Technical Report Under The CGIAR Nature Positive Solutions Initiative

Nature-Positive Seed Production for Sustainable Community Seed Banks in Kenya

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2024

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Nature-Positive Seed Production for Sustainable Community Seed Banks in Kenya

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Rationale

Access to high-quality and affordable seeds is crucial for farmers to improve their yields, produce better quality crops, and enhance nutritional value. This is especially important for farmer-preferred cultivars, which are often open-pollinated varieties lacking systematic quality assurance support from the formal seed sector. Recognizing this need, the ICARDA-ALIANCE seed component, under Work Package 2 of the Nature-Positive Solutions-CGIAR initiative, focused on source seed production. This effort aims to support the multiplication and distribution of these valuable cultivars through Community Seed Banks (CSBs). Early generation seed production is a critical skill for Community Seed Banks (CSBs) aiming to scale their impact. Mastery of these techniques allows for increased seed multiplication and distribution, directly supporting large-scale crop production. This strengthens CSB sustainability and contributes to agrobiodiversity conservation, resilient food systems, and improved farmer livelihoods

Modern breeding and technology have revolutionized seed sector development, resulting in high yielding varieties and hybrids that enhance commercial production of few staple crops. However, subsistence farmers have yet to fully benefit from these advancements in seed technology.

Whether a crop variety is a pure line or a population, successful seed production hinges on careful management throughout the entire process. This includes establishing a variety identity, maintaining purity, implementing good farming practices, and adhering to quality standards. From research and breeding to post-harvest handling and marketing, each stage demands attention.

In Kenya, the seed industry operates through both formal and informal sectors. Smallholder farmers in Western Kenya have bimodal rainfall and often rely on the informal sector of their local crops and cultivars, sourcing seeds from various sources like farm-saved seed, exchanges with other farmers, local markets, NGOs, and CSBs. Unfortunately, these seeds often lack quality assurance and traceability. This can result in poor yields, disease susceptibility, and lower incomes for farmers already facing challenges from erratic weather patterns, including unpredictable rainfall and hailstorms.

SHORT RAINY SEASON (SRS)-2023

During the 2023 SRS, our primary focus was on purifying existing farmer-preferred cultivars and producing source seeds of various crops. This high-quality seed was multiplied by seed production groups and Community Seed Banks (CSBs) for wider distribution. We planted 76 genotypes of common beans, green grams, groundnuts, maize, sorghum, and traditional leafy vegetables, at three locations: Kabudi, Nyando, and Kibos. This allowed us to produce source seed and further characterize these valuable cultivars.

A portion of the harvested seeds was reserved for planting during the 2024 Long Rain Season (LRS). This enabled us to continue purification and characterization efforts and generate more source seed (Annex 1). The main farmers' preferred cultivar integrity maintenance and early generation seed production was carried out at the Kibos research station and the Nyando CSB farm (Table 1). The remaining seeds were securely stored at the Nyando CSB as carryover seed stock.

Table 1. Short Rainy Season seed production for different crop species and local cultivars

Crops	Cultivars	Area planted (m2)	Yield (Kg)
Common beans	31	465	32.3
Green gram	1	15	3.9
Groundnut	3	45	2.2
Cowpea	4	60	3.7
Maize	8	240	24.9
Sorghum	18	607.5	61.3
African Kales	1	15	0.1
Grain Amaranth	3	45	4.8
Black Nightshade	2	30	1.1
Rattlepods	2	30	2.4
Jute Mallow	2	30	1.8
Sider plant	1	15	0.4
Total	76	1597.5	138.9

Fifteen members of the CSB are among the beneficiaries of the seeds delivered to Nyando CSB from the 2023 SRS harvests. Some of the seeds were also used for planting at Kibos research station, Nyando farm and the Jimo East Nature Positive Aggregated Farm (14 cultivars of sorghum, 4 cultivars of Traditional leafy vegetables (TLV) and 4 cultivars of beans), during the 2024 LRS. The carryover seed for each crop and cultivars was kept at the CSB (Table 2).

Table 2. Amount of seeds produced and distributed in 2023 short rainy season

Crops	Production (Kgs)	Uses of seeds	Preferred traits & cultivars	#Cultivars	Seed (Kg)
Common beans	32.3	Jimo East Nature$^+$ farm	Variable	4	4
		4 CSB farmers	Rosecoco big, Yellow green, Pinki, Nyarateng'	4	1.7
		Kibos & Nyando LR	Variable	31	3.2
		Subtotal			8.9
Sorghum	61.3	Jimo East Nature$^+$ farm	Variable	14	32.3
		Kibos & Nyando LR	Variable	18	1.1
		2 CSB farmers	Ochuti red, Kajimbo riat	2	2
		Subtotal			35.4
Maize	24.9	4 CSB farmers	Nyamula, Nyamilambo, Popcorn yellow	4	3.7
		Kibos & Nyando LR	Variable	8	0.8
		Subtotal			4.5
Traditional Leafy Vegetables (TLVs)	14.3	Jimo East Nature$^+$ farm	Variable	4	0.2
		Kibos & Nyando LR	Variable	15	0.6
		2 CSB farmers	Black Nightshade	2	0.3
		Subtotal			1.1
Green grams	3.9	Kibos & Nyando LR	Green grams	1	0.2
		2 CSB farmers	Green grams	2	0.5

Crops	Production (Kgs)	Uses of seeds	Preferred traits & cultivars	#Cultivars	Seed (Kg)
		Subtotal			0.7
Groundnuts	2.2	Kibos & Nyando LR CSB farmer	Variable Small groundnuts	3 1	0.3 0.2
		Subtotal			0.5
Totals					51.1

LONG RAINY SEASON (LRS)-2024

During the 2024 LRS, a total of 88 cultivars were planted in Kibos research station and Nyando farm for source seed production (Table 3; Annex 2).

Table 3. Crops, cultivars and amount of seeds harvested and delivered to Nyando CSB in 2024

Crops	Number of cultivars	Area planted (m^2)	Total seed produced (Kg)
Common beans	32	480	61.4
Green grams	3	45	4.5
Groundnuts	4	60	5.2
Cowpea	4	60	7.7
Maize	8	120	47.5
Sorghum	18	270	163.1
Finger millet	7	105	32.5
Grain Amaranth	3	45	8.2
African Kales	2	30	0.2
Black Nightshade	2	30	2.0
Rattlepods	2	30	3.4
Jute Mallow	2	30	2.7
Spider wisp	1	15	0.1
Total	88	1320	338.5

Three CSBs and 11 farmers from Nyando CSB received a total of 329.6Kg of clean seeds delivered to Nyando CSB from the 2024 LRS harvest. A total of 5.9Kg of this seed was used to plant Kibos research station for illustration of the technical manual development while 3Kg went to Nutritional value analysis work at ICARDA Quality Laboratory (Table 4).

Table 4. Lists of crops and beneficiaries of seeds produced in 2024 LRS

Crop	Beneficiaries	Purpose	Cultivars/varieties	Seeds (Kg)
Common beans	1. Vihiga CSB	Marketability	6	1.5
	2. Nyando CSB	Marketability	31	35.7
	3. Kabudi CSB	Marketability	20	21.1
	4. Nutritional value analysis	Research	10	0.6
	5. CGIAR Staff	Training	31	2.5
Finger millet	1. Nyando CSB	Marketability	7	24.8
	2. Kabudi CSB	Marketability	7	7
	3. Nutritional value analysis	Research	7	0.4
	4. CGIAR staff	Training	7	0.3
Sorghum	1. Nyando CSB	Marketability	18	131.5
	2. Kabudi CSB	Marketability	18	30
	3. Nutritional value analysis	Research	8	0.5

Crop	Beneficiaries	Purpose	Cultivars/varieties	Seeds (Kg)
	4 CGIAR staff	Training	18	1.1
Yellow maize, Nyamilambo & Rachich)	1. Nyando CSB (plus 6 farmers)	Marketability	6	36.8
	2. Kabudi CSB	Marketability	6	6
	3. Vihiga CSB	Marketability	6	3.5
	4. Nutritional value analysis	Research	6	0.4
	5. CGIAR staff	Training	8	0.8
Spider plant & Black Nightshade	1. Nyando CSB and 3 farmers	Marketability	13	23.0
	2. Nutritional value analysis	Marketability	13	0.7
	3. CGIAR staff	Training	13	0.6
Local green grams	1. Nyando CSB (plus 2 farmers)	Marketability	2	4.1
	2. Nutritional value analysis	Research	3	0.2
	3. CGIAR staff	Training	3	0.2
Groundnuts	1. Nyando CSB	Marketability	4	4.6
	2. Nutritional value analysis	Research	4	0.2
	3. CGIAR staff	Training	4	0.4
Total				338.5

Cultivar integrity and identity maintenance

Methodology

To maintain cultivar integrity and identity, a comprehensive methodology was employed, focusing on the evaluation of morphological and physiological characteristics across various plant stages. This involved a detailed examination of the following:

- **Plant:** Growth habit, stem pigmentation, leaf and leaflet shape, peduncle length and groove shape, vine pigmentation, and overall size served as key identifiers.
- **Inflorescence:** Flowering traits, including color and date, were critical for distinguishing cultivars.
- **Fruit:** Pod color, length, beak shape, and overall size were used to verify distinctiveness.
- **Seed:** A meticulous analysis of embryo structure, seed color, seed coat pattern, size, shape, dimensions, hilum color, and its positioning ensured consistency and accuracy.

This rigorous characterization process was applied to 88 cultivars collected from farmers. However, detailed evaluation revealed that only 79 were unique, with the remaining entries identified as duplicates. Ultimately, 95% of the cultivars provided by farmers were verified as true to type.

Outcomes

During the two rainy seasons, the key observations focused on cultivar integrity, characterization, and adaptation to short and long rainy seasons (Annex 2) with the following results:

1. Red maize and Rakwaro maize are adapted to short and long rainy seasons
2. Sorghum GBK 051768 and Red Sorghum are two names given to the same cultivar by farmers in different CSBs.
3. For beans, two names were given to the same cultivar by farmers in different CSBs in four cases;
    - Army green and Kanyawawa green
    - Osuko pease small and Kinyonyozi
    - Rosecoco big and Rosecoco long
    - Zebra black and Magwar.

4. Although sorghum variety Boke has small compact panicles, it has the highest tillering ability and as such would make an excellent cultivar as a fodder crop.

Seed Quality Traits and Uses for Community Produced Seed

At the end of the second season, an anonymous questionnaire was distributed to the CSB members and beneficiaries of the seed distribution to evaluate their appreciation of the quality of the seed they received and used. The summary of the survey results is below.

Seed genetic integrity and identity

The observed seed genetic integrity and identity by different beneficiary groups surveyed based on the homogeneity in shape, color, and pattern is illustrated using the below bar graph. There was practically no difference in the visually observed seed purity because the off types were removed in the field and cleaning was done by hand removing all the impurities after threshing.

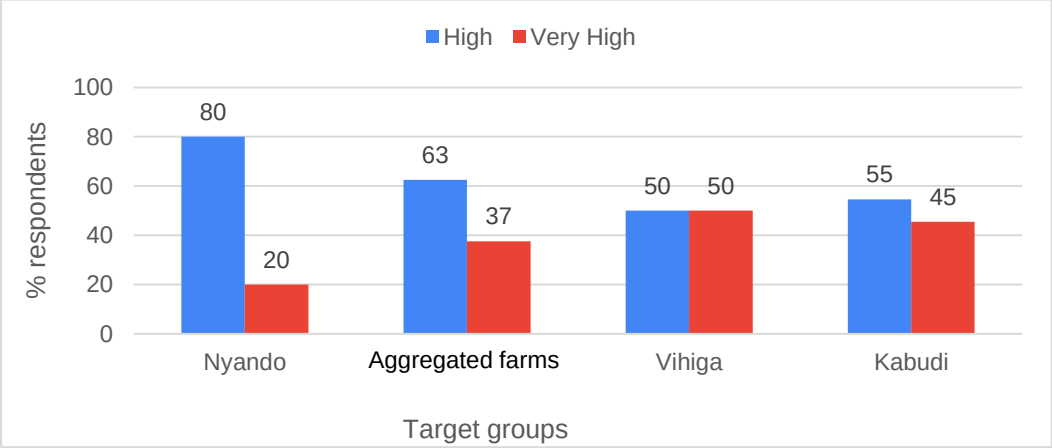

Figure 1. Observed seed genetic integrity and identity based on homogeneity in seed characteristic

From the survey, the genetic integrity and identity rating for Nyando was high for 80% of the seeds, while 20% were rated as very high. This suggests that seeds in Nyando have a relatively high genetic uniformity. The Aggregated farms demonstrated a range of purity levels, with 63% rated as high and 37% as very high. While this suggests a relatively balanced distribution, there is room for improvement in increasing the proportion of very high purity levels. In the case of Vihiga, both high and very high ratings were equal at 50%. This reflects a balanced level of genetic integrity and identity among seeds from this region. For Kabudi, 55% of seeds were rated as high purity and 45% as very high, indicating that many seeds in Kabudi have a relatively high level of genetic integrity and identity like Vihiga.
Overall, most regions have a high level of seed genetic integrity and identity, with Nyando achieving the highest high purity rating and Vihiga showing equal levels of high and very high purity. These results reflect the efforts made in maintaining seed genetic uniformity across different regions, though there is some variability.

Physical purity

The observed physical seed purity refers to the removal of impurities and foreign materials from seed lots to ensure that only pure, healthy seeds are planted. This is an essential aspect of seed quality that directly affects germination rates, crop health, and productivity. Maintaining physical cleanliness is crucial for commercial seed producers and farmers aiming for optimal crop performance. There was

practically no difference in the physical seed purity because the cleaning was done by hand removing all the impurities.

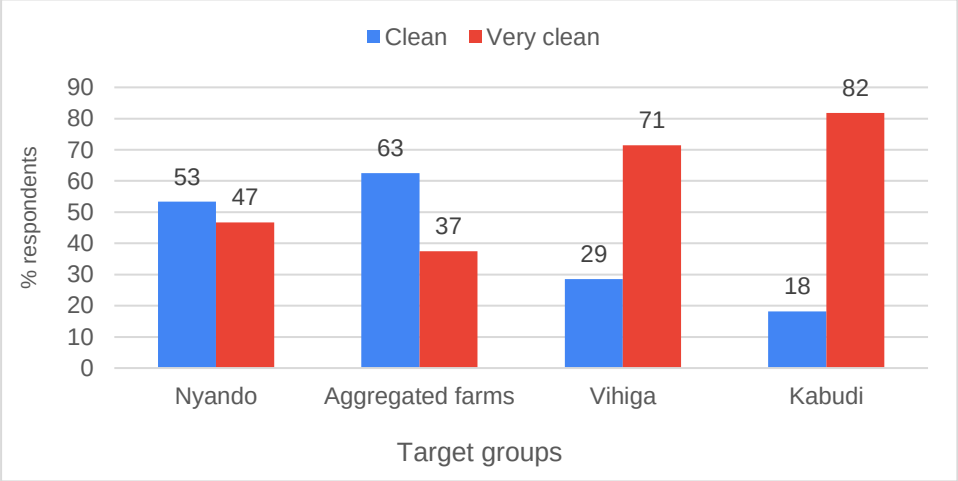

Figure 2. Observed physical seed purity through freedom from inert matters by beneficiary groups

The data revealed similarity in seed cleanliness across the surveyed groups. Practically, there was no significant differences between the seed stock distributed to different CSBs. Nonetheless, the similarity in the responses showed the difficulties for the respondents to differentiate between the seed stocks in terms of cleanliness. In general, lack of differences in physical purity reflects the fact that the seed stock were all properly cleaned

Field emergence

The observed percentages of field emergence as rated by different groups of target beneficiaries surveyed from different CSBs is presented in Figure 3. In Nyando, the emergence rate is balanced, with a slight majority perceiving it as high rather than very high. In the case of the Aggregated farms, a strong majority observed high emergence levels, with a smaller proportion reporting very high success. For Vihiga, most participants observed very high emergence success, making it the region with the highest positive perception of seed viability. The emergence rates in Kabudi are relatively balanced, with a slight inclination toward high emergence.

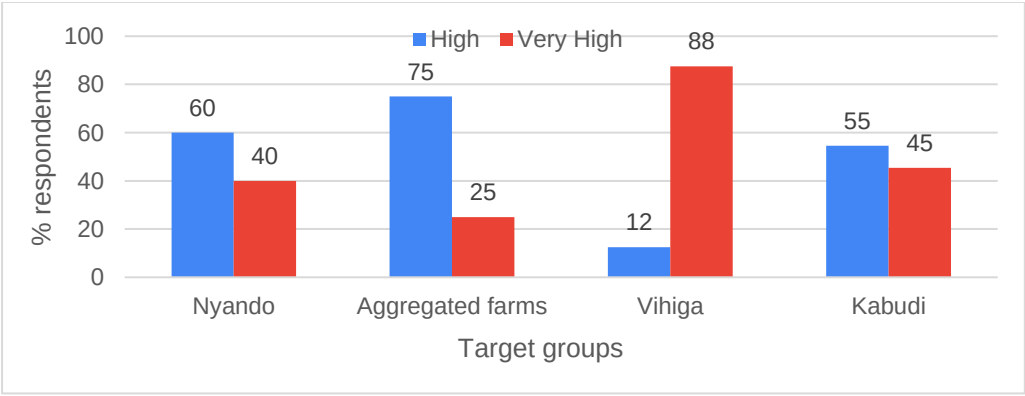

Figure 3. Observed field germination as observed by the target beneficiary groups

The survey result indicated variability in emergence rates across CSBs, with Vihiga showing highest germination, an indication that the beneficiaries in this region generally found the seeds most viable. This insight could guide future decisions on seed distribution and development programs, prioritizing factors that may have contributed to Vihiga's high success rates. The seed producers of the Aggregated farms rated the field germination as high with 75% and very high at 25% suggesting good performance under large scale planting under field conditions.

Field establishment

The survey findings indicated that the Aggregated farms had the highest percentage (88%) in the high category, while Vihiga recorded the lowest rate at 12%. Kabudi demonstrated a more balanced distribution between the high (55%) and very high (45%) categories (Figure 4). Notably, Vihiga stands out with a significantly stronger very high rating (88%) compared to the other regions, whereas the very high category was least observed in Aggregated farms (12%), reflecting a more dominant high establishment level in this area. The chart suggests that field establishment is generally rated as high across these regions, with Aggregated farms and Nyando showing the most pronounced levels of high establishment. This trend may be attributed to the use of clean, healthy seeds that are free from diseases or damage.

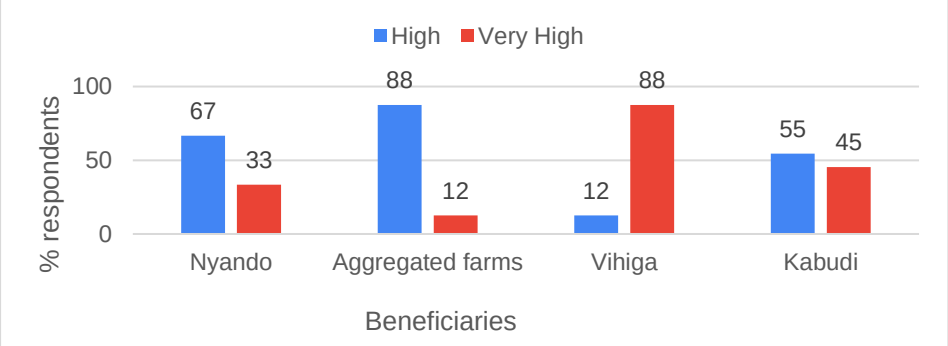

Figure 4. Observed field establishment by the target beneficiary groups

Seed yields

The results reported by the target beneficiaries surveyed showed that seed production in Vihiga was very high followed by Nyando and Kabudi (Figure 5).

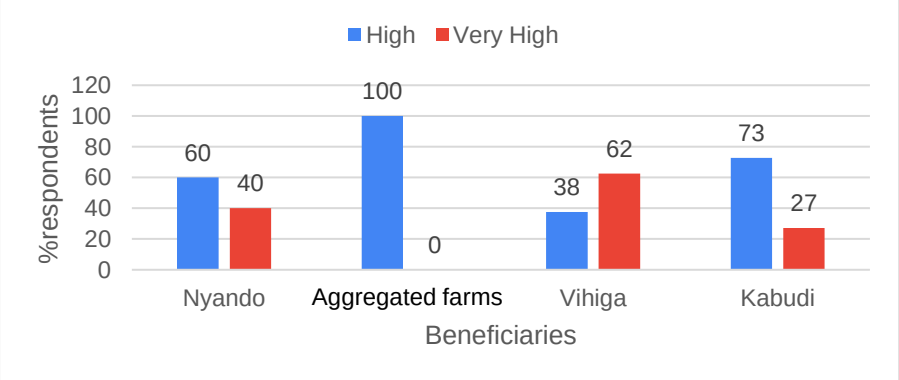

Figure 5. Yield from the seed provided to different target beneficiaries

A significant portion of farmers (60%) in Nyando reported high seed yields, while 40% of beneficiaries achieved very high yields. Aggregated farms in the region consistently reported high yields. In Vihiga, performance was strong in both categories, with a higher proportion of very high yields compared to

high yields. This suggests favorable conditions or practices that promote exceptional productivity, resulting in the region having the highest percentage of very high yields overall. In Kabudi, 73% of farmers reported high yields, while 27% achieved very high yields. This distribution reflects generally good productivity with occasional exceptional results, indicating stable farming practices. However, the gap between high and very high yields highlights potential opportunities for further agricultural innovation or support across the region.

Flour yield for value addition

To assess the flour yield obtained from seeds of Maize, Sorghum, Millet, and Beans used for value addition, two beneficiary groups (Nyando and Kabudi) were targeted. Both groups rated the flour yields as high. However, the Nyando group had a higher proportion of very high flour yields compared to Kabudi (Figure 6).

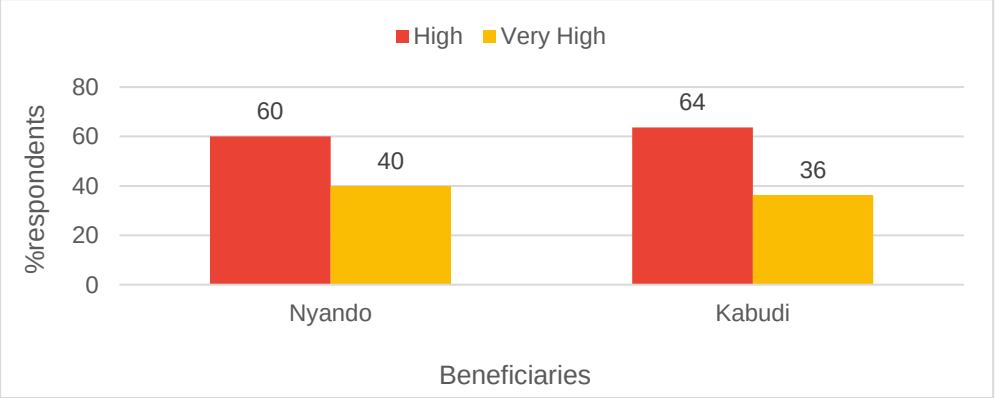

Figure 6. Flour yield obtained from seed of Sorghum, Millet, and Maize used for value addition

Findings from the survey revealed that 60% of respondents in Nyando rated CSB seed flour yield as high, and 40% as very high. In Kabudi, 64% rated it high, while 36% gave a very high rating. While both seed banks demonstrate strong yields, the presence of very high ratings highlights the potential in the quality of seeds used. While Kabudi had a slightly higher high rating, Nyando excelled in the very high flour yield category, suggesting its suitability for premium product marketing.

This comparative analysis indicates that both Nyando and Kabudi are effectively using good and clean seeds. Sharing best practices between these two CSBs could further improve yields and community benefits.

Loss reduction

In Nyando, 60% of beneficiaries rated waste reduction from value addition as very high, while 40% rated it high, reflecting significant benefits from using high-quality seeds (Figure 7). Beneficiaries in Aggregated farms showed an even split, with 50% rating waste reduction as high and 50% as very high, indicating consistent but moderate level of success in waste reduction across beneficiaries. Factors such as diverse farming practices, resource sharing, and variability in crop types grown may have influenced these results. Notably, the Kabudi women-managed CSB achieved the strongest outcome, with 82% of the beneficiaries reporting very high reduction and only 18% rating it high. This implies that value addition techniques have been highly effective in this CSB, indicating a more consistent and advanced implementation. High adoption of best practices, supportive infrastructure, cohesive community effort and crop specificity could be some of the factors attributed to such positive results.

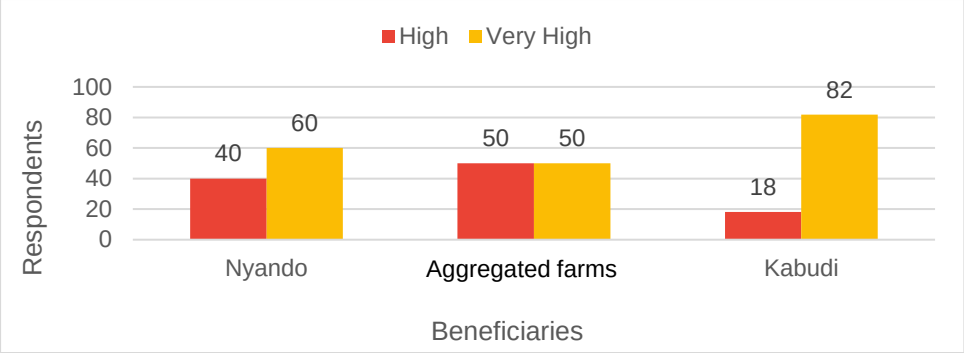

Figure 7. Reduced wastes from value addition as reported by beneficiaries

Overall, this data demonstrates that value addition practices are effective in reducing waste, but the extent of their impact varies by community. Kabudi showed the highest success, likely due to better skills of the women in value addition compared to the men majority CSBs. On the other hand, Nyando and Aggregated farms experienced moderate success, suggesting a need for tailored support and improvements in infrastructure or training. By addressing specific barriers in each community, these practices can likely achieve an even greater impact, benefiting both the farmers' livelihoods and the environment.

Price advantage

By transforming raw products into high-quality, processed forms that meet specific consumer demands, uniqueness and consumer preference, farmers often get to set prices higher than the farm gate prices offered by middlemen for the raw material (Figure 8).

Results illustrate that value addition practices led to significant price advantage across all three communities, albeit to varying degrees. Kabudi and Aggregated farms stand out, with most beneficiaries reporting substantial price advantages, likely due to effective practices, robust market connections, and consistent quality control. Conversely, Nyando exhibits a more balanced distribution of moderate to high price advantages, suggesting that while many farmers benefit from value addition, there is room for improvement in maximizing potential gains.

These findings underscore the potential of value addition in boosting farmers' incomes. However, realizing its full benefits hinges on factors such as product quality, consistency, and market access. Tailored support and community-specific training could enable more farmers across these regions to achieve and sustain higher price advantages, fostering economic growth and resilience.

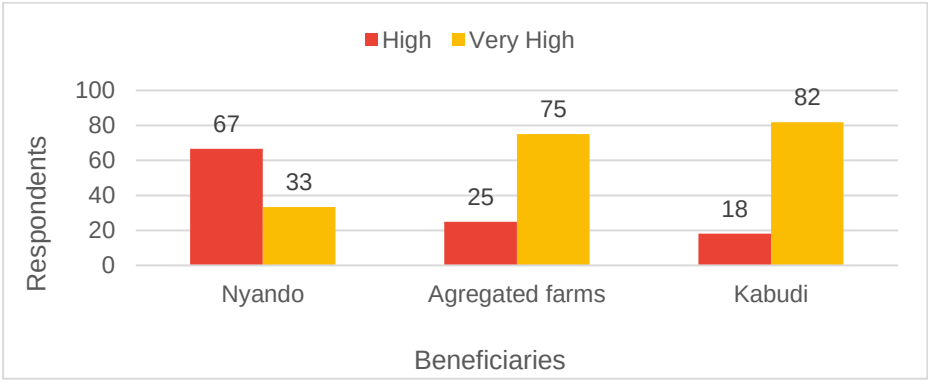

Figure 8. Price advantage on value added products as reported by the beneficiaries

Conclusions

The aim of the project was to boost Community Seed Banks with Nature-Positive Seed Production. Based on the results presented above, the project contributed to increasing availability, accessibility, affordability and profitability of high-quality seed of the farmers' preferred varieties of high nutritive crops.

Seed Production and Distribution

During the 2023 short rain season (SRS) and the 2024 long rain season (LRS), on-station source seed multiplication efforts yielded a total of 478.8 kg of seeds with 95% physical purity. Purity was assessed based on plant morphology, physiology, seed size, shape, and color.

2023 SRS Harvest:

- 8.4 kg distributed to 15 Nyando Community Seed Bank (CSB) farmers.
- 42.7 kg donated to Nyando CSB, with a portion used for planting at Kibos research station and Nyando farms.
- 87.8 kg retained as carryover seed.

2024 LRS Harvest:

- 8.9 kg allocated for research and training.
- 329.6 kg donated to three CSBs and 11 Nyando CSB farmers.
- 36.5 kg used to plant Jimo East Nature positive aggregated farms.

Feedback from the seed beneficiaries

- **Improved crop quality:** Leading to better market prices and increased income.
- **Increased crop yields:** Enhancing food security and income generation.
- **Improved incomes:** Contributing to improved livelihoods and economic well-being.
- **Enhanced food security:** Reducing reliance on external food sources.
- **Greater resilience to environmental changes:** Improving long-term sustainability of farming practices.

These outcomes collectively contribute to the socio-economic development of the farming communities.

Strengthening Local Seed Systems

By strengthening local seed production and distribution systems, this initiative ensures the availability and accessibility of improved seed varieties to rural farmers. This reduces their dependence on the grain market for planting material, promoting self-reliance and long-term sustainability. Quality seeds play a crucial role in boosting productivity and empowering farmers.

Communication of outputs: A blog on Community Seed Bank has been produced and published (Community Seed Banks)
Community seed bank support.mp4
https://drive.google.com/file/d/1DkeEWc8g4O4o66tmUMtdMM2GJirSKIsQ/view

Acknowledgments

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agricultural organizations has been essential in fostering community ownership and sustainability. The support of the Ministry of Agriculture, Fisheries, Food Security and Nature of the Netherlands is highly appreciated.

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Annex 1. Crops and Seeds Produced During 2023 Short Rainy Season, Western Kenya

Crop	Cultivars/Varieties	G.C.T	S.T.P	C.T.P	Area (m^2)	Yield (Kg)
Common Beans	Jeshi red	Red	Spotted	White	15	0.9
	Kanyawawa maroon	Maroon	Plain	None	15	0.9
	Nyayo purple long	Purple	Mottled	White	15	0.5
	Nyayo long	Red	Mottled	White	15	0.7
	Nyayo short	Red	Mottled	White	15	1.8
	Okwodo big /Punda	Grey	Speckled	White	15	0.1
	Rosecoco big	Pink	Spotted	Maroon	15	0.9
	Rosecoco small	Brown	Spotted	Maroon	15	2.0
	Rosecoco long	Pink	Spotted	Maroon	15	0.9
	Rosecoco medium	Brown	Spotted	Maroon	15	1.1
	Rosecoco yellow medium	Tan	Stripped	Maroon	15	1.9
	Army green	Jungle green	Plain	None	15	1.0
	Kanyawawa green	Jungle green	Plain	None	15	0.9
	Glo jaber	White	Plain	None	15	0.6
	Jeshi green	Cream	Spotted	Jungle green	15	1.4
	Kabanyarwanda	Red	Plain	None	15	0.4
	Kanyawawa	Grey	Plain	None	15	0.3
	Kanyawawa purple	Purple	Plain	None	15	0.1
	Nyarateng'	Black	Plain	None	15	0.0
	Nya-Uganda	Pink	Marbled	Maroon	15	1.2
	Nyazaire/Piriton	Cream	Plain	None	15	1.8
	Nyota *	Red	Mottled	White	15	1.7
	Okwodo small	Purple	Speckled	White	15	0.1
	Osuko Pease long/Rosecoco yellow long	Tan	Spotted	Maroon	15	1.8
	Osuko Pease small	Cream	Marbled	Jungle green	15	1.7
	Kinyonyozi	White	Marbled	Jungle green	15	0.3
	Pinki	Pale pink	Plain	None	15	2.4
	Purple long	Purple	Plain	None	15	1.2
	Yellow green	Yellow green	Plain	None	15	0.8
	Yellow green long	Yellow green	Plain	None	15	1.8
	Zebra black/Magwar	White	Stripped	Black	15	1.1
Subtotal Beans					**465**	**32.3**
Green gram	Local green grams	Green	Plain	None	15	3.9
Subtotal Green Gram					**15**	**3.9**
Cowpea	Cowpea brown	Brown	Plain	None	15	1.3
	Cowpea red	Pale pink	Plain	None	15	1.6
	Cowpea white	Cream	Plain	None	15	0.5
	Cowpea black	Black	Plain	None	15	0.3
Subtotal Cowpea					**60**	**3.7**
Groundnut	Black groundnuts	Dark purple	Plain	None	15	0.6
	Small groundnuts	Red	Plain	None	15	1.1
	Red valencia	Red	Plain	None	15	0.4
Subtotal Groundnut					**45**	**2.2**
Maize	Nyamilambo	White	Plain	None	30	4.7
	Nyamula maize	Yellow	Plain	None	30	1.8
	Oking' maize	Yellow	Plain	None	30	2.6
	Popcorn yellow maize	Yellow	Plain	None	30	3.6
	Rachich	Purple	Bicolor	Yellow	30	1.4
	Rakwaro	Red	Plain	None	30	1.6
	Red maize	Red	Plain	None	30	3.8
	Yellow maize	Dark yellow	Plain	None	30	5.3
Subtotal Maize					**240**	**24.9**
Sorghum	Andiwo madongo	Reddish brown	Plain	None	33.75	2.0
	Andiwo matindo	Brown	Plain	None	33.75	0.3
	Athanyra	Cream white	Plain	None	33.75	3.0

Crop	Cultivars/Varieties	G.C.T	S.T.P	C.T.P	Area (m^2)	Yield (Kg)
	Boke	Red	Plain	None	33.75	5.5
	G.B.K 044626	Brown	Plain	None	33.75	1.9
	G.B.K 044669	Cream white	Plain	None	33.75	3.9
	G.B.K 044672	Brown	Plain	None	33.75	2.6
Sorghum	G.B.K 051768	Red	Plain	None	33.75	7.3
	Red sorghum	Red	Plain	None	33.75	7.8
	Kajimbo riat	Brown	Plain	None	33.75	3.6
	KARI Mtama 4 *	Brown	Plain	None	33.75	5.1
	Migogo otho e dero	Reddish brown	Plain	None	33.75	1.3
	Nyakatai	Brown	Plain	None	33.75	3.1
	Nyalang'o	Red	Plain	None	33.75	6.0
	Nyamongo oyie	Brown	Plain	None	33.75	4.9
	Ochuti makwar	Reddish brown	Plain	None	33.75	2.0
	Bend rabuor	Brown	Plain	None	33.75	0.6
	Bend rachar	Cream white	Plain	None	33.75	0.5
Subtotal Sorghum					**607.5**	**61.3**
African Kales	African Kales (green stem)	Grey	Plain	None	15	0.1
Subtotal African Kales					**15**	**0.1**
Amaranth	Amarantha leaves (Golden seeds)	Gold	Plain	None	15	2.3
	Amarantha seed (Cream white)	Cream white	Plain	None	15	2.3
	Amaranthus veridis (Terere)	Black	Plain	None	15	0.2
Subtotal Amaranth					**45**	**4.8**
	Black Nightshade madongo	Cream white	Plain	None	15	1.0
Black Nightshade	Black Nightshade matindo (Local)	Cream white	Plain	None	15	0.1
Subtotal Black Nightshade					**30**	**1.1**
	Crotalaria bitter (small leaves)	Red	Plain	None	15	0.2
Rattlepods	Crotalaria sweet (large leaves)	Cream	Plain	None	15	2.2
Subtotal Rattlepods					**30**	**2.4**
	Jute Mallow (Apoth 1 -small dull leaves)	Grey	Plain	None	15	1.2
Jute Mallow	Jute Mallow (Apoth 2-large shiny leaves)	Grey	Plain	None	15	0.6
Subtotal Jute Mallow					**30**	**1.8**
Spider wisp	Spider plant	Black	Plain	None	15	0.4
Subtotal sider plant					**15**	**0.4**
Grand total					**1597.5**	**138.9**

G.C.T: Ground color of Testa; S.T.P: Seed Testa Pattern; C.T.P: Color of Testa Pattern

***: improved variety from KALRO**

Annex 2. Crops Produced During The 2024 Long Rains Season, Wester Kenya

Crop	Cultivars/Varieties	G.C.T	S.T.P	C.T.P	Area (m2)	Yield (Kg)
Common beans	Jeshi red	Red	Spotted	White	15	2.3
	Kanyawawa maroon	Maroon	Plain	None	15	2.2
	Nyayo purple long	Purple	Mottled	White	15	0.8
	Nyayo long	Red	Mottled	White	15	1.1
	Nyayo short	Red	Mottled	White	15	2.6
	Okwodo big /Punda	Grey	Speckled	White	15	1.1
	Rosecoco big	Pink	Spotted	Maroon	15	1.5
	Rosecoco small	Brown	Spotted	Maroon	15	3.1
	Rosecoco long	Pink	Spotted	Maroon	15	1.1
	Rosecoco medium	Brown	Spotted	Maroon	15	2.5
	Rosecoco yellow medium	Tan	Stripped	Maroon	15	1.6

Crop	Cultivars/Varieties	G.C.T	S.T.P	C.T.P	Area (m2)	Yield (Kg)
	Army green	Jungle green	Plain	None	15	1.3
	Kanyawawa green	Jungle green	Plain	None	15	1.3
	Glo jaber	White	Plain	None	15	0.3
	Jeshi green	Cream	Spotted	Jungle green	15	1.3
	Kabanyarwanda	Red	Plain	None	15	3.4
	Kanyawawa	Grey	Plain	None	15	0.1
	Kanyawawa purple	Purple	Plain	None	15	1.8
	Nyarateng'	Black	Plain	None	15	2.2
	Nya-Uganda	Pink	Marbled	Maroon	15	1.5
	Nyazaire/Piriton	Cream	Plain	None	15	1.3
	Nyota *	Red	Mottled	White	15	0.8
	Okwodo small	Purple	Speckled	White	15	2.2
	Osuko pease long/Rosecoco yellow long	Tan	Spotted	Maroon	15	4.8
	Osuko Pease small	White	Marbled	Jungle green	15	1.1
	Kinyonyozi	White	Marbled	Jungle green	15	0.1
	Pinki	Pale pink	Plain	None	15	4.7
	Purple long	Purple	Plain	None	15	1.5
	Yellow green	Yellow green	Plain	None	15	4.1
	Yellow green long	Yellow green	Plain	None	15	2.7
	Zebra yellow	White	Stripped	Yellow	15	2.2
	Zebra black/Magwar	White	Stripped	Black	15	2.8
Subtotal Beans					**480**	**61.4**
Green gram	Lesoriadre green	Green	Plain	None	15	3.1
	Lesoriadre maroon	Maroon	Plain	None	15	0.1
	Local green grams	Green	Plain	None	15	1.3
Subtotal Green Gram					**45**	**4.5**
Groundnut	Black groundnuts	Dark purple	Plain	None	15	1.0
	Small groundnuts	Red	Plain	None	15	0.8
	Red valencia	Red	Plain	None	15	0.9
	Homabay red	Brown	Plain	None	15	2.5
Subtotal Groundnut					**60**	**5.2**
Maize	Nyamilambo	White	Plain	None	15	6.4
	Nyamula maize	Yellow	Plain	None	15	8.4
	Oking' maize	Yellow	Plain	None	15	1.2
	Popcorn yellow maize	Yellow	Plain	None	15	3.1
	Rachich	Purple	Bicolor	Yellow	15	8.0
	Rakwaro	Red	Plain	None	15	9.7
	Red maize	Red	Plain	None	15	4.2
	Yellow maize	Dark yellow	Plain	None	15	6.5
Subtotal Maize					**120**	**47.5**
Sorghum	Andiwo madongo	Reddish brown	Plain	None	15	4.8
	Andiwo matindo	Brown	Plain	None	15	2.9
	Athanyra	Cream white	Plain	None	15	7.9
	Boke	Red	Plain	None	15	13.4
Sorghum	G.B.K 044626	Brown	Plain	None	15	9.9
	G.B.K 044669	Cream white	Plain	None	15	13.2
	G.B.K 044672	Brown	Plain	None	15	9.7
	G.B.K 051768	Red	Plain	None	15	14.6
	Red sorghum	Red	Plain	None	15	8.4
	Kajimbo riat	Brown	Plain	None	15	13.7
	KARI Mtama 4 *	Brown	Plain	None	15	12.9
	Migogo otho e dero	Brown	Plain	None	15	6.5
	Nyakatai	Brown	Plain	None	15	12.6
	Nyalang'o	Brown	Plain	None	15	5.4
	Nyamongo oyie	Brown	Plain	None	15	9.4
	Ochuti makwar	Brown	Plain	None	15	4.5
	Bend rabuor	Brown	Plain	None	15	7.3

Crop	Cultivars/Varieties	G.C.T	S.T.P	C.T.P	Area (m2)	Yield (Kg)
	Bend rachar	Brown	Plain	None	15	6.1
Subtotal Sorghum					**270**	**163.1**
Millet	Rateng' (Chepleliet)	Brown	Plain	None	15	5.1
	Rabuor (Chebririet)	Brown	Plain	None	15	4.3
	Nyanakuru (Naikuru)	Red	Plain	None	15	4.2
	Nyarkamoi (Cherurkemoi)	Red	Plain	None	15	4.5
	Aliet (Chemukuliet)	Reddish brown	Plain	None	15	2.3
	Atonga (Matongo)	Reddish brown	Plain	None	15	4.4
	Oteng' (Chepnyaliliet)	Brown	Plain	None	15	7.8
Subtotal Millet					**105**	**32.5**
African Kales	African Kales (green stem)	Brown	Plain	None	15	0.1
	African Kales (purple stem)	Brown	Plain	None	15	0.1
Subtotal African Kales					**30**	**0.2**
Amaranth	Amarantha leaves (Golden seeds)	Brown	Plain	None	15	3.3
	Amarantha seed (Cream white color)	Brown	Plain	None	15	4.2
	Amaranthus veridis (Terere)	Brown	Plain	None	15	0.7
Subtotal Amaranth					**45**	**8.2**
Black Nightshade	Black Nightshade madongo	Brown	Plain	None	15	2.0
	Black Nightshade matindo (Local)	Brown	Plain	None	15	0
Subtotal Black Nightshade					**30**	**2.0**
Cowpea	Cowpea brown	Brown	Plain	None	15	2.1
	Cowpea red	Brown	Plain	None	15	2.7
	Cowpea white	Brown	Plain	None	15	1.5
	Cowpea black	Brown	Plain	None	15	1.4
Subtotal Cowpea					**60**	**7.7**
Rattlepods	Crotalaria bitter (small leaves)	Brown	Plain	None	15	0.8
	Crotalaria sweet (large leaves)	Brown	Plain	None	15	2.6
Subtotal Rattlepods					**30**	**3.4**
Jute Mallow	Jute Mallow (Apoth 1 -small dull leaves)	Brown	Plain	None	15	2.1
	Jute Mallow (Apoth 2-large shiny leaves)	Brown	Plain	None	15	0.6
Subtotal Jute Mallow					**30**	**2.7**
Spiderwisp	Spider plant	Brown	Plain	None	15	0.1
Subtotal Spiderwisp					**15**	**0.1**
Grand total					**1320**	**338.5**

G.C.T: Ground color of Testa; S.T.P: Seed Testa Pattern; C.T.P: Color of Testa Pattern

***: improved variety from KALRO**

Annex 3. Plant, inflorescence, fruit, and seed characteristics for cultivar identity and integrity

Beans

Cereals

Traditional leafy vegetables

Photos were taken by Ms. Anne Achieng Nyambok