Dynamics of legume cropping and agro-ecological transition in the cotton savannah zones of West Africa: the case in the district of Koumbia (Burkina Faso) from 2008 to 2022

Abstract:

Aims: This paper shows the contribution of participatory research to upgrade the integration of legumes into cropping systems.

Place and Duration of Study: The investigation is based on survey data collected in 2008 and 2011 (two reference years) and 2021 and 2022 (current situation) in the village of Koumbia in western Burkina Faso.

Methodology: Data was collected through surveys and field measurements. The surveys were conducted with a sample of fifty (50) volunteer farmers. In 2008, 2011 and 2022, the same questionnaire was administered to all 50 farmers.Field measurements with GPS (Global Positioning System)were conducted on crop area.

Results: The results show that the proportion of area under legumes crops increased by 77,38% after 15 years. Other legumes crops (soybeans and mucuna) were introduced in addition to those previously grown (groundnuts and cowpeas) by farmers. Surface cropped in sorghum and millet declined while cotton and maize remain the main crops in the zone. The results on farmers' perception show that they prefer single cropping of legume crops as their insertion modality in the existing farming systems compared to their association with cereals.

Conclusion: The study shows that the role of legumes is increasing in the cropping system, and represents an opportunity to succeed in the agro-ecological transition, even though the intercropping of cereal/legume, which is put forward by the theoretical models of the agro-ecological transition, is still little practiced. The structuration of the legume sector can be a condition for achieving it.

Keys words: perception, single cropping, service plant, cropping system, Burkina Faso.

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1. **Introduction**

Agro-ecology (AE) is optimizing interactions between plants, animals, humans and the environment while addressing social aspects of food system such us sustainability and equity (FAO, 2018). With regard to their triple role of soil fertility improvement, food and forage crops, legumes crops represent an opportunity for agro-ecologic transition in West Africa. Ranged as service plants, legumes prevent soils from physical degradation while improving their nutrient content through fixing atmospheric nitrogen. Indeed, mucuna was shown to reduced runoff by 30-25% and erosion by 25% in five years (Azontondé, 1993). Zougmoré et al. (2000) reported that the association of cowpea with sorghum, led to the reduction of runoff in the range of 20 to 30% compared with single cropping of sorghum, and 5 to 10% compared to cowpea in single cultivation. As consequences, they found reduction in soil erosion in range of 45% to 80% according to the association method of leguminous plants to cereals compared to the cereals copped alone. Gebhard et al. (2013) reported that the nitrogen accumulated by legumes was mainly from symbiotic fixation while ranging it from few kg to 150 kg N/ha in three months of vegetation, and varies significantly according to the legumes species. Toé et al. (2022) obtained fodder yields of 1302 kg/ha for KVX-745-11P cowpea and 3231 kg/ha for IS-5874 cowpea in single cropping, compared to 3261 kg/ha for sorghum. The same authors ranged total nitrogen contained in cowpea fodder from 19.2 and 20.8% respectively for KVX 745 11P and IS-5874; and 7% for sorghum. Legumes play high socio-economic roles in the investigation areas; as reported by Koné et al. (2019); legumes play an important socio-economic role. They are consumed alone and also use in the preparation of daily dishes. Therefore, legumes crops production do not only generate significant income, but also offers households a varied range of food products.

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In terms of human consumption, Koné et al. (2019) report that groundnuts are consumed in several forms (roasted, boiled, processed into oil), and that oilcake is processed into patties. For Koné et al. (2019), peanut production not only generates significant income, but also offers households a varied range of food products, most of which are used to accompany meals.

Despite these agronomic advantages and their economic and dietary importance, many challenges are been met for integrating legumes plants into the cropping systems. These challenges are both technical (phosphorus requirements and storage difficulties) and socio-economic, such as the low nutritional value of certain legumes like mucuna and the lack of structured outlets for other legumes like soya and cowpea (Carsky et al., 2003).

In western Burkina Faso, legumes plants such us groundnuts and cowpeas, occupied only a marginal share (5%) of crop rotations in 2008, are considered secondary crops compared to the main crops such as cotton, maize and sorghum. Since 2008, research has been carried out in this area in a number of areas, including the insertion of legumes into the cropping system (Coulibaly et al., 2012a, Barro et al., 2016;

Ouattara et al., 2016, Perinelle et al., 2021). Coulibaly et al. (2012a) worked on the co-design of technical itineraries for single cropping of cowpea and mucuna. Barro et al. (2016) worked on maize/ cowpea association options that would reduce competition between two crops in association for better agronomic and economic performance. Ouattara et al. (2016) analyzed the large-scale effects of maize-cowpea association for intensification and optimization of agricultural production in agropastoral systems in the commune of Koumbia. Perinelle et al. (2021) explored new ways of reintroducing legumes by tracking innovations in legume cropping practices in the commune of Boni (Tuy province, Burkina Faso). For addressing climate change, volatile prices for agricultural products and inputs, and the emergence of new markets, farmers are tending crops diversification on their own initiative.

With the current situation, the question raised herein is to know if legume integration in cropping systems have been driving by research activities and farming contexts. This investigation was initiated in 2022 in order to respond to the question. The objective of this paper is show and explain that legume crops insertion trend un the cropping systems of the district of Koumbia in Burkina Faso after 15 years of farmers 'fields research activities

2. Material et methods

2.1. Study area

The study was carried out in the village of Koumbia (11° 14' 11" North; 3° 41' 47" West), located 67 km northeast of Bobo-Dioulasso in the rural district of Koumbia in western Burkina Faso (Figure 1). The village of Koumbia is characterized by a Sudanian climate. At Koumbia, the rainfall is ranged from 775 mm to 1,202 mm, with an average of 966.24| over the last 10 years. In the village of Koumbia, cotton-based farming systems are the most common ones with Agri livestock integration (Vall et al., 2006). The cropping system is dominated by cotton, grown in rotation with maize.

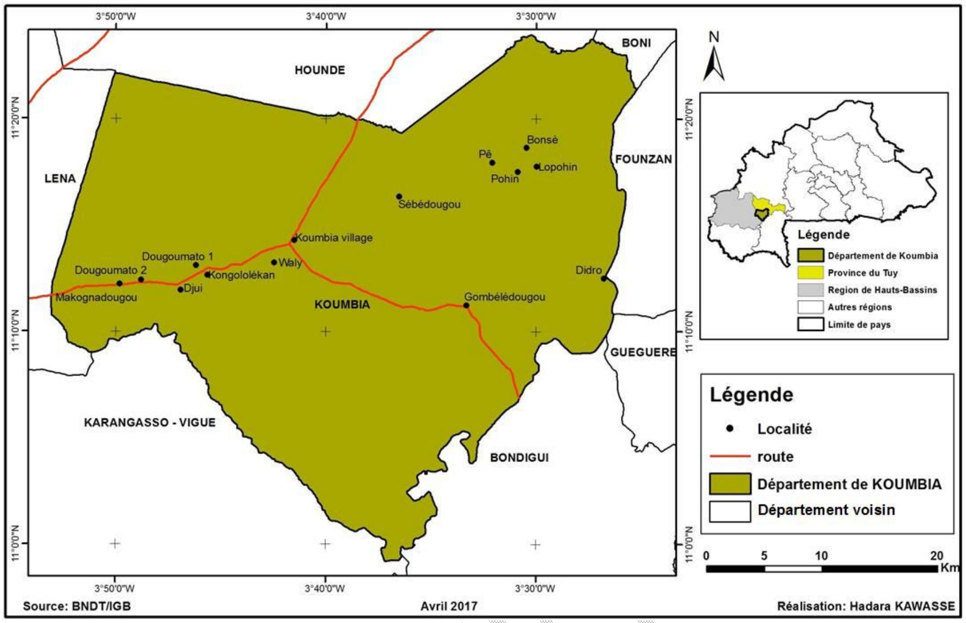

Figure 1 *: Location of Koumbia*

2.2. Data collection

Data was collected through surveys and field measurements. The surveys were conducted with a sample of fifty (50) farmers that voluntarily participated in the activities of the Fertipartenaires project (funded by the European Union) from 2008 to 2012. In 2008, 2011 and 2022, the same questionnaire was administered to all 50 farmers. According to the simplified typology built by Vall et al. (2006), the farms surveyed were farmers (n=27), agro-pastoralists (n=17) and cattle breeders (n=6). The main areas covered by the questionnaire were related to the characteristics of these AEs for 2008, 2011 and 2022, and their cropping system (type of crop, area and crop production) for year n-1 of each survey year (2007, 2010, 2021). Data for 2008 and 2011 are considered as reference data, and data for 2021 and 2022 as current ones. In 2022, in addition to crop type and area, the questionnaire took into account farmers' perceptions of how legumes could be integrated into the existing cropping systems. To capture this perception, the best/worst scale method was used to collect data from respondents (Amadou, 2021). Thus, 15 modalities of legume insertion were identified for analysis. These modalities are the single cropping of mucuna, cowpea, groundnut, soybean and bambara groundnut, the association maize and mucuna, maize and cowpea, maize and groundnut, maize and soybean and maize-Bambara groundnut and the association sorghum and mucuna, sorghum and cowpea, sorghum- and groundnut, sorghum and soybean and sorghum and Bambara groundnut. From these 15 modalities, each respondent was asked to choose 05 modalities that were the most important, and 05 modalities that were the least important in terms of agricultural production. Each respondent also gave the advantages and weaknesses of single cropping of legumes and cereal/legume associations.

Field measurements were conducted on crop area. Using a GPS (Global Positioning System) for crosschecking of the areas of crops declared by the respondents.

2.3. Data processing

Data collected was compiled using Excel, Office 2016; as well as calculations and drafting tables. Data on farm characteristics: areas and crop yields were subjected to analysis of variance (ANOVA) using Statistix 9.0 software. Means were separated at the 5% threshold using Tukey's test.

For farmers' perceptions of the different options of integrating legumes into existing cropping systems, the weight of each modality was determined according to the formula :

$$Pi = \frac{(Bi - Ci)}{aN}$$; Amadou (2021),

with Pi = weight of modality i, Bi = number of times modality i is cited as more important, Ci = number of times modality i is cited as less important, a = constant and N = size of sample.

For this study, the constant a=15/3 = 5 with 15 the number of modalities and 3 the possibility that each modality is selected by the respondent as more important or less important or neither (indicating respondent neutrality). Survey population N = 50.

3. Results

3.1. Characteristics of the farms

The results show that from 2008 to 2022, the respondent's age increased from 41 to around 47 (Table 1). The number of household members and workers in the fields, the total area of fields and the number of cattle have not changed significantly after 15 years. With the exception of respondent age, the difference in farm characteristics surveyed between 2008 and 2022 is not significant (p>0.05).

Table 1: ***Variation of farm characteristics from 2008 to 2022***

	2008	2011	2022	Pr(>F)	Significativity
Respondants'age	41.02^{b}±1.68	43.08^{ab} ±1.65	46.98^{a}±1.76	0.045	Yes
Number of person	16.38±2.67	16.18±1.87	15.22±1.05	0.907	No
Size of the human ressorce in the housholds (olader	7.64±0.82	8.68±1.17	8.18±0.69	0.725	No

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Number of plots	2.00±0.13	1.88±0.14	2.10±0.24	0.688	No
area of the plots (ha)	7.77±1.15	10.17±1.21	8.11±1.03	0.271	No
Number of oxen	14.50±2.87	14.28±2.48	14.30±2.74	0.998	No

3.2. Farming plots areas

For each investigated farmers the plots areas were determined using farmers ‘declaration during the surveys and the GPS records as well. And, the GPS field measurements did not showed significant difference between the declared ones (Table 2). When ranking field size by crop, cotton and maize occupied first and second place respectively, with mean areas in the range of 4.75±0.75 ha (declaration) to 4.64±0.53 ha (GPS records) and from 2.80±0.38 ha (declaration) to 2.57±0.24 ha (GPS records). The difference between declared and measured area was higher for sesame (65.71%) than for the other crops.

Table 2***: Variation between cropped areas estimated by the surveys and field measurements***

crops	declaration		GPS records		Pr(>F)	Significativity
	areas (ha)	Nb	areas (ha)	Nb		
Cotton	4.75±0.75	29	4.64±0.53	23	0.906	No
Maize	2.80±0.38	48	2.57±0.24	42	0.619	No
Sorghum	0.64±0.12	17	0.56±0.16	11	0.678	No
Millet	0.21±0.03	6	0.30±0.16	4	0.478	No
peanut	0.47±0.07	23	0.50±0.07	16	0.798	No
Cowpea	0.47±0.06	42	0.41±0.05	28	0.482	No
Rice	0.52±0.07	15	0.55±0.14	8	0.844	No
Bambara groundnut	0.22±0.09	4	0.10±0.06	2	0.46	No
Sesame	1.05±0.65	8	0.36±0.24	4	0.49	No
soybean	1.78±0.22	40	1.91±0.26	31	0.699	No
Mucuna	0.25±0.05	7	0.31±0.11	4	0.548	No

Nb = number

3.3. Cropping area dynamic from 2008 to 2022

From 2008 to 2022, the number of cotton, sorghum and millet farmers decreased (Table 3). On the other hand, the number of cowpea, soybean and rice farmers has increased. For maize, the number of farmers remained almost stable after 15 years.

Over the same period, cotton and maize occupy first and second rank respectively in terms of area (Table 3). Areas allocated to Sorghum and millet declined by 35.36% and 82.79% respectively after 15 years. In contrast, the area under sesame, soybean and rice increased by 31.25%, 57.52% and 23.81% respectively. Mucuna, which was absent in 2008 and 2010, was introduced with average areas of 0.33±0.08 ha and

0.25±0.05 ha in 2021 and 2022 respectively. Analyses of variance show that there is no significant difference (Pr>0.05) between crop areas from 2008 to 2022.

Averaging cereals and pulses, we noticed that cotton takes first place in 2008 with an mean area of 4.51±0.86 ha, compared with 1.88±0.19 ha, 0.50±0.06 ha and 0.80±0.30 ha for cereals, pulses and sesame respectively (Table 3). The ranking remains the same in 2022. Area under pulses has increased significantly (Pr<0.001) in 2021 (1.05±0.17 ha) and 2022 (0.88±0.09 ha), compared with 2008 (0.50±0.06 ha) and 2010 (0.42±0.04 ha). Also, cotton, cereal and sesame areas did not vary significantly (Pr>0.05) after 15 years.

Table 3: ***Variation of cropped surface and number of crop users from 2008 to 2022***

Crops	2008		2010		2021		2022		Pr(>F)	Significativity
	Area (ha)	**Nb**	**Area (ha)**	**Nb**	**Area (ha)**	**Nb**	**Area (ha)**	**Nb**		
Cotton	**4.51±0.86**	**37**	**4.36±1.06**	**27**	**4.48±0.66**	**29**	**4.75±0.75**	**29**	**0.978**	No
Maize	2.88±0.42	49	2.41±0.51	50	2.95±0.42	48	2.80±0.38	48	0.818	No
Sorghum	0.99±0.11	37	1.28±0.17	41	0.86±0.19	15	0.64±0.12	17	0.057	No
Millet	1.22±0.33	15	1.84±0.54	17	0.25±0.06	6	0.21±0.03	6	0.081	No
Rice	0.42±0.12	6	0.73±0.17	25	0.42±0.08	16	0.52±0.07	15	0.650	No
Mean for ceralcrops	***1.88±0.19***	***50***	***1.64±0.25***	***50***	***2.11±0.31***	***49***	***1.99±0.24***	***49***	***0.584***	No
peanut	0.49±0.06	27	0.41±0.04	19	0.49±0.06	21	0.47±0.07	23	0.788	No
cowpea	0.50±0.06	30	0.44±0.07	17	0.49±0.10	32	0.47±0.06	42	0.967	No
Bambara groundnut	0.33±0.08	5	0	0	0.25	1	0.22±0.09	4	0.676	No
Soybean	1.13±0.88	2	0	0	2.13±0.35	31	1.78±0.22	40	0.546	No
Mucuna	0	0	0	0	0.33±0.08	5	0.25±0.05	7	0.248	No
Mean for legumcrops	***0.50^{bc}±0.06***	***38***	***0.42^{c}±0.04***	***29***	***1.05^{a}±0.17***	***45***	***0.88^{ab}±0.09***	***48***	***<0.001***	***Yes***
Sesame	0.80±0.30	10	0.85±0.13	12	1.15±0.51	5	1.05±0.65	8	0.925	No
Total	**13.25**		**12.32**		**13.47**		**12.90**			

Nb = *number*

3.4. Global yields trends from 2007 to 2021

Overall, the surveys show that crop yields increased after 15 years (Table 4). Cotton yield increased from 845 kg/ha (2007) to 1.256 kg/ha (2021). As for maize it was from 1.146 kg/ha in 2007 to 2.190 kg/ha in 2021. Sorghum yield, in contrast, fell by 23.32% after 15 years. Statistical analysis shows that the difference observed for cotton, maize and sesame is significant at the 5% threshold. This is not the case for rice, sorghum and millet.

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For legumes, difference in yields was not significant at the 5%. However, there was an upward trend in yields of 22.48%, 27.62% and 442.18% respectively for groundnuts, cowpeas and soybeans after 15 years.

Table 4: *Variation of crop yields from 2007 to 2021*

Crops	2007		2010		2021		Pr(>F)	Significativity
	Yields (kg/ha)	Nb	Yields (kg/ha)	Nb	Yields (kg/ha)	Nb		
Cotton	$845.11^{b}\pm79.83$	37	$902.31^{b}\pm69.19$	27	$1256.28^{a}\pm73.91$	29	<0.001	Oui
Sesame	$78.50^{b}\pm14.45$	8	$215.83^{ab}\pm60.52$	12	$433.33^{a}\pm88.19$	4	0.008	Oui
Céréales								
Maize	$1146.02^{c}\pm116.84$	49	$1739.39^{b}\pm102.05$	50	$2190.29^{a}\pm113.97$	48	<0.0001	Oui
Sorghum	851.85±214.12	36	638.78±83.43	41	619.05±98.13	14	0.527	Non
Millet	429.73±95.18	15	353.80±56.04	17	619.13±76.20	5	0.212	Non
Rice	933.33±217.05	6	1960.53±639.02	25	2758.33±453.71	15	0.334	Non
Légumineuses								
Peanut	1155.93±234.99	27	1288.89±219.46	18	1415.79±271.26	19	0.745	Non
Cowpea	408.89±65.80	30	502.35±70.62	17	521.81±45.80	27	0.343	Non
Soybean	160.00±40.00	2	-	-	867.48±89.70	31	0.0574	Non

Nb = Number

3.5. Farmers' perceptions on the integration of legumes to the existing cropping systems

The overall results on farmers' perceptions show that single cropping of legume crops, cowpea (weight = 0.18), soybean (weight = 0.16), groundnut (weight = 0.15) and mucuna (weight = 0.10) are the legume insertion methods perceived by farmers as the most important in terms of agricultural production (Table 5). In contrast, associations of legumes plants with maize are perceived as the least important by these farmers, with weights of -0.17 for the maize and cowpea association, -0.15 for the maize and groundnut association, -0.14 for the maize and soybean association and -0.07 for the maize and Bambara groundnut association.

Table 5*: Proportion of farmers' responses on the most common and least common legume insertion methods according to agricultural production (n=50)*

Modalities for integrating legumes into cropping systems	**Common practice**	**Uncommon practice**	**Weigh**
Single cropping of Mucuna	36	11	0.10
Association Maize and Mucuna	16	27	-0.04
Association Sorghum and Mucuna	5	13	-0.03
Single cropping of Peanut	44	6	0.15
Association Maize-Peanut	5	43	-0.15
Association Sorghum and Peanut	11	19	-0.03
Single cropping of Cowpea	48	2	0.18
Association Maize and Niébé	1	44	-0.17
Association Sorghum and Niébé	9	10	0.00
Single cropping of Soybean	41	2	0.16
Association Maize and -Soybean	3	37	-0.14
Association Sorghum and Soybean	0	13	-0.05
Single cropping of Bambara groundnut	22	5	0.07
Association Maize and Bambara groundnut	0	17	-0.07
Association Sorghum and Bambara groundnut	0	0	0.00

Specifically for farmers, the single cropping of cowpea (weight = 0.20) is perceived as the first option for legume insertion (Table 6); while for agro-pastoralists, it's the single cropping of groundnut with a weight of 0.18. In the herder population, single croppings of mucuna, groundnut and cowpea were found to have the same weight (0.20). For the three (3) groups of farmers, the maize and cowpea combination was perceived as the least important modality. The maize and groundnut association and the one of maize and cowpea had the same with a weight of -0.18.

Table 6: ***Proportion of farmers' responses according to farm typology on the most important and least important legume insertion methods according to agricultural production***

Modalités d'insertion des légumineuses	Farmers (n=27)			Agropastoralists (n=17)			Cattlebreaders (n=6)		
	Common	Lesscommon	Weigh	Common	Lesscommon	Weigh	Common	Lesscommon	Weigh
Single cropping of Mucuna	19	5	0.10	11	6	0.06	6	0	0.20
Association of Maize and Mucuna	9	12	-0.02	4	12	-0.09	3	3	0.00
Association of Sorghum and Mucuna	4	6	-0.01	1	4	-0.04	0	3	-0.10
Single cropping of Peanut	22	5	0.13	16	1	0.18	6	0	0.20
Association of Maize and Peanut	1	25	-0.18	3	13	-0.12	1	5	-0.13
Association Sorghum and Peanut	5	11	-0.04	6	5	0.01	0	3	-0.10
Single cropping of Cowpea	27	0	0.20	15	2	0.15	6	0	0.20
Association Maize and Cowpea	0	24	-0.18	1	15	-0.16	0	5	-0.17
Association Sorghum and Cowpea	5	6	-0.01	4	2	0.02	0	2	-0.07
Single cropping of Soybean	24	0	0.18	13	2	0.13	4	0	0.13
Association Maize and Soybean	1	20	-0.14	2	13	-0.13	0	4	-0.13
Association Sorghum and Soybean	0	9	-0.07	0	2	-0.02	0	2	-0.07
Single cropping of Bambara groundnut	14	1	0.10	5	3	0.02	3	1	0.07
Association Maize and Bambara groundnut	0	11	-0.08	0	4	-0.05	0	2	-0.07
Association Sorghum and Bambara groundnut	0	0	0.00	0	0	0.00	0	0	0.00

3.6. Farmers' perception of the advantages and weaknesses of pure legume crops and cereal/legume associations

Farmers attributed 09 advantages to single cropping of legume crops, and 07 to cereal/legume associations (Table 7). Its main advantages are improving soil fertility (24.58% of respondents), better yielding (23.73%), low labour requirements (23.73%), and their role as food for humans and animals (10.17%). For cereal/legume associations, the main advantages cited are crop diversification (32.65%), improvement soil fertility (22.45%), food for humans and animals (16.33%), better yielding (14.29%), and efficient land use (10.20%).

The results show 09 weaknesses attributed to single cropping of legumes, and 06 weaknesses attributed to cereal/legume associations (Table 7). Difficulty in conducting some farm operations (27.54% of respondents), soil impoverishment (21.74%) and pest attacks (17.39%) were the main weaknesses attributed by farmers to single cropping legume. Difficulty conducting some farm operations (58.62% of respondents), low production (19.54%) and competition between crops (18.39%) were the main weaknesses attributed to cereal/legume combinations.

Table 7: ***Advantages and weaknesses of legume insertion in the cropping system according to farmers***

N°	Criteria	Advantages of single cropping of leguminus crops (%)	Advantages of Association leguminus crops to cereals (%)
1	food (household and cattle.)	10.17	16.33
	Convenient management of soil	-	10.20
2	Precocity of the production cycle	1.69	-
	Crops diversification	-	32.65
3	Economicadventages	5.08	2.04
4	High marcketdemands	5.93	-
	Weeding	-	2.04
5	Easy to cropping	3.39	-
6	Soilfertility management	24.58	22.45
7	High yielding	23.73	14.29
8	Low labordemand	23.73	-
9	Easyprocessing	1.69	-
Total		**100**	**100**
N°	**Criteria**	**Weaknesses of single cropping of leguminus crops (%)**	**Weaknesses of Association leguminus crops to cereals (%)**
1	Soilfertilitydeplection	21.74	2.30
2	Pest attack	17.39	-
3	Pesticide expenditures	2.90	-
	Shelters for reptiles	-	1.15
	Competition between cultures	-	18.39

4	Difficulty for conducting some farming operations cultural	27.54	58.62
5	Damage to crops and harvests	11.59	-
6	Low production (low yield)	1.45	19.54
7	Market prices Instability	2.90	-
8	Lack of equipment (cultivation and harvest)	7.25	-
9	Requires more labor	7.25	-
Total		**100**	**100**

4. Discussion

4.1. Over 150% increase in legume area after 15 years

The results show that the characteristics of the farms surveyed have not changed significantly after 15 years. However, the area allocated to legumes in the cropping system increased by 156.47% from 2008 to 2022. In addition to the traditional legumes (cowpea, Bambara groundnut and groundnut), soybean and mucuna have also been introduced. This increase in the area planted with legumes in Koumbia can be explained by the intervention of research and development projects and non-governmental organizations (NGOs). Indeed, the farmers'community of Koumbia have been working with researchers since 2005 on innovative farming systems building (CPASI) using co-design approach (Vall et al., 2006; Coulibaly et al., 2012b; Vall et al., 2016). Also, Coulibaly et al. (2012b) investigated the integration of two legumes (cowpea and mucuna) both for single cropping and in association. In Koumbia, the introduction of mucuna (a forage legume) as an innovation in the cropping systems was driving by co-design work conducted by farmers in partnership with researchers (Vall et al., 2016). As for the soybean, it was also facilitated by the national policy and development projects in charge of promoting soybean sector in Burkina Faso (Guilloux et al., 2018). Indeed, a national policy for promoting soybean production was established in Burkina Faso targeted to100,000 tones by 2022. The increase of farm areas under legumes crops can also be due to land pressure. With the expansion of areas under crops, there is a restriction of grazing land, and consequently the need for fodder production to address forage demand during the lean periods. Crop diversification to strengthen households' resilience to climate change and income source diversification is also one of reasons why legumes crop production is in increase; compared to most of the other crops, legume have high economic value.

Although the area planted with legumes has increased, yields have not varied significantly after 15 years. The noncompliance of farmer in conducting farm operations can explain this yield trends. Legume yields may also be underestimated, because for some crops such as cowpeas, part of the harvested product is directly used for family consumption specially during the lean season. Consequently, this part is not accounted during yield estimation. Soybean yields have risen from 160 kg/ha in 2007 to 867 kg/ha in

2021, according to growers. This yield, achieved in 2021, is in the same range as those obtained by Sermé et al. (2018) with the farmers' practice (600 to 900 kg/ha). This may reflect the growing interest of producers in this legume crop, which is used for semi-industrial and artisanal processing into flour, oil, soumbala, poultry feed (roasted soybeans) and kebabs (Bila et al., 2009).

Despite the increase in the area under legumes, cotton and maize remain at the backbone of the cropping system in the village of Koumbia, with a slight increase in their area. This is justified by the fact that cotton, which is grown in rotation with maize, is a well-organized sector by the cotton companies. Yields of both crops even increased significantly after 15 years.

4.2. Single cropping as the preferred method for integrating legumes into the cropping systems

Growers with their own constraints and habits prefer integrating legumes crops in the exting cropping systems using single cropping approaches. This agroecological configuration of farming plots is in discordance with crop association generally perceived by agronomists as agroecology as a means of optimizing the Land Equivalent Ratio (LER) and the symbiotic relations between legumes and cereals crops. the choice for single cropping of legumes can also be explained by the advantages that farmers attribute to pure legume crops, namely high forage and grain production, low labour requirements and improved soil fertility. Research has also shown that yields in association are low compared with pure crops (Coulibaly et al., 2017; Zongo et al., 2021). The high production of folder in single cropping of legumes is a way of building up fodder for cattle. For Toé et al. (2022), fodder crops are effective means of addressing fodder deficit in the farming systems. In addition to their role as fodder, groundnuts and cowpeas are high protein sources when consumed by household members. Due to their early maturation compared to the other crops, cowpea is even used as food during the cotton and maize harvest. Indeed, in this areas, the harvest period often correspond to the lean periods for households. The role played by legumes in soil fertilization is well demonstrated (Muhammad et al., 2010; Hamidou et al., 2018; Guinet et al., 2019). It why legumes insertion in the farming system is recommended ether in rotation with other crops or in association. Guinet et al. (2019) found improvement in wheat yield when cropped in rotation after a large majority of legumes compared to the ones grown after cereal crops.. Yeo et al. (2022), who showed a positive background-effects of groundnut and cowpea on eggplant, suggest that these two (2) legumes should be used as an organic alternative to mineral fertilizers. Current field management practices seriously compromise the possibilities of cereal-legume association (use of herbicides, mechanization of farm operations such as weeding, etc.).

However, with the reduction in arable land coupled with land preasure, the option of siggle cropping of legume crops may not last. It is therefore appropriate to work on the association options of legumes in association with other crops. These include crop diversification on the same plot, and optimization of farm lands used with land equivalent ratios higher than 1 (Toé et al., 2022).

As conclusion, the driving force behind agro-ecological transition that include legumes in Burkina Faso's western cotton zone, the limitations raised by farmers need to be address. These constrains include (i) the difficulty of conduction some farm operations (mechanical weeding, phytosanitary treatment, ridging, harvesting, threshing, post-harvest processes, etc.), (ii) pest preasure in the field and in store. weak value chain for fodder legumes and/or seed legumes can also be a hindrance to the large-scale integration of legumes into the cropping system.

5. Conclusion

The inclusion of multi-interest legumes in a context of promoting agro-ecology appears to be both opportunities and challenges. The results of the study reported herein showed an increase in the area under legumes; over 150% after 15 years. The number of producers also increased for legumes, notably cowpeas and soybeans. Mucuna, a forage legume introduced by research, is also being adopted. Moreover, analysis of perceptions shows that single cropping of legumes remain the favorite insertion modality of farmers. One of the most important explanatory factors is the partnership-based co-design of innovative agricultural systems (CPSAI) implemented in western Burkina Faso. In order to maintain this dynamic and using legumes as a lever for agro-ecological transition in western Burkina Faso, addressing the obstacles to their introduction (mechanization of cultivation and harvesting operations, pest control) and on structuring their value chain (exchange platform between legume industry players) would seem appropriate.

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