chad, Cameroon Guinea, Senegal, Kenya, Zimbabwe, Malawi and Mozambique	90-110	<b>Biotic stresses:</b> Shoot fly, stem borer, anthracnose, leaf blight, Striga, smuts <b>Abiotic stresses:</b> Drought and heat	<b>Must have traits:</b> Plant height: 1.0-2.0 m Brown/red; white bold, lustrous grains; non-testa, malting, stay green, higher stover digestibility, low P, photoperiod <b>Nice to have traits:</b> High grain Zn and Fe; 100-seed weight >2.5	10-20% increase in grain yield and 20% increase in stover yield over best check, 30-40% increase in fodder uptake and 10% increase in digestibility
(2) Medium late-maturing rainy season sorghum (OPV/hybrids) for food, feed and industrial uses (flour and malt processing)	12.9	45	<b>Target:</b> India, Mali, Niger, Nigeria, Burkina Faso, Sudan, Ethiopia, Tanzania and Uganda <b>Spillover:</b> Togo, Chad, Cameroon, Senegal, Ghana, Guinea, Kenya, Zimbabwe, Malawi, Zambia and Mozambique	110-140	<b>Biotic stresses:</b> Striga, stem borer, midge, anthracnose, leaf blight, grain mold, shootfly	<b>Must have traits:</b> Plant height: 1.8-2.5 m Brown/red; white, non-testa bold grains; malting, photoperiod, stay green, biofuel, low P <b>Nice to have traits:</b> High grain Zn and Fe; 100-seed weight >2.5	10-30% increase in grain yield and 10% increase in stover yield over best check <i>In vitro</i> organic matter digestibility >52%; higher stalk yield and higher brix (>14%)
(3) Low temperature tolerant long-duration dual-purpose OPVS/hybrids	0.8	10	<b>Target:</b> Ethiopia and Uganda  <b>Spillover:</b> Kenya, Rwanda, Burundi and Eritrea	130-180	<b>Biotic stresses:</b> Stem borer, leaf rust <b>Abiotic stresses:</b> Low temperature (<10 degrees Celcius)	<b>Must have traits:</b> Plant height; 1.5-2.5m Red/brown; white grain, high biomass/stover, good malting <b>Nice to have traits:</b> High grain Zn and Fe	10% increase in grain yield and 20% increase in stover yield, 10% increase in digestibility; white no-testa grain for malting
(4) Postrainy season sorghum for food and feed	4.0	15	<b>Target:</b> Indian sub-continent  <b>Spillover:</b> Parts of Sudan and Chad	120-130	<b>Biotic stresses:</b> Shoot fly, aphid and charcoal rot <b>Abiotic stresses:</b> Post-flowering drought	<b>Must have traits:</b> Plant height: 2.0 to 2.2 m; white, globular, bold, lustrous grains; high biomass; high stover quality and digestibility <b>Nice to have traits:</b> High grain Zn and Fe, >2.8 g (100-grain weight)	5% increase in grain yield and 10% increase in stover yield over best check

## Pearl millet

Product concept	Estimated area (m ha)	% area/ effort	Target and spillover agroecologies	Maturity (days)	Resistance/tolerance required	Other criteria	Product development goals
(1) Early-duration pearl millet (OPV/hybrids) for adaptation to Sahelian zone of West Africa	8	25	<b>Target:</b> Niger, Mali, Burkina Faso, Senegal and Nigeria <b>Spillover:</b> Parts of Sudan, Chad, Cameroon and India	70-80	<b>Biotic stresses:</b> Downy mildew and head miner <b>Abiotic stresses:</b> Drought, flowering period heat stress, low P tolerance	<b>Must have traits:</b> Grain yield:1.5-2.0 t/ha; plant height: 170-200 cm; panicle length: 30-50 cm; panicle width: 8-10 cm; test grain weight: 10-15 g; high grain Fe and Zn content	10% increase in grain yield and stover yield over local and improved check
(2) Medium <i>gero</i> pearl millet (OPV/hybrids) for adaptation to better endowed environments of West Africa	7.5	20	<b>Target:</b> South of Niger, Mali Nigeria, Burkina Faso, Ghana and Senegal <b>Spillover:</b> Parts of Sudan, Chad and Cameroon	85-100	<b>Biotic stresses:</b> Downy mildew and Striga <b>Abiotic stress:</b> Drought	<b>Must have traits:</b> Grain yield: 2.0-2.5 t/ha; plant height:170 - >200 cm; panicle length: 60-75 cm; panicle width: 7-10 cm; test grain weight: 10-15 g	10% increase in grain yield and stover yield over local and improved check
(3) Dual-purpose <i>maiwa</i> pearl millet (OPV/hybrids) for adaptation to better endowed environments of West Africa	3-4	10	<b>Target:</b> Nigeria, Mali, Senegal and Burkina Faso <b>Spillover:</b> Parts of Sudan, Chad and Cameroon	110-120	<b>Biotic stresses:</b> Downy mildew and Striga <b>Abiotic stresses:</b> Drought tolerance; flowering period heat stress	<b>Must have traits:</b> Grain yield: 2.0-2.5 t/ha; plant height: >200 cm, panicle length: 70->85 cm; panicle width: 8-12 cm; high grain Fe and Zn content	10% increase in grain yield and stover yield over local check with >40 ppm Fe
(4) Early- to medium-maturity high-yielding varieties and hybrids for Eastern and Southern Africa	3.0	10	<b>Target:</b> Sudan, Tanzania and Uganda <b>Spillover:</b> Kenya, Zimbabwe, Namibia, Eritrea, Malawi, Somalia and Mozambique	65-90	<b>Biotic stresses:</b> Striga, downy mildew, covered and kernel smut, stem borer <b>Abiotic Stresses:</b> Drought	<b>Must have traits:</b> High yield: 1.5-2.0 t/ha (varieties) and 2.0-2.5 t/ha (hybrids), high grain Fe and Zn	10% grain yield increase compared to the commercial check
(5) Parent lines of medium- to late-maturing, dual-purpose hybrids for adaptation to better endowed environments of South Asia	6.0	25	<b>Target:</b> India: East Rajasthan, Central and South Gujarat, Haryana, Uttar Pradesh, Maharashtra and Peninsular India <b>Spillover:</b> Tanzania, Kenya and Uganda (ESA)	75-90	<b>Biotic stresses:</b> Downy mildew and blast <b>Abiotic stresses:</b> Flowering period heat stress tolerance (summer season)	<b>Must have traits:</b> Parents with high productivity and good GCA for grain yield, hybrids with grain yield of 3-4 t/ha, high grain Fe and Zn content, better fodder quality	Hybrid parents to develop hybrids with 10% increase in grain yield over representative checks
(6) Parent lines of early-maturing, dual-purpose hybrids for adaptation to drought prone	1.5	5	<b>Target:</b> India: Western Rajasthan and drier parts of Gujarat and Haryana (200-400 mm/annum)	65-75	<b>Biotic stresses:</b> Downy mildew and blast <b>Abiotic stress:</b> Drought	<b>Must have traits:</b> Parents with high productivity and good GCA for grain yield, hybrids with grain yield of 2.0-2.5 t/ha	Hybrid parents to develop hybrids with 10% increase in grain yield over representative

environments in South Asia			<b>Spillover:</b> Sudan (ESA), Northern Niger and Senegal (WCA)				
(7) Cultivars and hybrid parents exclusively for forage and high biomass in South Asia	1.0	5	<b>Target:</b> India: Gujarat, Punjab, Rajasthan, Uttar Pradesh, Madhya Pradesh, Peninsular India (summer and rainy season) <b>Spillover:</b> Central Asian countries and Brazil	Single cut (50-80); Multicut (50-110)	<b>Biotic stresses:</b> Downy mildew, blast and rust	<b>Must have traits:</b> Green biomass of 40-55 t/ha, dry biomass of 15-20 t/ha, non-hairy, leaf: stem ratio of 3-5, IVDMD of 50-55% with protein of 10-12%	5% increase in biomass yield over best check