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Importance of the Social Structures in Cowpea Varietal Demands for Women and Men Farmers in Segou Region, Mali

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Abstract: Cowpea is the second most consumed leguminous crop after groundnut in Mali. Its national production was 260,000 tons in 2018. It contributes to nitrogen fixation in the soil. The improved varieties of cowpea cultivars contain traits such as high grain yield, drought resistance, and early maturity. However, the adoption of improved cowpea varieties remains low. The non-participation and or non-consideration of the needs of men and women farmers in the varietal selection process contributed to the low adoption rate of improved cowpea varieties. This study aims to understand the gender dynamics and social structures within the communities. It examines its influence on the adoption of improved varieties of cowpea. Anchored on gender relations theories, gender and social structures are analyzed as the core frame for organizing social relations that guide and coordinate individuals' actions in a given situation. Qualitative and quantitative approaches were applied to collect data from cowpea growers in 11 villages around the Cinzana Research Station. It emerged from the study that male farmers are quick adopters of newly released cowpea varieties because they are mainly more involved in trials, innovation platforms, field visits, demonstration plot activities, and FPVS than women. Women are less involved in these activities, except in sorting harvested cowpea grains and seeds in the Cinzana Research Station. Women's participation in cowpea related-activities is determined by the rules and norms of physical mobility and the structures that control and guide social interactions and connections within and outside of households and communities. The study recommends efficient resource allocation within households and communities, and the set up of strong institutional frameworks (such as innovation platforms) to enable women in adopting new and improved cowpea varieties and to expand the available opportunities in the cowpea production system.

Keywords: structures; roles; gender; relations; cowpea

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1. Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most affordable sources of protein and micronutrients available to the rural and urban dwellers and is especially important to millions of women and children living in Africa and South Asia as it is a source of food for both human and animal nourishment and a major crop in regional trade within West and Central Africa [1,2]. In Mali, cowpea contributes highly to food security, nutrition, household income, and roles in social relationships [3,4]. The second most consumed leguminous crop after groundnut, cowpea annual production in Mali was 260,000 tons from 450,000 ha in 2018 [4].

In terms of agronomic gains, cowpea contributes 30–125 kg N/ha to the soil due to its nitrogen-fixing properties and also serves as a residue that benefits succeeding crops [5]. Being a shade-tolerant crop and compatible as an intercrop with a number of cereals and root crops, cowpea is adapted in marginal lands and drier regions of the tropics, where rainfall is scanty and soils are sandy with little organic matter [6]. Unlike cereal crops

(maize, sorghum, and millet), which are cultivated by a specific social group (sorghum is mainly cultivated by men), cowpea is grown in Mali by all social groups (men, women, and youth) because of its high selling price on the local markets, although the heads of the families have more control over the income.

In addition to the low adoption of improved varieties which is a common challenge in agricultural innovations in Mali, the social structures and influencing factors which could determine participation have not been studied. Gender, as well as social relations, are critical issues for increasing improved cowpea varieties' adoption.

The social construction of crops such as cowpea and groundnut makes them the most cultivated crops by women to meet children's nutritional needs [7] and to generate cash by selling grains or by processing cowpea grains into doughnuts [8]. Although the benefits of cowpea are recognized, its production and consequently its adoption is largely determined by gender relations and social structures (social norms and social institutions) in farm households [9]. Despite this improvement, the adoption of newly released improved cowpea varieties is very slow in the villages surrounding the Agronomic Research Station of Cinzana (Segou).

This is because gender relations and social structures and norms embedded in the communities influence access to productive resources such as land and farming innovations and agricultural production and marketing between men, women, and young people. Men and women have different roles and responsibilities in agriculture and have distinct varietal preferences, which may have implications on adoption of crops [10]. Thus, there is no question that the examination and subsequent consideration of gender and socio-cultural relations in agricultural innovations, production, and marketing is essential to understand access and control between men and women and in different political communities [11]. For instance, Fairhead and Leach showed how men, women, senior wives, cowives, and daughters control coffee, beans, upland rice fields, and vegetables in specific social and economic contexts across sub-Saharan Africa through intense negotiations over space, planting, and weeding labor [11].

Gender is a core frame for organizing social relations and, as such, it depends on common knowledge (i.e., cultural knowledge) that guides and coordinates individuals' actions in a given situation [12]. In most cultural settings in developing countries, traditional rights over communal resources, traditional social support systems, and support from the state and nongovernmental organizations (NGOs) remain as vivacious as the agency of a farmer to innovate [13,14].

Gender relations are fit into social structures which define production relations [10,11], access to land and to agricultural inputs, distribution of agricultural tasks, and labor and equipment utilization in the production, consumption, marketing, and processing of cowpea products for both men and women [12,13]. During recent years, the Cinzana cowpea breeding program has developed and released five cowpea varieties (ECOWAS catalog) to the farmers in the commune of Cinzana (region of Segou, Mali) using the participatory varietal selection and dissemination approach.

The varieties include: Acar 1, Simbo, Jiguifa, CZ06-4-16, and CZ06-1-05. The approach for the cowpea breeding was to compare these released varieties with the local variety checks or already improved cowpea varieties in order to convince farmers to adopt new varieties, or not, based on their comparative advantages in terms of yield and adaption to biotic and abiotic stresses. The main hypothesis of this study is that the social structures influence the adoption of improved cowpea varieties among men and women.

The main objective of this study was to identify the social structures for cowpea adoption by men and women farmers in Segou. The main research questions that study addresses are:

- (i) How do gender relations influence farmer's uptake of improved cowpea varieties?
- (ii) How do gender relations influence farmer participation in the selection of improved cowpea varieties?

- (iii) What are the gendered trait preferences for men and women farmers in cowpea production, marketing, and consumption in Segou region?

The aim of the study is to contribute to existing knowledge and develop new knowledge on the importance of the social structures in the adoption of new technologies by women farmers.

The paper is, thus, organized as follows: the first section describes the research area, the methodological approach, and the nature of the collected data. This section discusses the statistical test model and the theoretical framework. In the second section, empirical results are discussed and analyzed.

2. Existing Review of Literature

Recently, several researchers have worked in Mali on cowpea production patterns as well as gaps and opportunities in cowpea seed systems, the potential use of cowpea in the local market, gendered differentiated perceptions, and the adaptation of cowpea growers to climate variability [3,4,6,7]. Some of these studies found that being a man, having household headship, being involved in innovation platforms, and having labor resources are the drivers for the adoption of cowpea innovations in Mali [3,7], while women are seen being at the heart of cowpea grain processing and marketing activities [4]. Other studies found the importance of culture and abiotic and biotic constraints, and the poor targeting of women in the past by breeding programs and extension services [6]. All these factors and constraints are translated into gendered differences in the perception and choice of adaptation strategies between men and women cowpea growers [15].

If the adoption of agricultural technologies generally follows a five-step path: awareness, interest, evaluation, trials, and adoption [16], the review of literature on cowpea production and innovation shows that the sociocultural norms and contextual factors of production and social roles can challenge a five-step customized path of innovations, as identified by Rogers in his seminal work on 'the Diffusion of Innovations' [16]. Adoption conceptualization has guided methods chosen by researchers and extension agents in exposing farming communities to new technologies through awareness-raising forums such as field days, experience-building activities such as demonstrations, and other participatory methodologies [17]. However, factors that facilitate or inhibit the participation of men and women in such training activities are increasingly becoming prioritized areas of interest to development actors and scholars [17]. The areas identified in the literature include gender norms and agency. Gender norms refer generally to gender dimensions of social norms, or the societal expectations of how men and women ought to behave in their everyday affairs. Social norms also "structure social interactions in ways that allow social actors to gain the benefits of joint activity. And they determine in significant ways the distribution of the benefits of social life" [18]. Stereotypical beliefs about men's greater authority and competence compared with women are often "re-inscribed into new organizational procedures and rules that actors develop through their social relations in that setting" [12] (p. 21).

3. Theoretical Framework

The study is anchored in gender relations, theoretical framing, and gender and social structures. Existing gender norms, attitudes, and practices around agriculture including the division of labor, market access and mobility, marriage practices, family structures, and intra-household decision making enable, or not, gender-responsive agricultural innovations. Social behavior and traditional rules of men and women have to be well considered [19]. It was observed that compared with women, men have easier access to technology and training, mainly due to their strong position as head of the household and greater access to off-farm mobility. Socio-cultural factors need to be analyzed and understood in order to develop effective extension and training programs to reach rural women farmers [20].

If gender norms are determinant in innovations and social change, it is also necessary to recognize that the agency of social actors allows for the defiance of norms and makes possible social change by actors who are socially disadvantaged by norms. Agency is "the

ability to define one's goals and act upon them" [21], either independently or jointly with others. The process of exercising agency is mainly embedded in, and conditioned by, formal and informal local institutions [22]. It recognizes that increased agency, or empowerment, of disadvantaged groups can transform constraining institutions and their rules.

The main hypothesis of this study is that the availability and circulation of seeds within social structures and households allows for better adoption of improved seeds by women.

4. Materials and Methods

4.1. Data sources and Sampling

The study relied on primary collected data using both qualitative and quantitative methods. Mixed methods help gain a more complete picture than a stand-alone quantitative or qualitative study, as it integrates the benefits of both methods by triangulating results, examining the complementarities and overlapping facets of a phenomenon, discovering paradoxes, and contradictions, and complementing the limitations of the used methods [23]. The sampling procedure used for the study followed a multi-stage approach to select initially 200 respondents, out of which 74 (37%) are women, engaged in cowpea production and cowpea innovations in the commune of Cinzana. We applied both purposive and simple random sampling techniques to select individual respondents and FGD participants. In stage-1, 11 villages were purposively selected within a radius of 10 km around the Cinzana Research Station where the IER cowpea program is based. This selection criterion was based on the participation of the villages in cowpea innovations (participation in field days, cowpea innovation platforms, FPVS, demonstration and trial plots, and seed multiplication).

One of the special features of the study villages is the patriarchal social organization and the importance of dry crops (sorghum, millet, and maize) in the diet of the populations. In the study villages, women and young people have limited access to agricultural land and agricultural equipment, and participate less in agricultural training because of the patriarchal structure of agricultural production households, as in many other rural communities in West and Central Africa.

In stage-2, within the selected villages, respondents were randomly selected for the study and interviewed. Farmer individual information was collected using the Open Data Kit (ODK) application, and the KII guide, while sex-disaggregated FGDs were conducted to validate and triangulate information or data from surveys and key informant interviews (KIIs) to gather additional information on the participation of farmers in the setting and the prioritizing of breeding decisions and varietal preferences, and to explore gendered patterns of the participation in Participatory Plant Breeding (PPB) in the households, the reasons of variety rejection, and farmer aspirations and expectations of the varietal traits of the varieties been grown. Finally, data from FPVS were also used to triangulate and compare with those obtained from the individual surveys, sex-disaggregated FGDs, and KIIs.

4.2. The Process of Data Collection

The study was conducted in Cinzana communities (District of Segou, Mali) where farmer participatory varietal selections (FPVSs) are organized with cowpea growers. The villages of the commune of Cinzana were chosen because of farmers' active participation in conducted tests and demonstrations for the project and because of the high contribution of cowpea to food, livestock feed, the Malian national market needs, and income-generating activities for women. This means that the applied sampling technique was to target expert farmers to assess their understanding regarding the prioritization of traits of cowpea in production, marketing, and consumption. First of all, two separate focus group discussions (FGDs) were conducted with men and women cowpea growers on cowpea varietal selection (traits of preference), productivity and production, market needs, nutritional values, and gender relations in production (access to land, inputs, training, commercialization of products, etc.). At the end of the FGDs, two key informant interviews (KIIs) were conducted

with one female and one male innovator mainly involved in cowpea cultivation and innovations. Innovations are “social constructs, and as such, they reflect and result from the interplay of different actors, often with conflicting interests and objectives, and certainly with different degrees of economic, social, and political power” [24]. In addition to farmers’ KIIs, two KIIs were conducted with extension service workers to document, on one hand, extension agents’ approach to disseminating released cowpea varieties and, on the other hand, the technical itineraries of released cowpea varieties and the constraints facing farmers in the uptake. After conducting FGDs and KIIs, a survey was carried out with men and women cowpea growers. The size of the sample was 200 cowpea growers (including men and women).

Secondary data on former FPVs were collected from the records of the Cinzana cowpea program to analyze and triangulate them with the qualitative and quantitative data generated from the cowpea-producing communities.

4.3. Empirical Model: Statistical Tests on Drivers Influencing the Adoption of Improved Cowpea Varieties

To explore the influence of the respondents’ social characteristics (experience in cowpea production, gender, membership in IPs, and participation in demonstrations, trials, field days, trainings, and extension visits) on the adoption or the utilization of new cowpea varieties popularized by the cowpea breeding program, we used a logit binary model to analyze the effects of respondents’ social characteristics on the adoption of improved cowpea varieties. The model is as follows:

$$\ln \left(\frac{P_i}{1 - P_i} \right) = Y_i^* = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \epsilon_t \text{ with } (P_i/1 - P_i)$$

as the relative probability of choice.

Y = production of improved varieties

x1 = Respondent sex

x2 = Respondent age

x3 = Membership status

x4 = Num. year in cowpea production

x5 = Extension visit status

4.4. Description of Variables (Table 1)

Production of improved varieties: these are the respondents who produce the improved cowpea varieties. The modalities of the variable production of improved varieties are binary (yes or no).

Respondent sex: the sex of respondent is also binary (male/female) and is used to determine if the sex variable can influence the production of improved varieties by the respondent.

Respondent age: the age of the respondent.

Membership status: whether or not the respondent belongs to associations or innovation platforms.

Num. of years in cowpea production: the number of years the respondent has worked in cowpea production.

Extension visit status: whether or not the respondent has received extension visits during the last three seasons.

Both qualitative and quantitative data were collected between October and November 2019. Qualitative data analysis was conducted using qualitative content analytical methods [23,25], while the logit binary model was conducted using quantitative survey data. The bulk of the information collected was analyzed and is presented separately in tables and graphs.

Table 1. Variables and modalities.

Variables	Modalities	Units	Results
Production of improved cowpea varieties		%	31.5
Respondent sex	Male	%	63
	Female	%	37
Respondent age	Years	Mean	48
Membership status	Yes	%	51.5
	No	%	48.5
Num. of years in cowpea production	Years	Mean	17
Extension visit status	Yes	%	70
	No	%	30

5. Results

All the data presented in this section pertain to the 2018–2019 cropping season.

5.1. Distribution of Respondents

Table 2 shows the distribution of respondents per study area (villages) and sex (male and female). Among the 200 farmers surveyed, 37% are females.

Table 2. Distribution of respondents by villages and sex of respondents.

Villages	Male Sub-Sample	Female Sub-Sample	Total	%
Cinzana village	25 (56.82)	19 (43.18)	44	22
Diambougou	19 (86.36)	3 (13.64)	22	11
Falema	8 (47.06)	9 (52.94)	17	8.5
Fambougou	12 (50.00)	12 (50.00)	24	12
Kondogola	16 (80.00)	4 (20.00)	20	10
Minangofa	13 (68.42)	6 (31.58)	19	9.5
Nambougou	2 (100.00)	0 (0.00)	2	1
Niatia	9 (45.00)	11 (55.00)	20	10
Sanogola	10 (58.82)	7 (41.18)	17	8.50
Sonsorobougou	12 (80.00)	3 (20.00)	15	7.50
Total	126 (63.00)	74 (37.00)	200 (100.00)	100.00

Men represent 63% against 37% of women. This confirms that cowpea production is strongly dominated by men, who mobilize the labor force of their households in view of its importance in generating income, providing food, and supplying livestock feed. In view of its importance, cowpea production is increasingly controlled by the household chieftainship, while its production increasingly requires the labor of the entire family, including women and youth of both sexes.

The average age of the respondents is around 48 years (see Table 1). The respondent's average years of experience in cowpea production is 17 years. This shows a solid practical experience in cowpea production. Half of the respondents are members of agricultural organizations in which the members benefit from information, training, participation in extension programs, and innovation practices. These benefits support the optimization of decisions in agricultural production and information on new varieties and their performance, as well as ensure regular monitoring of agricultural innovations in real production conditions.

5.2. Cowpea Plot Management in the Household According to the Surveyed Respondents

The study revealed that 82.50% of the cultivated cowpea varieties were under the responsibility of the household heads and 13% were under wives' responsibilities. Sons or daughters were responsible for 3% of cowpea crops during the 2018–2019 cropping season (see Table 3). A total of 9.5% of cowpea crops were under the responsibility of other

family relatives (i.e., married adults and brothers and sisters of the household head). The characteristics of plot managers showed the importance of gender relations in productivity differential and plot ownership among farmers [26].

Table 3. Person responsible for cowpea plots in the household.

Persons Responsible for Cowpea Plot in the Household	Freq.	Percent (%)	Cum (%)
Household head	165	82.50	82.50
Husband	1	0.5	83
Wife	26	13	96
Children (daughters or sons)	6	3	99
Respondent brother or sister	1	0.5	99.5
Others	1	0.5	100.00
Total	200	100.00	

The nature of the family structure means that the production of most crops, whether produced individually or collectively by family members, is controlled, if only symbolically, by the family head. Therefore, if you ask the women who is the owner of the field on which they produce their cowpea, groundnut, or okra, many will answer that it is for the head of the family, even though they have full control over the income from the fields and contribute to the maintenance of these fields. The idea behind the full control of the head of the family over the income from its dependents (especially the women) is that it is conceived in the social praxis that all the goods and assets of the family belong to the head of the family symbolically.

This symbolic relationship between the elders and their dependents may explain the high tendency of heads of households to be cowpea plot managers (about 82%), even if this imaginary relationship may mask the real managers or owners of plots.

“ . . . It is men who make the decisions. In the case where the woman makes the decisions regarding to her cowpea production by herself, if she is facing to other problems, her husband refuses to help her to solve them. To avoid this kind of conflictual relationships in the household, women stand behind the decisions of their husbands and avoid claiming rights over what they do” (Male respondent, FGD).

This kind of relationship can be idiomatically translated as the relationship of the eagle to the hen, according to which *"the hen and everything in her bosom belongs to the eagle"*. Based on such reasoning, the general practice related to field management is to consult men before making decisions. This indicates clearly that there are asymmetries in the power to bargain among household members [13] regarding field management. The cultural construction of appropriate female behavior affects their ability to bargain and that social norms could impinge on the bargaining power [27] by setting a limit on what can be bargained for, affecting how the process of bargaining is conducted by favoring some groups over others (i.e., men over women) [17].

5.3. Number Years in Farming and in Cowpea Production

Table 4 presents the average respondents' experience in farming in general, and in cowpea cropping in particular. The average years in cultivation can be a good driver for the awareness and the adoption of new varieties

Table 4. Number of years in farming and the cultivation of cowpea (number of years).

Sex of Respondents	N	Average Number of Years in Production of Cowpea	Average Number of Years in Farming
Men	126	19.43	32.44
Women	74	11.91	22.72
Total	200	16.65	28.85

The average number of years in cowpea production for men is 19.43 years and 32.44 years in farming experience. For the women, the average number of years in cowpea production is 11.91 years and 22.72 years in farming. When the entire sample is considered, the average number of years of cowpea production in the study is 16.65, while the respondents' average number of years of experience in farming is 28.85 years. The difference between men and women in terms of their experience in cowpea production is 7.52 years, which is significant at 10%. However, when we consider the experience of improved cowpea variety production, we notice that the average duration is very low compared with that of local varieties, and this is true for both men and women.

The average number of years in the production of newly released varieties of cowpea (Acar 1, Simbo, Jiguifa, CZ064, and CZ06105) by IER through the Cinzana Research Station is 2 years while the average number of years in the production of local varieties of cowpea is 22.90 years. When we disaggregated this figure by sex, we found that the average number of years in the production of newly released cowpea varieties by men is 2.21 years while it is 2 years for women (see Table 5). However, the variety Jiguifa is the one that has the highest average growing duration time for both men (3.11 years) and women (3.08 years), implying an overall average of 3.10 years for this variety.

Table 5. How long have respondents adopted the varieties of cowpea?

Sex of Respondents	N	Acar 1 (N = 26)	Simbo (N = 11)	Jiguifa (n = 48)	CZ064 (N = 4)	CZ06105 (N = 4)	Locale (N = 175)
Men	126	2.70	2.28	3.11	1.5	1.5	30.84
Women	74	1.33	1.5	3.08			9.14
Total	200	2.30	2	3.10	1.5	1.5	22.90

Membership in producers' associations and innovation platforms (IPs) is the best way to be in contact with new innovations, new technologies, and to network with the market, aid institutions, research structures, and extension services. However, participation in the activities of associations and IPs is based on gender norms that limit the full participation of women in these places and in the transfer of innovative technologies in cowpea production and marketing.

Table 6 shows the status and the number of times respondents participated in technology transfer activities, the status and number of extension visits received, the status and number of times respondents participated in FPVSSs, etc.

Table 6. Membership and participation in technology transfer activities and extension work.

Sex of Respondent	N	Technology Transfer Activities (NO. of Times)	Group Membership Status of IPs (%)	Visit to Extension Agent (%)	Visit from Extension Agents (No. of Times)	Status of Participation in FPVS (Yes in %)	Average Times of Participation in FPVS (Times)	Participation in Farmer Field School (%)	Attendance in Cowpea Seed Production Training (%)	Attendance in Storage Technique Training (%)	Participation in Farm Open Days (%)
Men	126 (63.00)	1.79	2.38	73	3.17	28.57	3.27	36.50	22.22	37.30	8.73
Women	74 (37.00)	1.53		35	3.31	22.97	2.82	20.27	14.86	29.72	8.10
Total	200 (100.00)	1.63	1.50	70	3.22	26.50	3.13	30.50	19.50	34.50	8.50

The average number of participations in cowpea technology transfer activities (testing and demonstration) is 1.63 (about 2) participations for the entire sample of the study. This is 1.53 times for women and 1.79 times for men. Concerning their participation in IPs, the average number of participations is 2.38 for men. However, it was found that no one woman in the sample attended cowpea's IPs while IPs are seen as the best means of technology transfer by variety selection and extension programs [3,28]. To enable women farmers full involvement in extension activities, the incorporation of gender sensitivity training for the extension workers is very important because extension takes place in highly complex environments where roles are largely driven by gender relations [29].

The IP was created in 2016 by the Agronomic Research Station of Cinzana to offer a framework for cooperation and learning through the direct networking of actors of a

sector or community of common interest in order to address the problems of poor or inadequate information, mistrust, and knowledge about improved varieties and other agricultural technologies [3], (p. 144). Cowpea seed production and distribution in the IP of the Cinzana Rural Commune is part of the TL-III project seed system to ensure more sharing of information and knowledge among the different actors in the cowpea value chain in Mali with the aims of improving the production and the distribution of quality seeds of improved cowpea varieties [3], (p. 144).

The processes of cowpea seed production and distribution in the IP of Cinzana are not yet working to make the participation of women in the platform's knowledge transfer activities inclusive and gender sensitive. In addition to the non-participation of women in cowpea innovation platform activities, Table 6 shows not only the low percentage of visits by women to agricultural extension services, but also low participation by women, rarely exceeding 35%, to FPVSs, field schools, seed production and storage training, and field days. This low participation of women in training activities and their absence from IPs is a huge barrier to the adoption of improved cowpea varieties. It was demonstrated that indirect adoptions are made possible by the density of their social capital, which is considered as a key element in the adoption of agricultural innovations and technologies [30].

During the 2018–2019 cropping season, as shown in Table 6, 26.50% of the respondents participated in farmer participatory varietal selection (FPVS) at the Cinzana Research Station including 23% of the surveyed women. Visits from extension agents are also a strong determinant in the adoption and diffusion of innovations and technologies [31] as well as participation in training [32]. Based on that, this innovator's narrative supports the analysis above that links social capital to a farmer's adoption of agricultural technologies:

"In the community, it is men who adopt most improved varieties because they have available lands for demonstrations and trial purpose and because they visit easily the fields of their neighbors" (Male innovator, 66 years old, KII, Cinzana commune).

This can be explained by the normative rules governing land acquisition, hence, adult men are able to obtain cropland for trial or demonstration needs. However, some respondents are not in agreement with normative and symbolic rules governing lands as one of the drivers to enable males to adopt improved cowpea varieties in the communities of the commune of Cinzana.

"I am not agreed with this comment made by For me, it is case of lack of agency unsuitable bargaining techniques towards elders. Our children and women do not know how to negotiate access to land. All of this must be discussed within the family; it is up to the men to take land requests from women and children to go to the landowners when the family has no land available. This applies to all land and technology transfer issues here. We are not going to accept a woman taking such an initiative. It is not good for her" (Male participant, FGD, Cinzana-Village)

Instead of the interplay of norms and symbolism in women's mis-adoption of improved cowpea technologies, we can assume that men's agency [21] and positionality [33,34] is more expanded than that of most of females due to the increased participation in breeding and technology dissemination activities than their female counterparts. In situations of insufficient bargaining power within the household, women do not benefit from new technologies even if they are designed specifically to target women [35]. The low use of improved seed varieties of cowpea by women can be explained by their low involvement in formal markets for certified quality seed, their low purchasing power, their poor targeting by crop breeding programs and agricultural extension services in the past [36], and their limited access to information, land, and the influence and interplay of social norms [37,38].

Although the proportion of women participating in training on innovations is low, we can see an expansion of the agency of women who are starting to produce improved varieties and this narrative goes in the direction of a normative change regarding the participation of women in innovations:

“Basing on my experiences, in this community, it is women who adopt more improved varieties because they target profitability. It is very easier for women to earn much in the cultivation of cowpea nowadays due to their new innovation capacities” (A female innovator, KII, Cinzana).

5.4. Production, Consumption, and Marketing Patterns

The distribution of harvests shows the interlinked relations between men and women related to expenses and food provision (see Table 7). It allows to determine who does what in the household and according to which rationality.

Table 7. Production, consumption, and marketing patterns of cowpea by sex.

Stock, Production, Consumption, Marketed Quantities (kg)	Sex of Respondents		Overall (n = 200)
	Male Respondent (n = 126)	Female Respondent (n = 74)	
Stock (2017–2018)	24.63 (100.0)	14.95 (100.0)	21.05 (100.00)
Production	447.78 (100.0)	242.63 (100.0)	371.87 (100.00)
Consumption	78.66 (21.94)	39.46 (16.04)	64.15 (21.19)
Sale	359.83 (78.05)	202.09 (83.95)	301.47 (80.91)

The average production of cowpea grains from the sampled respondents is about 372 kg. For male respondents, it is about 448 kg, while for female respondents, the average production is about 243 kg. When the respondents started the 2018–2019 cropping season, they had on average 21 kg of cowpea grains in their stock. This stock is generally reserved for the seeds of the coming cropping seasons. By sex, male respondents had about 24 kg of cowpea grains in the stock while female respondents had on average about 15 kg of cowpea grains in stock.

Concerning the human consumption patterns, on average, respondents consumed 64 kg of cowpea grains in their household in 2019. For male respondents, the amount of cowpea grains consumed in 2019 was about 79 kg and for females it was about 39 kg. This is not a surprising finding because in general men are in charge of feeding the entire household, and as we can see in Table 3 and the narratives, the main cowpea plots are under the responsibility of men and the head of the household.

Finally, the respondents marketed 301 kg of cowpea grains from their harvests in 2018–2019, representing 80% of the production. For male respondents, they marketed on average 360 kg of cowpea grains, and for female respondents, they marketed about 202 kg of cowpea grains. It is true that men’s production is far greater than women’s; however, women market more than 83% of their cowpea harvests. This demonstrates that women are more market-oriented than food providers when it comes to cowpeas. To a lesser extent than women, men also market about 80% of their cowpea harvests. Cowpea serves as a valuable and dependable revenue-generating commodity for farmers and grain traders [4]. However, our results that show a higher share of cowpea harvests reserved for market contradicts a study that found that only 45% of cowpea produce was marketed [4].

The share of cowpea reserved for human consumption may seem derisory; cowpea is not consumed daily like millet, sorghum, maize, or rice. In spite of its proven high nutritional value, cowpea is consumed mainly during special social ceremonies (namely, ceremonies, funerals, and sacrificial rites) and festivals in Mali [3].

Clearly, cowpeas are produced primarily as a cash crop in Mali. While men are more concerned with the provision of cowpea grains for household consumption (especially for special events such as name-giving parties, funerals, etc.), respondents note that women are much more inclined toward cowpea commercialization because they are not obliged to provide food for the family, which remains primarily a social responsibility of adult married men.

5.5. Social Structure of Agricultural Production, Intra-household Decision Making, and Responsibility of Farm Tasks

Table A1 (in Appendix A) presents the social structure of groundnut production and marketing. It shows the main activities performed and different roles played by adult men and women and young men and women in cowpea production and marketing.

The roles played by farmers based on their sex and age show how relations are structured and the level of interdependence of each other in the chain of production, marketing, and consumption within the household.

Both survey data and FGDs/KIIs narratives showed that there is a specialization of agricultural tasks according to social groups (adult men, adult women, and young people). Of the 10 areas of activities that were assessed during the study, adult men exercise real control in 4 areas, namely: (1) management of seeds (83.50%); (2) pest and disease control (48.50%), (3) produce marketing (73.50); (4) and intra-household income management (75.50%) (see Table A1).

On the other hand, youths exercise real control in the areas of land preparation (59%), application of herbicides (57.50%), and the transport of crops to the home (85%). Weeding, harvesting, and planting are jointly performed by adult men, adult women, and youths. In none of the ten domains do women have real control in terms of decision making although their contribution is inestimable in each of the areas mentioned. Although cowpea is considered a women's crop, its production in the commune of Cinzana, which is largely dominated by the Bamana tribe, is governed by social and cultural patterns in Bamanan culture leading to "a gender-biased system of access to commercially viable productive resources in which women are limited from these endeavours" [35,36]. Cowpea is becoming a cash crop par excellence for men and women as shown in Table 7, and the importance of the head of the household, although symbolic, in the management of cowpea plots was revealed in the previous sections.

However, women who produce cowpea on individual plots manage the income from their plots. Data collected from FGDs show that cowpea products are governed by particular types of gender relations. For instance, the amount of grain consumed or sold from the collective fields is under the responsibility of the heads of households while the revenues from individual plots are managed by the plot owners. This necessarily raises the issue of women's market participation, which is not specific to cowpea in Mali.

In the focus groups, it appeared that women are almost excluded, regardless of their age or social status, from the management of income from the household's collective fields:

"Rarely, we women are involved in making decisions about family harvesting products. The head of the family decides to sell the quantity of grains of cowpea. From time to time, he gives us grains to cook. But if it is our little field, we ourselves decide everything" (Female participant, FGD, Cinzana Research Station).

Based on that, the study revealed a hierarchy of the domains of making decisions: there are some areas that are governed by the heads of households and some are individual decisions; however, these decisions and domains are context specific. Each household implements its own hierarchy of the domains of making decisions.

"... the decisions to process cowpea grains are made by women who want. In my household, the profits are managed by the head of the family because it is him who is in charge of the expenses of the family. The head of household makes the decision on the amount of cowpea grains to be consumed and sold. In some cases, the head of household can be consulted, but he cannot decide about the quantity of grains of cowpea to be consumed and sold" (Male respondent, FGD).

To summarize, we can say that based on the types of plots, the decisions can be differentiated and contextualized in view of the economic functions delivered by the owners of the individual fields of cowpea. The management of collective fields of the households is the realm of the household head. Gender relations determine the division of labor,

access to resources, and decision-making power in agricultural-dependent communities and households [39].

Gender relations have created a system of power relations where farmers are perceived to be male and women are perceived as helpers, which trivializes and devalues the contribution of, and benefits for, women in agriculture [40].

5.6. Drivers Influencing the Adoption of Improved Cowpea Varieties

Table 8 reveals the influence of respondent's social characteristics on the production of improved cowpea varieties. Gender, age, membership in associations or innovation platforms, number of years in cowpea production, and extension participation status influence the adoption of improved cowpea varieties. In agricultural production, men generally have much more responsibility, resources, and opportunities for contact with innovations than women. This reinforces the adoption of improved varieties by men, most of whose seed is purchased or distributed in lieu of participation in varietal demonstrations and trials.

Table 8. Binary logistic regression analysis: factors related to improved cowpea varieties' adoption.

Independent Variables	Estimation	Pr (> z)
Respondent sex	0.86915	0.040298 **
Respondent age	0.06858	0.000643 ***
Membership status (yes)	1.19258	0.002635 ***
Num. of years in cowpea production	−0.06005	0.009093 ***
Extension visit status (yes)	1.72711	0.0000133 ***
(Intercept)	−3.53206	0.0000658 ***

Significance code: 0.01 « *** »; 0.05 « ** ».

In addition, the production of improved varieties requires compliance with technical practices that are often unknown to women because of their low participation in training on innovations, poor contact with extension services, and the burden of their off-farm activities. Our findings are similar with those of Ragasa et al. which clearly demonstrated gender differences in access to extension because male heads are more likely to be visited by, and to receive advice from, development or extension agents than female heads [41].

The age of respondents does not have a strong influence on the adoption of improved cowpea varieties. Table A1 shows that the number of years in cowpea production has a negative effect on adoption when all other independent variables are constant.

Several explanations can be offered for this. A producer will not change the (usually local) variety unless it shows limitations in the sense of yield, yield stability over a number of years, resistance to biotic and abiotic stresses, or poor adaptation to the producer's current needs. From farmers' perspectives, local varieties offer prospects for relative yield stability and most often protect them from the uncertainty of producing improved varieties with new risks in prospect, despite the productivity of the improved ones recognized by them.

Table 8 shows that membership in farmer organizations and IPs and the gender of the respondent are the key determinants of the adoption of improved cowpea varieties in the Cinzana zone. Indeed, producers who are in organizations are more likely to adopt improved varieties. The associations are excellent places for exchange, information sharing, and training opportunities. Women, who often have limited mobility agency due to social norms (religious and social requirements of male approval of women's mobility) that regulate their movements outside of communities, are disconnected from the outside world where innovations, opportunities, and information exist.

Participation in extension sessions or innovation platforms, made possible by membership in farmers' organizations, encourages the adoption of improved varieties. Indeed, the extension allows producers to appreciate the new varieties through concrete demonstrations that are decision-making tools. This strengthens the confidence of producers in

the new variety, which is a necessary step towards adoption in the short, medium, and long term.

Since men are more involved in farmers' organizations and IPs and have regular contact with extension and research services, it shows that the gender of the respondent becomes a factor in the adoption of improved cowpea varieties. From this perspective, previous studies have shown that gender, collective action, and agriculture are intricately linked in the sense that the active participation of women and young adults in social groups improves agricultural productivity and welfare [42]. This is made possible by their exposure to knowledge and innovations that are economically and technically proven [43,44] which in return, will improve their well-being.

5.7. Grounded Experiences and Traits Preferences in Cowpea Innovations

The analysis of the intrinsic characteristics of innovation can be complementary to inform on the uses made by the users independent of the social framework of the innovation.

The main incentives for the adoption of improved cowpea varieties that emerged from qualitative data are their high grain and fodder yielding, use of cowpea as an income source towards revenues (market preference demands), and the early maturation of cowpea and its white color (grain quality) which is valued in the market (see Table A2). The experience endowment in cropping was revealed as a driver of the adoption of cowpea new varieties by respondents. This shows that variety attributes are interlinked to the social experiences of the innovator.

Respondents' former or current experiences enable them to know if the released varieties meet their needs regarding feeding, cash needs, or adaption to abiotic and biotic stresses (resistances or tolerance to drought or insect attacks). Based on these grounded experiences, women as well as men have particular preferences and demands, which are sometimes translated into the varieties to breed during the FPVSs.

According to an extension officer who was working in Cinzana for 10 years, *"farmers are more interested by improved cowpea varieties than the locals. because of the high yielding in grains and fodder of improved varieties"*. Approaching the incentives to adoption, this respondent was agreed with the argument of the extension agent.

He reported growing cowpea for 20 years, but for him, the traits he considered the most are:

"the early maturity of the varieties I adopted. They reach maturity during the lean period. They are also a very good source of revenues and foods pour all the families of this place [. . .] And the cowpea varieties as Sangaraka, Korobalen, Acar 1, M'barawa and Wilibali are those which have these traits and their grains are appreciated by both consumers and buyers".

Some respondents consider the grain's white color, grain yield, and fodder yield as the main incentives to adopt released cowpea varieties: *"Acar 1 and Wilibali are the most adopted varieties. the grains of these varieties are easily sold in the market and are good in the processing"* (KII, Female, Cinzana-Gara).

Based on the insights of women participating in FPVS at the Cinzana Research Station, a valuable female innovator stated this: *"As women, we consider the early maturity of the variety, the resistance to diseases, the grain yield, the good qualities of grains especially those which have the white color are much appreciated on the market"*. Another woman participating in FPVS activities in October 2019 in Cinzana stated this: *"For we women, the medium and large white grains are appreciated for consumption and sale. Sweet grains are reserved for consumption because they are difficult to sell on the market. Early maturity, purity and awareness of the variety are also considered in our decisions to adopt a variety or to reject it"*.

Trait preference analysis showed that gender differences exist in regard to male and female farmers' crop preferences and varieties (Table A1). Women and men rate cowpea characteristics differently and prefer traits because of the intended consumption objectives, for markets, or their own consumption, special dishes, feed [45,46], or animal feeding, processing, and storing requirements [47].

In summary, cowpea innovations are introduced in the area of Cinzana by the cowpea program of the IER research station to boost the adoption of improved cowpea varieties and to train farmers on new storage techniques for cowpea grains. The storage and preservation of cowpea have been major concerns for the producers due to constant pest attacks in the stores. Based on this, customized training on post-harvest techniques are delivered to farmers by cowpea IPs in collaboration with cowpea breeders. In addition to this training, women and men are increasingly involved in the participatory selection of traits for varieties at the early stages of the breeding process.

At this level, each group (of women or men) identifies the traits that are important for them in the varieties to be developed.

Data collected from the FPVS helped to triangulate the data from the FGDs, KIIs, and surveys. From the FPVS experiment (Table A2), drought resistance, early maturity, high grain yield, and high fodder yields are the four main traits identified by respondents. Drought resistance, early maturity, high grain yield, and high fodder yield represent 53.5% of the traits of preference identified by respondents. According to female respondents, drought resistance, early maturity, high grain yield, and high fodder yield are the must-have traits they consider before adopting any variety of cowpea. Our results regarding traits are quite similar to that of a study that revealed that grain quality and grain size are common traits preferred by the producers, consumers, and traders of cowpea in Mali, Ghana, and Nigeria [36].

However, our study found that early maturity, high fodder yield, and drought resistance are highly important for women to alleviate food insecurity and to feed their small ruminants.

For men, drought resistance, early maturity, high grain yield, and high fodder yield are the main traits they consider before adopting cowpea varieties. These traits represent 71% of all the traits identified by males as important in their decisions to adopt cowpea varieties. A closer analysis of the traits mentioned by women participating in the FPVSs shows that the traits selected by the participants in the FPVSs are very similar to those identified by farmers in the surveys, FGDs, and KIIs.

6. Discussions

6.1. Emerged Opportunities from Cowpea Innovations

The introduction of new cowpea varieties provides more economic opportunities to farmers, and new gender relations emerged in the cultivation of cowpea with some specializations based on sex roles and gender relations [48]. As cowpea production, especially improved varieties, is highly driven by the market, cowpea cultivation offers many opportunities to respondents, specifically regarding gender and personal soft skills of the respondents. These opportunities range from expanding plots of cowpea crops, strengthening collaboration between innovators and agricultural extension services and research, diversification of economic resources and opportunities for processing cowpea products, food diversification and food provision during the lean period, provision of livestock feed for fattening as a secondary activity, and the ability to sell cowpea grains and tops to cope with cash problems (purchase of school supplies for students, child health costs, payment of weekly contributions from women's tontines, etc.) [4].

During FGD discussions, a respondent testified that:

"The availability of lands for men is a real opportunity for them to increase the production of cowpea. The higher demand of cowpea on local and Malian national markets is also an opportunity for growing cowpea all farmers of the regions".

However, if land availability is considered a chance for male farmers to expand their cowpea plots and make a profit from the cultivation of cowpea by enhancing their selling capacities, land issues were reported by female respondents as one of the main constraints to cowpea production. Addressing land issues and reinforcing the collaboration between extension service workers and farmers are the best ways to increase the adoption rate of

improved varieties to increase the revenues of the households and improve the well-being of the community.

To highlight the importance of cowpea in income generation, a female respondent argued that:

“... women sell more cowpea to meet household expenditures. The white color of cowpea is most preferred by buyers. New improved cowpea varieties enable us increase our revenues, to diversity dishes in the households and to implement cowpea processing activities”.

The profits from cowpea cultivation for women are generally used to meet family needs such as health prescriptions charges, condiment fees, purchase of agricultural materials and clothes, or in petty trading. As most of the improved cowpea varieties are dual purpose (high yielding in grain and fodder), about 80% of respondents found that these attributes encourage them to grow improved varieties. This result is similar to some extent to Tipilda et al. who show that dual-purpose cowpea addressed problems of low productivity in northern Nigeria and improved the social and economic status of the wives from male adopters [49]. However, unlike the results of Tipilda et al., which showed that the production and sale of cowpea is a male activity, our study finds that both women and men produce and market cowpea, but that women are more oriented towards marketing their cowpea grains than men.

With cowpea breeding and IPs activities, women are increasingly engaged in the sorting of cowpea grain seeds at the Cinzana Research Station because they are seen or perceived to be more patient and careful. This has presented an opportunity for income generation in this gendered off-farm activity.

6.2. Strategies to Increase the Adoption of Released Cowpea Varieties and to Improve Inclusiveness

The FGDs results revealed that social ties help to increase the adoption rate of new seeds of cowpea because access to seeds is sometimes difficult for farmers when they are not participating in FPVS or they have no direct collaboration with extension or research services. Farmers who do not benefit from extension services have indirect access to improved cowpea seeds through the ones who have direct access with seed producers, extension services, or research agents.

“During inter-farmer visits we choose the best varieties that we adopt. If we see a cowpea field in a neighbor field who has produced a lot of pods, he is asked for some seed of that variety”.

With access to high quality seeds being a real concern for many farmers, especially women who participate poorly in extension activities, the study respondents expect an improvement in extension work and new forms of collaboration with extension services or research institutes through an increase in the number of persons involved in trials and demonstration fields, by making improved cowpea seeds available early in the season, changing the strategies of targeting and reaching farmers, providing growers with improved varieties that are resistant to insects, and by making training programs and IPs as inclusive as possible. The poor involvement of women in IPs poses the problems of institutional dimensions of agricultural technology adoption [41,50,51]. Our hypothesis stated that the availability and circulation of seed in social structures and households allow the adoption of new cowpea varieties by women. Our study found that in addition to the sex and the age of the farmers, the membership status in farmer grassroot organizations (e.g., innovation platforms), the number of years of cowpea production, number of extension visits, and the participation in technology transfer activities, are the important drivers in the adoption of new cowpea varieties by women in the commune of Cinzana.

7. Conclusions

The importance of social structures is paramount in the uptake of new cowpea varieties in the region of Segou, Mali. In this article, the study revealed that the intra-household relations in farming and farmer organization are the drivers of the uptake of new and

improved cowpea varieties. The shift toward gender transformative farmer participatory varietal selection is essential to boost the adoption of new cowpea varieties by women.

Grain yield, drought resistance, and early maturity are the traits which are mostly preferred by both female and male respondents. For production, marketing, and consumption, drought resistance, early maturity, high grain yield, and high fodder yield are the must-have traits considered by respondents. However, early maturity, high fodder yield, and drought resistance are highly important for women to alleviate food insecurity and to feed their small ruminants.

Although the technologies are accessible, women are facing poor accessibility to proven improved cowpea varieties due to their poor connectedness to the dissemination channels for new varieties and some fixed roles of women in households and in social structures (IPs). These barriers prevent women from being fully engaged with the innovation cycle and from fully benefitting from farming technologies.

This study also revealed the significance of cowpea in terms of income generation strategies for women and in terms of cultural and religious patterns (cowpea is used in the main dishes of social ceremonies such as name-giving ceremonies) [52]. In terms of integrating cowpea and livestock, many male farmers grow cowpea because of its leaves for animal feeding (their own needs or for sales). From women's insights during focus group discussions, cowpea cultivation in general enables them to meet their own needs and to solve daily problems, most often without the contribution of their spouses.

Cowpea cultivation offers women opportunities to process more cowpea grains into marketable and high-demand local processed products (*akra*, a local doughnut, etc.). Whether or not the study shows that women are expanding their income generation capacities, they do not yet have full control on the revenue they generate from cowpea commercialization and processing. The general pattern is that women's income is controlled by their husbands or used in compliance with the husband, and many women accept this norm not because they are obliged to do so, but to strengthen the understanding and cooperation between men and women in the accomplishment of their daily and agricultural activities.

The study found that the gender relations in the household determine how women participate in cowpea innovations and how they access improved cowpea varieties. This leads to women's poor adoption of new cowpea cultivars in Cinzana, although the IER cowpea program is managing to integrate gender into its activities through a participatory breeding approach.

A strong targeting and inclusion of women in IPs and FVPSs will be beneficial to women in the sense that it will improve their productivity through the adoption of new agricultural and commercial techniques that are more economically profitable, strengthen their self-esteem, and expand their agency and networking with extension services and development agencies.

Although the study is a key contribution to analyzing gender roles and social structures in the adoption of new cowpea varieties, one of its limitations is the small sample size and its focus solely on the sex dimension. An intersectional perspective could provide more insights on relevant aspects of adoption that would be hidden behind the sex pattern. Future research will take into account an intersectional perspective to better contribute to discussions on gender and the adoption of agricultural innovations in Africa, particularly in Mali.

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Appendix A

Table A1. Social structure of production and marketing of cowpea.

Activities/Making Decisions	Person Responsible	Male's Responses (N = 126) %	Female's Responses (N = 74) %	All (N = 200) %
Management of seeds	Adult men	98.41	58.10	83.50
	Adult women	-	36.48	13.50
	Young/children	0.79	5.40	2.59
	Jointly	0.79	-	0.50
Land preparation	Adult men	15.87	18.91	17
	Adult women	-	1.35	0.5
	Young/children	50	74.32	59
	Jointly	34.12	5.40	23.50
Planting/seeding	Adult men	3.96	1.35	3
	Adult women	-	14.86	5.50
	Young/children	33.33	16.21	6
	Jointly	62.69	67.56	64.50
Weeding	Adult men	3.17	2.70	3
	Adult women	-	14.86	5.50
	Young/children	31.74	25.67	29.50
	Jointly	65.08	56.75	62
Herbicide application	Adult men	11.11	14.86	12.50
	Adult women	-	13.51	5
	Young/children	66.66	41.89	57.50
	Jointly	22.22	29.72	25
Pest and disease control	Adult men	44.44	55.40	48.50
	Adult women	-	2.70	1
	Young/children	42.06	31.08	38
	Jointly	13.49	10.81	12.50
Harvest	Adult men	4.76	6.75	5.50
	Adult women	3.96	17.56	9
	Young/children	19.04	9.45	15.50
	Jointly	72.22	66.21	70
Transport	Adult men	3.17	2.70	3
	Adult women	0.79	6.75	3
	Young/children	85.71	83.78	85
	Jointly	10.31	6.75	9
Marketing	Adult men	96.03	35.13	73.50
	Adult women	2.38	63.51	25
	Young/children	0.79	-	0.5
	Jointly	0.79	1.35	1
Intrahousehold income management	Adult men	98.41	36.48	75.50
	Adult women	1.58	63.51	24.50
	Children	-	-	-
	Jointly	-	-	-

Table A2. Matrix of traits by varieties emerged from FPVS.

Cowpea Variety Names	Village Name	Number of Evaluators of Traits	Traits Considered as Important to Boost the Adoption
CZ06-1-12	Fambougou	20 farmers	The variety CZ06-1-12 under the selection process results in pods well-filled with grains and fodder with a good yield; drought resistant; early maturation; the test plots under CZ06-1-12 are not infested by striga or diseases
	Konodogola	15 farmers	Good yield; well-filled pods; white grains; drought resistance; early maturity; resistant to striga and diseases; good fodder yield
CZ06-4-16	Konodogola	5 farmers	Good yield in white grains; early maturity; drought resistance and resistance to striga
CZ06-2-17	Konodogola	20 farmers	Good yield of white and wide grains; good yield of fodder; drought resistant; no striga infestation or diseases
	Fambougou	15 farmers	Good grain yield; good resistance to drought and to striga; early maturity; good fodder yield
CZ06-3-1	Fambougou	5 farmers	Very early maturity; good grain and fodders yield
Acar -1	Kondogola	21 farmers	Good yield of white grains and good fodder yield; resistant to drought and to striga; early maturity
Fakson	Kondogola	21 farmers	Good yield in white grains and good fodder yield; resistant to drought and to striga

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