Sustainable Intensification of Mixed Farming Systems

CGIAR

Basona Worena Farming Household Typology: An Insight into The Challenges, Opportunities, Structural Barriers, and Risks of Different Farming Households

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The Sustainable Intensification of Mixed Farming Systems Initiative aims to provide equitable, transformative pathways for improved livelihoods of actors in mixed farming systems through sustainable intensification within target agroecologies and socio-economic settings.

Through action research and development partnerships, the Initiative will improve smallholder farmers' resilience to weather-induced shocks, provide a more stable income and significant benefits in welfare, and enhance social justice and inclusion for 13 million people by 2030.

Activities will be implemented in six focus countries globally representing diverse mixed farming systems as follows: Ghana (cereal–root crop mixed), Ethiopia (highland mixed), Malawi: (maize mixed), Bangladesh (rice mixed), Nepal (highland mixed), and Lao People's Democratic Republic (upland intensive mixed/ highland extensive mixed).

Contents

Introduction

The objective of this study is to develop a farming household typology in the woreda of Basona Worena, Ethiopia (Figure 1). By creating this typology, it is hoped that a more nuanced understanding of the different farming systems will be established. This will help in the targeting of farming households for rural development projects related to sustainable intensification. It will also provide insight into which sustainable intensification technologies and innovations are already used by different farming household types, and which of these may help further farming intensification initiatives in the future. Materials and methods

Study area – Basona Worena

Figure 1: Map of Ethiopia indicating study area (Basona Worena) and the capital city (Addis Ababa)

Data collection, management and analysis

Two hundred and fifty farming households were surveyed using the Rural Household Multi-Indicator Survey (RHoMIS - https://www.rhomis.org/). RHoMIS is a structured questionnaire conducted using tablets or mobile phones with the Open Data Kit (ODK) software adapted to Android-based mobile phones or tablets (https://opendatakit.org/). The survey comprises questions related to household demographics, agricultural and livestock production and management, nutrition, poverty, and off-farm activities. Raw data from the survey is used to calculate indicators that characterise and facilitate the analysis of farming systems and the vulnerability of rural households. Households were

randomly selected from a list of households from the woreda and were interviewed in May and June 2022.

The main RHoMIS indicators were reviewed to identify and remove any outliers based on the use of histograms and expert estimates of achievable maximum responses. A between class principal component analysis (PCA) and the Ward method of hierarchical clustering were used to create a farming household typology based on a set of RHoMIS indicator variables assessing household assets (household size, livestock herd size, and land cultivated), farm and off-farm income streams (income from crops, livestock and off-farm activities) and market orientation (proportion of farm production sold to market).

To further explore the differences among farming household types, linear regressions and least significant difference tests were used assess differences among groups for variables used to create the typology and other farm and household variables not included in the typology development. Differences among groups for the latter variables help further characterise the farming household types and provide further insights into the differences in farming and livelihood approaches. A more detailed assessment of the crop and livestock production activities was also conducted of the different farming household types focusing in on the top crop and livestock production streams. Means and standard deviations are presented for these data. Finally, logistic regressions combined with least significant difference tests were applied to the data to assess differences in the probability of use of different innovations promoted by Africa Rising among the different farming household types.

Table 1: Variables used for the development of the farming household typology

Category of variables	**Variables**
Household demographics	Household size (members of household)
Farm assets	Herd size (livestock Tropical Units) Land area cultivated (ha)
Farm income	Crop income (ETB Br $year^{-1}$) Livestock income (ETB Br $year^{-1}$)
Off-farm activities	Off-farm income (ETB Br $year^{-1}$)

Results

Typology development

Figure 2 presents the between class PCA and the results of the Ward method of hierarchical clustering, grouping farming households surveyed by similarities displayed in the selected indicator variables (Table 1). The Dendrogram for the hierarchical clustering is presented in Annex 1 and indicates that the optimal number of clusters for the typology was four. PC1 accounted for 36% of variability, while PC2 accounted for 21% of variability. All variables to some degree differentiated between household types along the horizontal axis, correlating most strongly with Diversified and Moderate-income farming households, and least with Small subsistence and Large subsistence households. Along the vertical axis (PC2), household size, livestock herd size and land cultivated were more highly correlated with Moderate-income farms, while livestock income, crop income, off-farm income, and market orientation were more correlated with Diversified farming households (Figure 2).

Figure 2: BCA of farming household typology variables. L = Large subsistence farms; S = Small subsistence farms; M = Moderate-income farms; D = Diversified farms

The means and least significant differences tests applied to the variables used to create the farming household typology reveal that the Small subsistence farming households have the lowest means for all variables except market orientation (Table 2). Diversified farming households on the other tended to display that highest means for all variables except for household size. Large subsistence farming households were larger, cultivated more land, and owned more livestock compared to the Small subsistence household types. Moderate-income households were the largest of all farming household types and also cultivated the most land and reared the most livestock. Levels of income generated from crops and livestock for Moderate-income did not differ from Diversified farming households at the 5% level of probability, but were lower. A description of the farming households is outlined in Table 3.

Table 2: Means, standards errors and least significant difference tests results for the variables used to create the typology by farming household type

Variable	Diversified-commercial		Moderate-income		Large subsistence		Small subsistence	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
HH size (members)	3.3	0.2	4.6	0.2	3.8	0.2	2.4	0.1
Land cultivated (ha)	1.8	0.1	2.2	0.1	1.3	0.1	1.0	0.1
Livestock herd (TLUs)	5.2	0.7	5.9	0.7	3.8	0.4	1.2	0.1
Crop income (ETB Br year^{-1})	21204	16475	2961	1879	136	86	156	81
Livestock income (ETB Br year^{-1})	36405	29635	2631	1749	37	25	66	36
Off-farm income (ETB Br year^{-1})	493	388	2	2	1	<1	2	1
Market orientation (% farm production sold)	54	5	29	3	13	2	25	2

Grey = lowest mean; Green = second highest mean; Orange = highest mean according to the least significant difference test. Different colours indicate differences at the 5% level of probability

Table 3: Farming household type description

Farming HH type	Number of HHs (% of sample)	Description of farming HH type
Diversified commercial oriented farms("Diversified")	40 (16%)	These farming households generate significantly higher levels of off-farm income compared to other farming households (although generally off-farm income remains relatively low – 494 Ksh $year^{-1}$). Diversified farming households also generate the most livestock and crop production income (21,204 Ksh $year^{-1}$ and 36406 Ksh $year^{-1}$ respectively) and are the most market oriented, selling more than half of their production to market. Farming household size is smaller than the Moderate-income farming households comprising around 3.3 members per household.
Moderate-income farms ("Moderate-income")	60 (24%)	These farming households generate significantly more income from crop and livestock farm production than the subsistence farms (around 3000 Ksh $year^{-1}$ per production stream). While this income is less than Diversified farming households, the difference is not significant at the 5% level of probability. On the other hand, Moderate-income farms own more livestock (5.94 TLUs) and cultivate more land (than any other farming household type (2.23 ha) (although these differences are not significant at the 5% level of probability compared to the Diversified farming households. Moderate households are also large, comprising on average more than 4.5 members per household, which is significantly different to all other farming household types. One of the main differences to Diversified farming households is that Moderate-income farms generate virtually no income from off-farm income sources.
Large subsistence farms ("Large subsistence")	60 (24%)	These households are characterised as generating little on- or off-farm income and selling very few farm products to market (13%). These farming household types differ from the "small household subsistence farms" in terms of household size, generally comprising of more than one household member more than these farming households (an average of 3.82 household members compared to 2.37). Large household subsistence farm households also own more farm assets (3.79 livestock TLUs and 1.32 ha of land cultivated) compared to their

Farming HH type	Number of HHs (% of sample)	Description of farming HH type
		smaller counterparts (1.16 livestock TLUs and 0.99 ha of land cultivated).
Small subsistence farms (“Small subsistence”)	90 (36%)	These farming households are similar to “large household subsistence farms”, in that they sell little farm produce to market and generate little income however, their household is smaller (on average just over 2 household members – 2.37) and they have fewer farm assets (1.16 livestock TLUs and 0.99 ha of land cultivated).

Additional indicator variables

When assessing indicator variables that were not included in the development of the typology, Diversified farming households displayed joint highest with Moderate-income farming households for total income (off- and on-farm); and crop and livestock value production (which includes production sales and production consumed) (Figure 3). Diversified farming households also displayed the highest level of dietary diversity. On the other hand, Small subsistence farming households displayed the lowest levels of all variables measured.

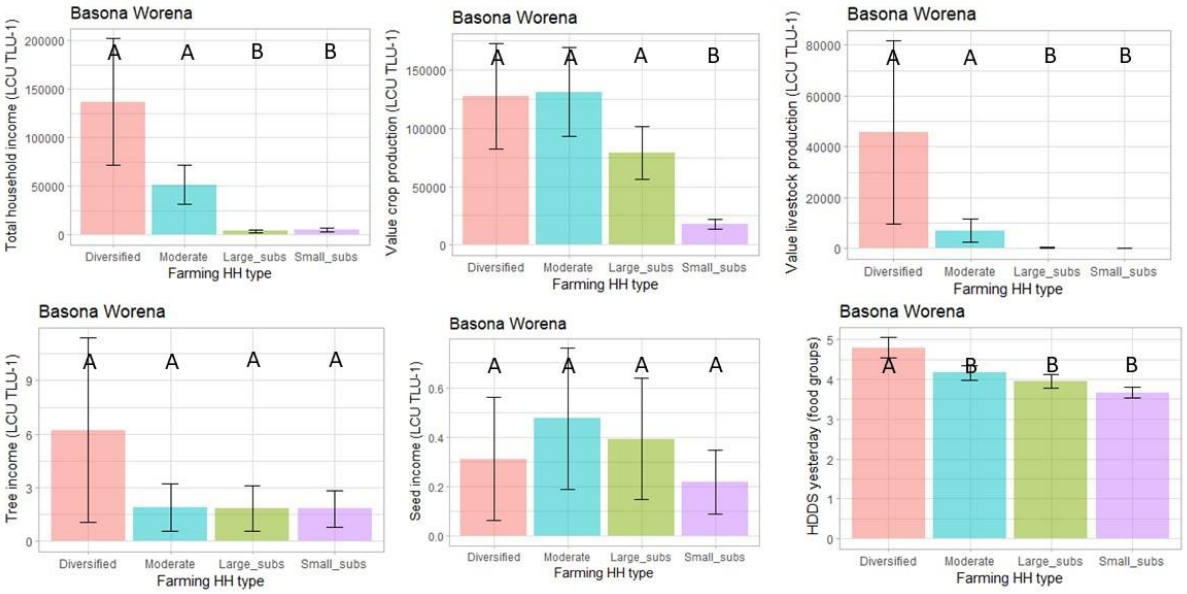


Figure 3: Means, standard errors and least significant difference results by farming household type for A) total household income, B) Value crop production, C) Value livestock production, D) Seed income, E) Tree income, F) Household dietary diversity over the past 24 hours. Whiskers at the top of each bar indicate standard error, while letters indicate the results of the least significant difference test with different letters indicating differences at the 5% level of probability

Crop production by farming household type

The most commonly cultivated crops were broadly similar across the four farming household types (Figure 4). Wheat bread, teff, faba beans, food barley, and malt barley were the five most commonly cultivated crops. Other crops that were commonly cultivated included lentils and field-peas, especially by Diversified and Moderate-income farming households.

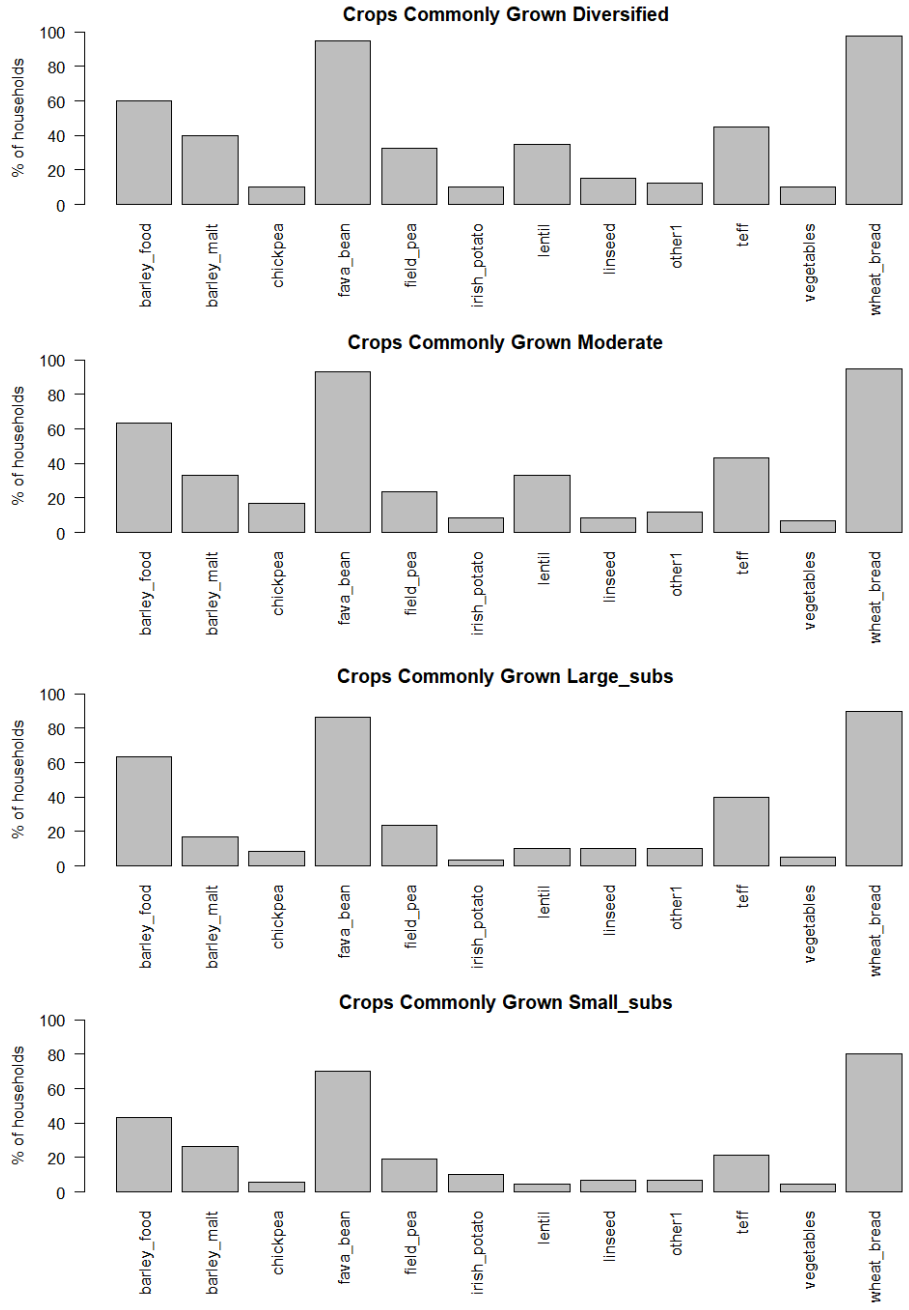


Figure 4: Proportion of households cultivating different crops by farming household type

Land area dedicated to crops by farming household type

Most land was dedicated to the production of food barley and bread wheat across the three farming household types with around 35-40% of land from all farming households dedicated to these crops. Less land was dedicated to malt barley, faba beans and teff (<30%). There were no statistical differences in the amount of land dedicated to the different crops across farming households (Figure 5).

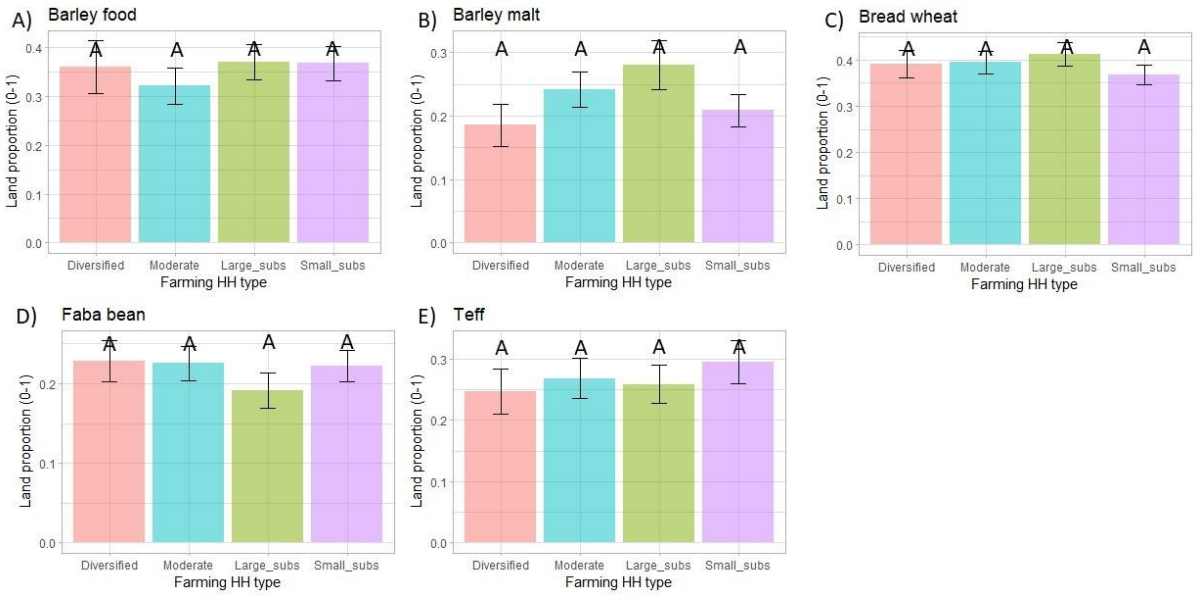


Figure 5: Proportion of land dedicated to different crops by farming household type A) Barley food, B) Barley malt, C) Bread wheat, D) Faba beans, E) Teff. Whiskers at the top of each bar indicate standard error, while letters indicate the results of the least significant difference test with different letters indicating differences at the 5% level of probability

Malt barley was the crop most likely to be sold to market with up to 84% of the harvest sold to market by Diversified farming households (Table 4). All other crops tended to be more likely to be consumed by the farming households (usually >70% of the harvest was consumed, except for Bread wheat in Diversified farms). Malt barley and faba beans tended to be cultivated on less land than the other others crops. Malt barley and bread wheat generated the most income for all farming households, suggesting that bread wheat is both important for self-consumption and sales to market. While land areas cultivated tended to be smaller for Small subsistence farming households yields did not appear to vary widely among farming household types, except for malt barley and faba beans where yields were notably higher for Diversified farming households.

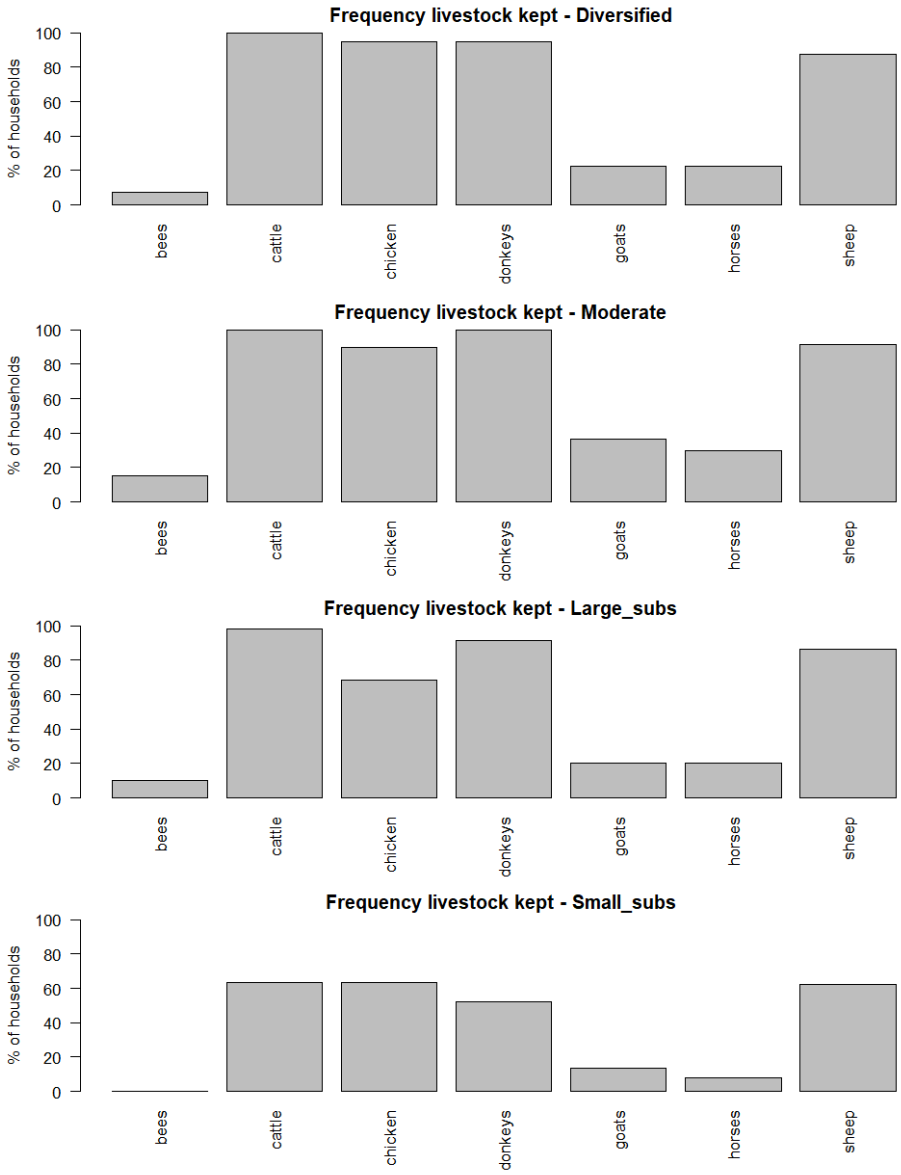
Table 4: Crop production variable means and standard deviation (SD) for the five most commonly cultivated crops

Crop	Crop variable	Diversified		Moderate		Large_subs		Small_subs	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food barley	Harvest (kg)	1127	879	858	1024	648	419	445	256
	Land area (ha)	0.7	0.6	0.8	0.6	0.5	0.4	0.4	0.3
	Yield (kg ha^{-1})	2312	1739	1483	3038	1758	971	1629	1639
	Proportion consumed (%)	72	24	89	25	91	21	89	29
	Proportion sold (%)	28	29	11	21	9	19	11	26
	Sale income (ETB Br $year^{-1}$)	16700	37538	2054	5728	1210	3813	1141	5753
Malt barley	Harvest (kg)	657	323	800	1157	575	392	407	625
	Land area (ha)	0.3	0.2	0.5	0.6	0.4	0.3	0.2	0.2
	Yield (kg ha^{-1})	2911	1877	2184	2320	1810	1359	1832	2102
	Proportion consumed (%)	16	31	53	50	58	70	35	50
	Proportion sold (%)	84	41	47	51	42	49	65	45
	Sale income (ETB Br $year^{-1}$)	23878	17293	6202	10153	5022	5804	7606	11226
Faba beans	Harvest (kg)	578	408	443	443	296	372	218	807
	Land area (ha)	0.4	0.3	0.5	0.4	0.3	0.2	0.2	0.2
	Yield (kg ha^{-1})	1692	1785	1213	2254	1370	1273	1136	5476
	Proportion consumed (%)	46	36	72	42	77	33	73	43
	Proportion sold (%)	54	39	28	34	23	31	27	37
	Sale income (ETB Br $year^{-1}$)	7967	17476	3312	4996	1726	3561	1746	3334
Bread wheat	Harvest (kg)	1500	2015	1375	1475	779	1408	680	609
	Land area (ha)	0.8	0.8	1.0	0.8	0.6	0.5	0.4	0.3
	Yield (kg ha^{-1})	2012	2392	1793	1735	1642	2387	2041	1767
	Proportion consumed (%)	74	33	81	27	87	26	85	27
	Proportion sold (%)	26	33	19	26	13	22	15	24

Crop	Crop variable	Diversified		Moderate		Large_subs		Small_subs	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Sale income (ETB Br year^{-1})	15520	33892	5120	9411	1763	3331	1682	5410
Teff	Harvest (kg)	582	461	650	390	431	260	371	322
	Land area (ha)	0.7	0.7	0.8	0.8	0.4	0.3	0.3	0.2
	Yield (kg ha^{-1})	1260	1320	1006	879	1384	1175	1351	850
	Proportion consumed (%)	73	35	71	33	80	29	72	36
	Proportion sold (%)	27	29	29	30	20	28	28	32
	Sale income (ETB Br year^{-1})	8235	11561	6079	7291	3538	4347	4079	3960

Livestock production by farming household type

A similar pattern of ownership of different livestock species was observed for all farming household types (Figure 6). Cattle and donkeys were owned by between 90-100% of farming households, except for Small subsistence households, that were much less likely to own livestock (around 50-60% owned cattle and donkeys). Chickens and sheep were also commonly owned by around 70-90% of households from the Diversified, Moderate-income and Large subsistence types. Around 60% of Small subsistence farming households owned these livestock.



Goats, horses and bees were owned by fewer than 30% of households.

Figure 6: Proportion of households owning different livestock species by farming household type

As noted above, Diversified and Moderate-income farming households owned the most livestock, while Small subsistence farming households owned the fewest. Moreover, Diversified and Moderate-income farming households generated significantly more income than either of the two farming subsistence household types (Table 2). Cattle were the main livestock species in the herd that generated income for all farming households indicating their importance for the farming systems in Basona Worena. Diversified and Moderate-income farming households generated the greatest amount of income from cattle (47871 and 24119 ETB Br year^{-1} respectively) compared to less than 3000 ETB Br year^{-1} for Large and Small subsistence farming households (Table 5). Sheep generated the second highest income stream in each of the farming household types except for Small subsistence farming households, where chickens generated the second highest income levels. Moderate-income farming households had the largest sheep and goat herds of all types (9.5 and 5.0 heads respectively), however, Diversified farming households generated the most income from sheep (3119 ETB Br year^{-1}), while goats tended not to generate much income for any farming household type. While donkeys were commonly owned, they did not generate income, suggesting that they were mainly used as draught power.

Table 5: Livestock production variables of households owning the livestock by livestock species and farming household type. Means presented followed by standard deviation in (parentheses)

HH type	Livestock	kept (heads)	sold (heads)	Slaughtered (heads)	Milk yields (litre day^{-1})	Cash income (ETB Br year^{-1})
Diversified	Cattle	4.2 (1.7)	0.9 (1.0)	0.0 (0.2)	3.1 (2.6)	47871 (44231)
	Sheep	8.9 (5.5)	1.0 (2.4)	1.9 (1.6)	NA	3119 (7250)
	Goats	3.8 (2.9)	1.0 (1.5)	0.4 (0.8)	NA	139 (5296)
	Chicken	6.4 (4.5)	NA	1.5 (1.7)	NA	3046 (8639)
	Donkeys	2.1 (1.0)	0.2 (0.4)	0 (0)	NA	261 (1088)
Moderate-income	Cattle	4.6 (1.2)	0.5 (0.6)	0.0 (0.3)	2.3 (2.0)	24119 (23670)
	Sheep	9.5 (5.9)	1.2 (2.2)	1.7 (1.6)	NA	1942 (4364)
	Goats	5.0 (3.8)	0.3 (0.7)	1.1 (1.0)	NA	0.0 (1251)
	Chicken	6.5 (5.0)	NA	2.1 (1.8)	NA	769 (4890)
	Donkeys	1.9 (0.7)	0.1 (0.5)	0 (0)	NA	124 (1690)
Large subsistence	Cattle	3.5 (1.1)	0.1 (0.3)	0 (0)	2.1 (1.4)	2921 (8515)
	Sheep	6.7 (4.2)	0.7 (1.6)	1.3 (1.1)	NA	1096 (3161)
	Goats	2.3 (1.3)	0.9 (1.7)	1.1 (0.1)	NA	0.0 (1571)
	Chicken	4.8 (3.3)	NA	0.6 (1.2)	NA	133 (1803)

HH type	Livestock	kept (heads)	sold (heads)	Slaughtered (heads)	Milk yields (litre day^{-1})	Cash income (ETB Br year^{-1})
	Donkeys	1.4 (0.6)	<0.1 (0.3)	0 (0)	NA	0.0 (671)
Small subsistence	Cattle	2.5 (1.3)	0.2 (0.6)	0.0 (0.0)	1.7 (1.2)	2598 (11639)
	Sheep	4.0 (2.0)	0.5 (1.2)	0.8 (1.1)	NA	621 (2727)
	Goats	2.4 (1.1)	0.3 (0.5)	0.1 (0.3)	NA	0.0 (563)
	Chicken	6.1 (4.1)	NA	1.4 (1.8)	NA	1113 (7355)
	Donkeys	1.4 (0.6)	0.0 (0.2)	0 (0)	NA	0.0 (347)

Technologies trialled

Diversified farming households used more technologies promoted by Africa rising (around 5.5) compared to Large and Small subsistence farming households (around 3 technologies each) (Figure 7). Moderate-income farming households employed around 5 technologies which was greater than the Small subsistence farming households at the 5% level of probability.

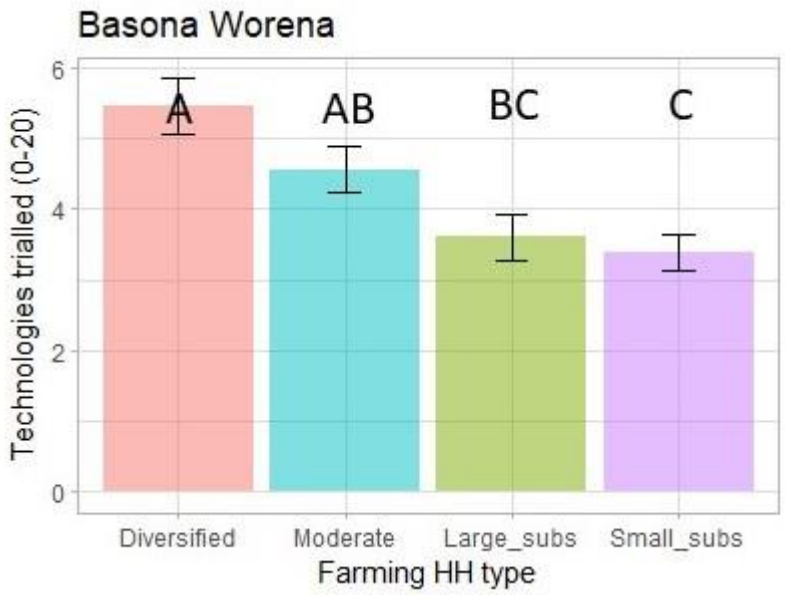


Figure 7: Average number of technologies promoted by Africa Rising trialled by farming household. Whiskers at the top of each bar indicate standard error, while letters indicate the results of the least significant difference test with different letters indicating differences at the 5% level of probability types

Crop related technologies

The five main crop technologies used in Basona Worena were the use of improved seeds for bread wheat, faba beans, food and malt barley, and potato (Figure 8). Seed production for sale of potato, faba beans and food barley; tractor thresher; and the cultivation of apple trees were also innovations that were used to a degree by some farming households. The use of improved bread wheat varieties was the technology that was most widely used with between 75% (Small subsistence) and 90% (Diversified) farming households using this technology. Improved faba bean varieties were also very popular with up to 75% of Diversified farming households using the technology. Improved food and malt barley, and potato varieties were used more or less equally by the different farming household types (by around 25-35%). Seed production of faba beans and a tractor thresher were innovations more commonly used by Diversified farming households (25%). Apple trees were cultivated by around 15-20% of households.

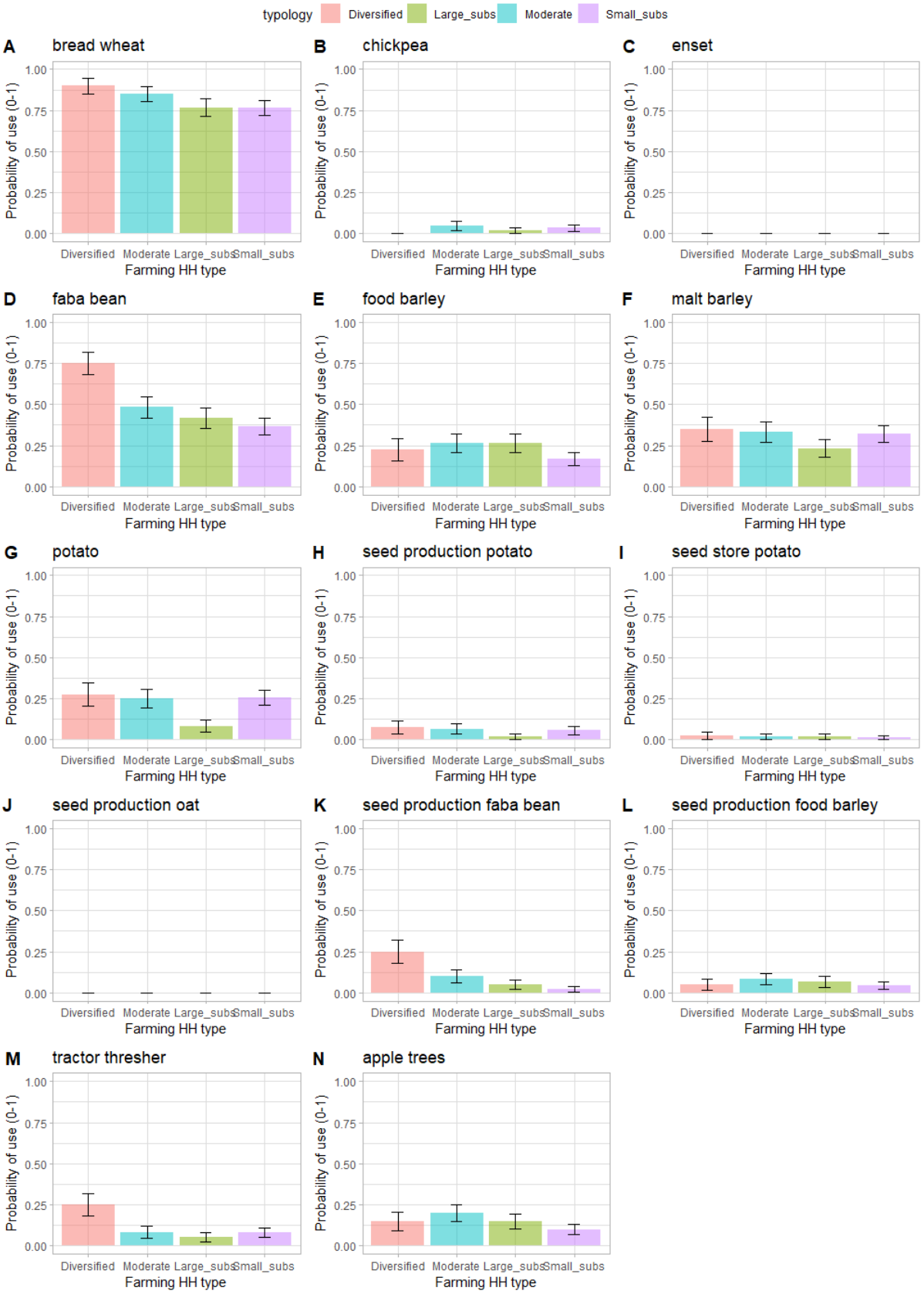


Figure 8: The proportion of use of different crop technologies promoted by Africa Rising by farming household type A) improved bread wheat seeds, B) improved chickpea seeds, C) improved enset seeds, D) improved faba bean seeds, E) improved food barley seeds, F) improved malt barley seeds, G) improved potato

seeds, H) potato seed production, I) potato seed storage, J) oat seed production, K) faba bean seed production, L) food barley seed production, M) use of a tractor thresher, N) cultivation of avocado trees. Whiskers at the top of each bar indicate standard error

Livestock technologies

The cultivation of oat vetch, Phalaris grass and tree lucerne were the improved forage technologies used in Basona Worena (Figure 9). Usually Diversified farming households tended to be more likely to use these improved forages (between 30-50%). Feed troughs were also used by between 15-20% of all households except Small subsistence farming households which did not tend to use this innovation.

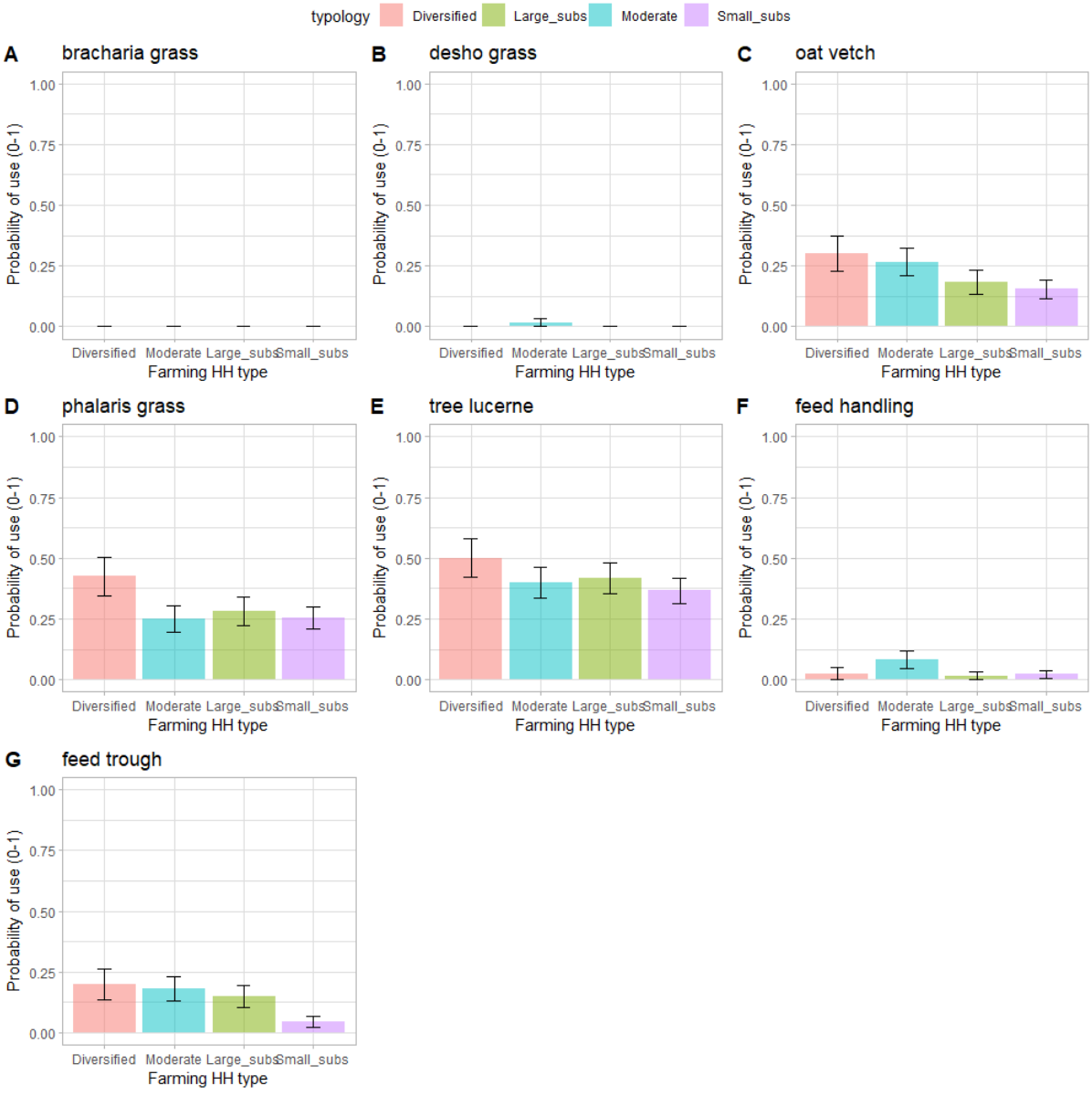


Figure 9: The proportion of use of different livestock technologies promoted by Africa Rising by farming household type A) bracharia grass forage cultivation, B) desho grass forage cultivation, C) oat-vetch forage cultivation, D) phalaris grass forage cultivation, E) tree lucerne forage cultivation, F) improved feed handling, G) use of feed troughs. Whiskers at the top of each bar indicate standard error

Discussion

Observations about the site as a whole

Generally, according to the results of the current analysis, the farming systems found in Basona Worena remain largely similar in a number of respects. Despite different levels of income, farm assets, market orientation, and engagement in off-farm activities, farms throughout the woreda tended to cultivate similar crops (wheat bread, teff, faba beans, food barley, and malt barley) and reared similar livestock (mostly cattle, sheep, and chicken, with a donkey for draught power). Malt barley was mainly cultivated for sale to market, but both malt barley and bread wheat were important crop income streams. This suggests that bread wheat is a crop that is both important for home consumption and as a cash crop which may indicate a tension between income generation and food security for this crop. The other crops tended to be consumed primarily by the households themselves (usually >70% of the harvest). Livestock production focused on cattle and sheep production, with most livestock income being generated by cattle, followed by sheep, and in the case of Diversified and Small subsistence farming households from the sale of chickens and their eggs too. While donkeys were commonly owned, they were used for draught power. Livestock sales represented the largest income stream for Diversified farming households, while crop sales were slightly higher that livestock sales for Moderate-income farming households. Both of the subsistence farming household types barely generated income from farm production.

Despite the similarities in cropping and livestock structure, there were also some very clear differences among farming households in Basona Worena. As described in the Results, Diversified farming household types were much more market orientated and generated more off-farm income than any of the other three farming households. Moderate-income farming households on the other hand were the largest, cultivated slightly more land and owned slightly more livestock than Diversified farming households. As a result, despite lower levels of market orientation, they generated broadly similar levels of farm income. Neither of the Subsistence farming household types generated much on- or off-farm income. The differences between these two farming household types were that the Large subsistence farming households were larger, cultivated more land, and owned more livestock. Indeed, it was notable that Small subsistence farming households were considerably less likely to own the different livestock species than any other farming household type. Given this analysis, it can be concluded that Small subsistence farming households were the least resource endowed and also very vulnerable.

While Small subsistence farming households may be the least resource-endowed, Large subsistence farming households are likely to be equally vulnerable. Whereas Large subsistence farming households cultivated more land and owned more livestock than Small subsistence farming households, their size of households were also much larger (3.8 members on average compared to 2.4 members). Larger households obviously require larger amounts of food, which necessitates cultivating more land and rearing more livestock for home consumption, in effect decreasing the potential to sell to market. This analysis is

supported by the observation that Small subsistence households sell more farm produce to market (25%) compared to Large subsistence households (13%). As such it is likely that Large subsistence households are as vulnerable as Small subsistence households.

Larger households for Moderate-income farming types may also be a reason why these farms sell less to market (29%) compared to Diversified farming households (54%). Indeed, despite cultivating more land and owning more livestock, Moderate-income households generate less income from both of these income streams than Diversified farming households. It is therefore likely that household size may present an important barrier to commercialization of farm produce for these farming types as households prioritise self-consumption over sale to market. On the other hand, it cannot be discounted that the reverse is also true, that important barriers in terms of access to market prevent these households from selling their farm produce and therefore must consume their farm produce. Whatever the underlying reason, it should be noted that any sustainable rural development project that aims to stimulate farm intensification and market orientation must consider the potential that these farming households may experience important food security and farm income trade-offs as their market orientation varies.

It is also noteworthy that crop yields tend be lower for Moderate-income farming households compared to Diversified farming households. Livestock value production is also much lower for these household types, despite owning more livestock than Diversified farming households. This suggests that Moderate-income farming households have an important yield gap.

These starkly contrasting characteristics indicate important differences in livelihood outcomes, as well as different challenges, opportunities, barriers, and risks to more sustainable rural development.

Pathways toward more sustainable rural development

Table 7 presents a summary of the main challenges, opportunities, structural barriers, and risks to sustainable rural development by farming household type. Farm intensification, both crop and livestock production, present clear opportunities to enhance the resilience and welfare of farming households in Basona Worena. Out of the four farming household types identified in this research, it is evident that Diversified farming households already generate more income and are more resilient than the other three household types. Moreover, according to the analysis, these households are likely able to more easily integrate new innovations and technologies into their farming systems as they already enjoy access to more resources and assets potentially enabling them to risk more on these novel investments. They also tend to be the early users of many of the innovations and technologies trialled by Africa Rising.

Nevertheless, these households only account for 16% of the population surveyed (Table 7). Moderate-income and Large subsistence household types on the other hand account for 24% of the population each while Small subsistence farming

households account for 36%. Facilitating a pathway to more intensified farm production in these more populous farming households may therefore provide the potential for larger scale impacts for rural development projects. However, these farming household types are faced with more structural barriers to such changes compared to Diversified farming households; and these barriers also differ among these household types.

In particular, the two subsistence farming household types are much less resource endowed than the Moderate-income farming households. They cultivate less land, have smaller livestock herds, and importantly generate the least amount of farm income (have less financial resources). These structural barriers to farm intensification present important constraints to these farming households. On the other hand, Moderate-income farming households already cultivate the largest area of land and own the largest livestock herds, while crop and livestock yields remain low making the potential of farm intensification an important pathway to enhance their livelihoods.

It would therefore appear that out of the four farming household types studied, Moderate-income households present the most important opportunity to impact the largest proportion of the population with the highest potential for improved livelihood and welfare outcomes. This is not to say that the transition of these farming households to more intensified forms of farming is without risks or important barriers. For example, the current analyses also indicate that for Moderate-income farming households, access to financial resources, market, and inputs may present limitations to the ability of these farming households to intensify their farm production activities. Moreover, the analysis presented suggests that farm production is closely associated with a need to feed a larger households. As such, any potential changes to their farming systems that may lead to more sales to market as opposed to self-consumption, may erode food security. It is therefore important that these potential trade-offs are thoroughly explored and understood before implementing any rural development project aimed at stimulating farm intensification measures.

Considering the current context in terms of crop and livestock production and the assessment of which technologies are currently used by farming households in Basona Worena a list of recommended innovations promoted by Africa Rising is presented in Table 6.

Table 6: Summary of recommended sustainable intensification technologies.

Crop production innovations	Livestock production innovations	Livelihood diversification innovations
• Improved bread wheat variety • Improved faba bean variety • Improved food barley variety • Improved malt barley variety	• Oat-Vetch forage • Phalaris grass • Tree lucerne • Feed handling and trough	• Apple tree cultivation • Seed production faba beans • Seed production potato • Seed production food barley

Crop production innovations	Livestock production innovations	Livelihood diversification innovations
• Improved potato variety		

Table 7: Summary of the main challenges, opportunities, structural barriers, and risks to sustainable rural development by farming household type

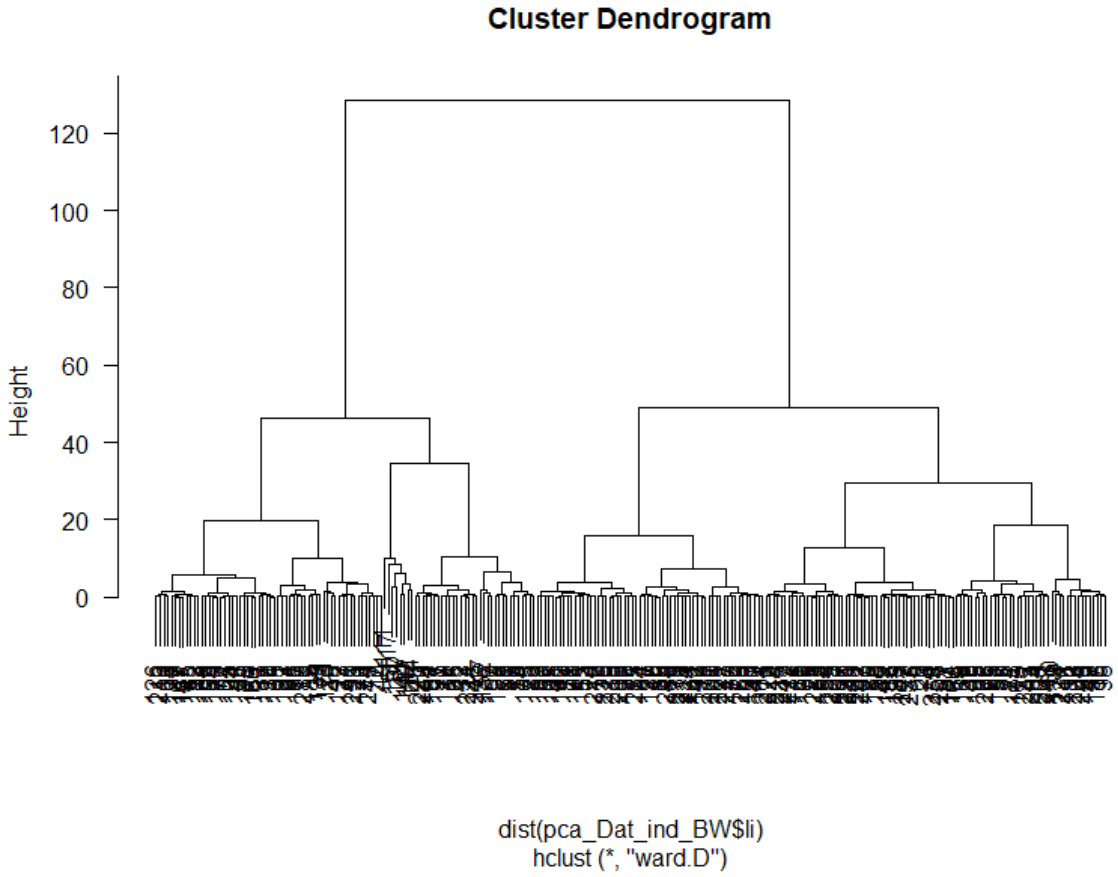
Farming household type	Challenges	Opportunities	Structural barriers	Risks
Diversified	• Despite generating the most on- and off-farm income, these farming household still have the potential for farm intensification as yields remain less than their potential • Despite displaying the highest levels of market orientation, these households still only sell around half of their farm production to market	• Further crop and livestock intensification • Further on-farm diversification (tree and seed production – apple trees planted by around 15%, while seed production and sale is employed by up to 25% of households depending on the crop)	• Access to land – Moderate-income HH types cultivate more land than Diversified HH types indicting that this maybe a limitation to further farm income generation • Access to labour maybe limited due to off-farm activities. Household size is already smaller than Moderate-income HHs. This could constrain further farm intensification, but may also limit self-production requirements • Access to financial resources (although easier compared to other subsistence HH types due to diversified income sources)	• These HH types appear to be relatively resilient generating different income streams and owning significant assets which should enable them to better cope with shocks than other HH types.

Farming household type	Challenges	Opportunities	Structural barriers	Risks
			• Access to market – still only around 50% of farm production sold to market • Access to inputs? – this may be a reason for inadequate yields	
Moderate-income	• Despite generating significant farm income from crops and livestock, these farming household still have the potential for farm intensification as yields remain less than their Diversified HH types • Market orientation is low (around 30% farm production sold to market), despite cultivating more land and owning more livestock than Diversified HH types • Lack of diversification of income sources	• Crop intensification – despite high crop value production, yields are still the lower than Diversified HH types. However, these HHs already cultivate the most land so the potential to intensify is important • Livestock intensification – despite larger livestock herds, livestock value production is still lower than Diversified HH types and milk production is nearly a third less than Diversified HH types • Livelihood diversification on-farm	• Requirements for home-consumption of farm production are higher as farming HH size is largest of all HH types • Access to financial resources (although easier compared to other subsistence HH types due to higher income) • Access to market – still only around 30% of farm production sold to market • Access to inputs? – this may be a reason for inadequate yields	• Trade-off with food security in the case of increased sales to market. These HH types already have lower levels of dietary diversity than Diversified HH types

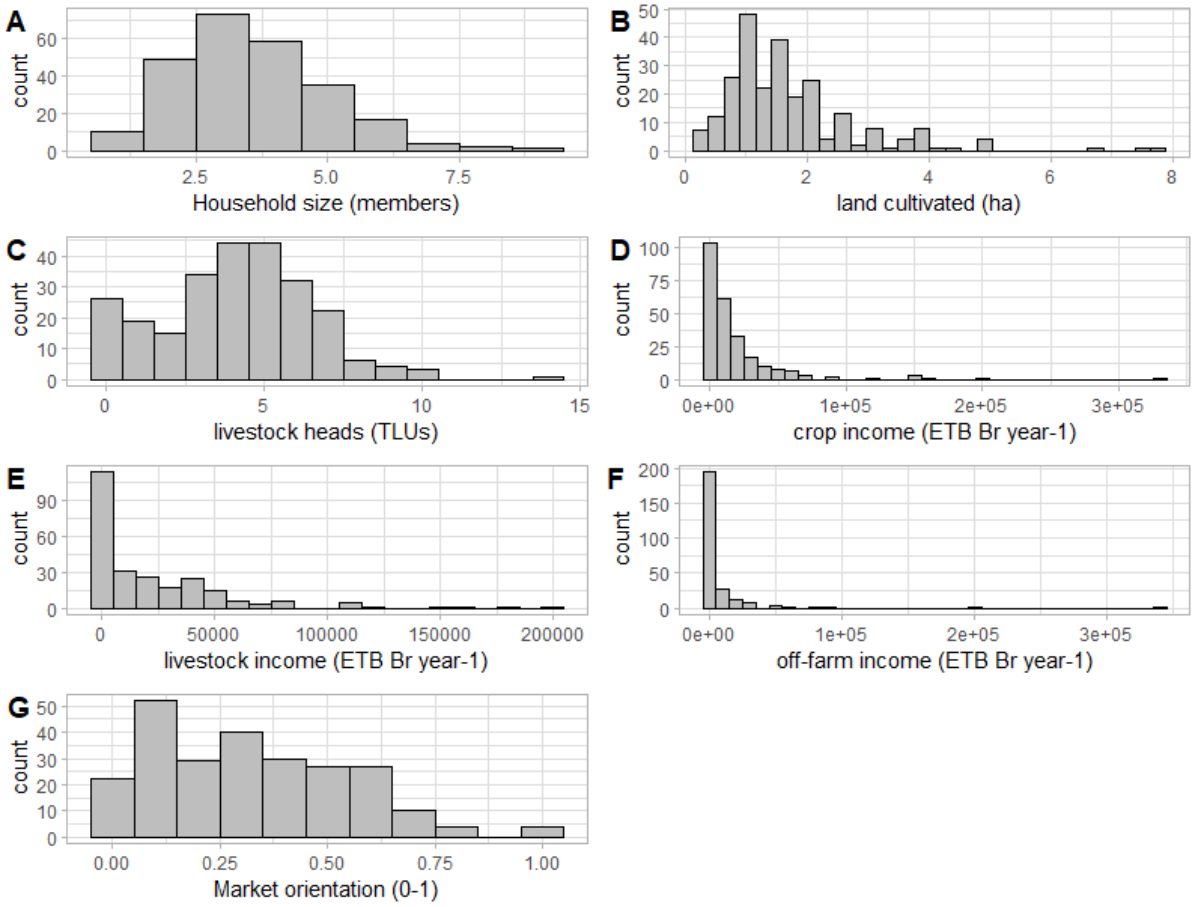
Farming household type	Challenges	Opportunities	Structural barriers	Risks
		(tree and seed production)		
Large subsistence	• Low crop yields (similar to Moderate-income and Small subsistence HH types) • Low livestock value production despite significantly larger herd size than Small subsistence HH types • The least sales to market of all HH types (13%) perhaps due to preference for self-consumption or problems in access to market • Low income generation/financial resources and lack of diversification	• Crop intensification – despite cultivating more land, higher crop value production, income from crops production is no greater than Small subsistence HH types. Yields are also among the lowest • Livestock intensification – despite larger livestock herds than Small subsistence HH types, livestock income and value production is different • Livelihood diversification on-farm (tree and seed production) – currently these HHs are reliant on very low levels of farm sales	• Access to financial resources – these HH types generate very little income • Access to market – currently the least proportion of farm produce is sold to market • Access to inputs – yields are particularly low suggesting that access to inputs may be severely constrained	• These HH types are among the most vulnerable. Encouraging such HHs to experiment with new activities may increase their exposure to risk • Trade-off with food security in the case of increased sales to market.
Small subsistence	• Resource poor (small herd size, small area of	• Livestock and crop intensification potentially provide	• Access to land – these HH types cultivate the least land. It is likely	• These HH types are the most vulnerable. Encouraging such HHs

Farming household type	Challenges	Opportunities	Structural barriers	Risks
	land under cultivation, small family size) • Low income generation/financial resources • Few sales to market (25%) perhaps due to preference for self-consumption or problems in access to market	important opportunities to increase resilience of these farming HHs from both an income and food security perspective • Livelihood diversification may be more complicated due to less access to labour	that this is an important limitation • Access to labour – these HH types are the smallest and therefore have least access to HH labour • Access to financial resources – as the poorest HH types, access to financial resources is severely restricted • Access to market – few farm products are sold to market • Access to inputs? –low yields could indicate poor access to inputs	to experiment with new activities may increase their exposure to risk • Trade-off with food security in the case of increased sales to market.

Annex 1: Cluster dendrogram for the hierarchical clustering using the Ward method



Annex 2: Histograms of the variables used for the typology development



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CGIAR INITIATIVE ON Mixed Farming Systems

https://www.cgiar.org/initiative/19-sustainable-intensification-of-mixed-farming-systems/

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