

Gendered Roles in Agrarian Transition: A Study of Lowland Rice Farming in Lao PDR

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Abstract: Traditional lifestyles of lowland rice farmers of the southern provinces of Lao People's Democratic Republic are rapidly changing, due to two important trends. Firstly, there is a push towards modernization and commercialization of farming. Secondly, though farmers still focus on rice farming as a key activity, there is an increasing move towards diversification of livelihoods. The changes have seen the uptake of non-rice crops, livestock husbandry and forest and river utilization; as well as non-farming activities. This has influenced gender relations, impacting household agricultural production decisions and amplified transitional trends. To explore the processes, we analyzed data from a study of innovation adoption amongst rice farmers in southern Lao PDR. The study revealed nuances of gender-based differences in the priorities and attitudes towards farming and off-farm activities, as well as differences in behaviour related to the adoption of new practices. Women were more focused on non-farming practices and considered engaging in the modern, non-traditional, economy more so than men. Women also reported experiencing greater challenges when engaging and trading in the agricultural marketplace. The study supports the importance of taking a gendered approach to understanding the inherent complexities within agrarian change.

Keywords: rice; gender; smallholder farmers; technology adoption; Lao PDR; innovation diffusion; agrarian transition

1. Introduction

The Lao People's Democratic Republic (Lao PDR) is a sparsely populated nation in Southeast Asia where agricultural production usually occurs on farms that are less than two hectares, and where populations have tended to be spread out in a way that gives farmers limited access to processing industries and markets [1,2]. Smallholder farmers have traditionally been subsistence farmers;

dependent on cultivatable land for rice and livestock production with an array of non-timber forest and river products used as supplementary food sources and marketable goods [3–5]. More recently, Lao PDR is experiencing agrarian transitional changes that are also occurring elsewhere in Southeast Asia. These transitions are intricate and may cause social change and have considerable impacts on resource management practices as well as a fundamental change of landscapes [6,7]. Agrarian transition has been described by [7] p. 286: “as the transformation of societies from primarily non-urban populations dependent upon agricultural production and organized through rural social structures, to predominantly urbanized, industrialized and market-based societies”. The changes that are happening in Lao PDR include intensified production, the territorial expansion of large actors, market integration, including urbanization of the population, rapid industrialization, increased movement of the population as well as a series of regulatory and environmental dilemmas [7–11]. Lao farmers are also contributing to a bigger picture of regional agrarian transition [12]. In this context, to improve rural livelihoods, the Lao government is trying to shift farmers to commercial agricultural production through interconnected strategies that aim to (a) guarantee food security, (b) deliver comparative and competitive agricultural commodities, (c) expand clean, safe and sustainable agriculture, and (d) deliver a modernized, resilient and productive agricultural economy that contributes substantially to the national economy [13]. International aid organizations are also helping with the agrarian transition that is aimed for by the Government of Laos [14–18].

What this means for smallholder farmer households in Lao PDR is that many are shifting from traditional low-yield, subsistence-oriented activities towards diversified livelihood strategies by attempting to maximize the income-generating potential of available labour within the family [19–21]. As part of this trend, more non-traditional off-farm and non-farming activities have become integral to the way that households generate income.

It is becoming clear that there is an important gender perspective associated with this evolving socio-cultural system, with the changing roles of men and women, described as the “feminization of agriculture” [22,23]. In this rapidly changing context, there is a need to understand the trends in gender roles, social norms, as well as the roles of members and heads of households and whole communities as they are increasingly afforded international aid to encourage and support the intensification of agricultural production [24]. It is argued that, as part of the introduction of new technologies by aid agencies, the gendered roles and social norms, acceptable behaviour and agency that are prescribed according to ethnicity, must also be taken into account [25].

With this in mind, we use data from a previous research project to explore differences in what men and women aim to achieve in the agrarian transition, any gendered differences in livelihood strategies, and if there are any gender-based differences in the capacity to engage with modern technologies or farming markets. Specifically, this paper explores, in the context of agrarian transition amongst smallholder farmers in southern Lao PDR:

- What are the differences, if any, between how men and women choose to adopt new technology?
- What are the differences between men and women, if any, in strategies and attitudes to farming and related activities?
- What are the differences between men and women, if any, in the ability to generate income and engage with farming markets?

Exploring these questions using our data contributes to an improved understanding of gender dynamics—strategic thinking, farming attitudes and decision-making—in agrarian transitions. The findings also carry implications for better targeting of gender-sensitive agricultural research. Furthermore, if there is a gender difference in priorities and decision making at this time of transition, then the gender perspective may provide useful information about the multiple directions of agrarian change in Lao PDR.

To explore these questions, we draw primarily on the analysis of quantitative data from 293 female and 452 male farmers surveyed in 2016 in 18 villages in Southern Lao [26,27]. We further use the qualitative and other research data, i.e., from interviews and focus groups, key informant insights, and

field observations, to provide plausible explanations and to, as best as available primary and secondary data permit, validate our interpretations of what is causing the quantitative results.

2. Gendered Economic Transition in Lao PDR

Rapid and uneven economic growth occurring in Southeast Asian countries over the last few decades has resulted in new and challenging inequities between social groups and for men and women [28–31]. In Lao PDR, the New Economic Mechanism introduced in 1986 has seen the government move from a planned economy towards an open-market economy [32].

Phouxay and Tollefsen [31] have argued that the different results for men and women during the agricultural transition can be observed in migration patterns and changes in urban labour markets, where young female migrants in many cases end up in precarious work and/or doing hard manual labour in Southeast Asian cities. There are many examples of young men and women migrating for wages and remittances [31,33–36]. The number of women working in Vientiane, the capital of Lao PDR, has increased, particularly young rural women employed in textile factories, which has influenced women's roles and status as industrial workers both inside and outside the workplace [31]. The Mekong Commons [37] indicate that many Lao people are illegally employed as undocumented workers in Thailand, gaining benefits by contributing remittances but also being exposed to risks.

Women are an important part of the agriculture sector in Lao PDR, contributing to every part of agricultural production [25]. However, men and women typically have different roles and responsibilities in the household [38,39]. Gendered roles in rural areas in Lao PDR are similar to other countries in Southeast Asia [28] and can be conceptualized as 'loose patriarchies' where women's rights, mobility and labour participation are higher than in other places [40,41]. The head of the household, however, is typically a man who is also the key agricultural production decision-maker [42]. Women tend to have less power in negotiations than men and more limited decision-making opportunities [43,44]. Interestingly, women can take responsibility for saving income, while decisions to spend income is usually made by the man in the household [44]. However, [44] has noted that gender status can change with commercial agricultural opportunities. Furthermore, changes to gender status can drive further changes and improvements to socio-economic situations [44].

It is important to consider the multiple roles of women as mothers, wives, farmers, entrepreneurs and agents as they play a significant role in main crop production, livestock production, horticulture, post-harvesting operations, agro-social forestry and fishing [45]. Women's duties are often directed towards household caretaking with significant domestic and reproductive responsibilities [43,46]. In Lao PDR, it is well-known that there are differences between households headed by women rather than men. However, it is not very well known what the roles and contributions of rural women are within male-headed households, nor the decision-making and levels of informal and formal control that occur in the households [47].

3. Methodology

This article primarily draws on quantitative data collected using farmer surveys [26,27] whilst also drawing on qualitative data from focus group discussions and interviews designed to validate interpretations of the statistical analysis. For greater explanatory power, we have also drawn from the literature review, Bayesian network findings and outcomes of serious games that explored gender differences in a hypothetical situation of rice production in a game setting.

A farmer survey was carried out as part of a study commissioned by the Australian Centre for International Agricultural Research (ACIAR) (ASEM/2014/052 "Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints"), designed to understand conditions that influence farming households' decisions to adopt or not adopt innovative farming practices [48,49]. The study included a literature review [50], focus group discussions, interviews, farmer surveys [26,27], as well as the application of Q methodology [48,51], serious gaming [52] and Bayesian network (BN) analysis [20]. The research team used a mixed-methods approach for

synthesizing qualitative and quantitative data. Publicly available reports and papers are on an online repository (<https://sites.google.com/view/acrtechnologyadoption/project-reports>).

3.1. Survey Data

A review of the literature was undertaken to explore the factors that influence the adoption of technologies, drawing on adoption literature and literature from the fields of organizational change, supply chains and project management. Based on the review, an exploratory survey instrument was developed and, following a piloting process, finalized to 39 questions. The survey questions can be found in the relevant project report [27] and explored demographic and socio-economic factors, technology understanding and attractiveness, as well as perceived technology benefits, support, risk and uncertainty, etc [26]. The survey included a series of questions with dichotomous or a multiple item scales (1–7 Likert scale).

The survey-generated data explored farmers' perceptions of factors that are relevant for their agricultural decisions. Understanding such factors will influence the success of agricultural research because it can be used to unlock opportunities for farmers. Details of the survey design and analysis can be found in the relevant project report [27]. The questionnaire explored demographics, technology attributes and attractiveness, as well as benefits, levels of support, risk, uncertainty and costs associated with a change of production systems [20,53].

3.2. Choice of Participants and Survey Administration

Households drawn from 18 villages in Savannakhet and Champasak Provinces in Southern Lao PDR were chosen for the survey using a purposive sampling frame. The villages selected were predominantly characterized by their use of lowland rice-growing agricultural systems with a history of involvement and/or were currently involved in development projects. Villages were at different levels of elevation, soil profiles, access to water supplies and presence or absence of irrigation. The selection procedure also considered additional factors such as the level of access to markets, credit or finance and areas where the production of two crops per year was possible.

The survey was delivered using electronic voting technology. To reduce the risk of misunderstanding, the survey was extensively tested, with iterations of translations of questions from English to the Lao language. There was considerable effort to ensure that clear and non-ambiguous terminology and phrasing were used. Farmers were asked about activities that their household had been involved in, making it difficult to discern the experiences of individual technology types. Instead, the survey aimed to elicit a systems-view of their experiences. A total of 745 farmers participated in an electronic voting exercise; 427 from nine villages in the Province of Savannakhet and 318 from nine villages in the Province of Champasak [27]. The data collection methods were approved by the Human Ethics Research Committee at James Cook University (H6109).

Interview data indicated that the surveyed villages had a variety of ethnic and language groups [48] including Lao Loum, Phouthai, Makong, Lao Theung Kmuk, Lao Kang, Suay and Thoy ethnic participants. Lao was the predominantly spoken language, with Lao Theung, Phouthai, and Makong languages also spoken. Villages ranged in size from 121 to 302 households per village, and with an average household size of 6 people. The main income source was from rice production and livestock husbandry, with income also from crops, vegetables and fruit. It was also found that households reported off-farm income from remittances, wages and other activities. Fewer women than men reported that they generated income, although women did make small contributions through livestock raising, wages, remittances and other activities. Families generally worked together to generate income. Reported sources of off-farm income included: house building, handicrafts, weaving, collecting non-timber forest products (such as frogs or cardamom), selling fish, snails, chicken or ducks, wages from offspring working outside of Laos, and wage labour jobs, such as unexploded ordnance removal, electrical technician, construction jobs, minimart shop or outsourcing of mechanized farm equipment, such as tractors. In each village, off-farm work occurred primarily in Thailand, with an estimated 20–120 households per village having members working in Thailand. Up to 60 households had members

working in Vientiane. The total percentage of households in the sample with members engaging in off-farm employment ranged from 30% to 80%.

3.3. Analysis of Survey Data

We interrogated survey data from the electronic voting exercise in the 18 villages to (1) explore important gender-related summary statistics generated from the survey; and (2) undertake statistical analysis, including chi-square tests, to understand any systematic differences in participant responses between men and women, and differences due to age, education and household role. Based on the statistical analysis, we discuss the relevance of these results in terms of how the current agrarian transition is influencing gender relations and, in turn, how gender relations may be influencing the agrarian transition. Relevant qualitative information from focus groups, interviews and field observations enabled a greater explanatory capability when combined with the statistical analysis.

We also note that some questions refer to the participant as an individual and some questions refer to the individual's household, but in the majority of cases, the respondent was the head of the household, and in 81% of the cases the respondent was either the head of the household or the wife of the head of the household.

4. Results

In all, 745 participants from 18 villages in 2 provinces, with 39% (293) women and 61% (452) men, attended the electronic voting exercise. Depending on how each question was asked, the participants sometimes responded on behalf of the household, and sometimes on behalf of themselves as individuals. A total of 81% of the respondents were either the head of the household or the wife of the head of the household. The gender balance of participants differed markedly across the 18 villages, with one village having had as few as 6% women participating, whilst at the other extreme, one village had as many as 69% women participating. Local government officers recruited villagers to meet in the common facility in each village and as participation was voluntary, we cannot account for the dynamics that resulted in variations in gender participation.

4.1. Gender-Related Differences in Age and Educational Level

To provide some baseline information about who the respondents were, we explored age and education, and any gendered differences in these attributes. The age and education profiles of female and male participants were significantly different, as shown in Figure 1 and Figure 2. Female participants were predominantly in the 31–40 age group, while male distribution by age was more evenly distributed between age categories. Nearly half of the female participants were illiterate, compared with 31% illiteracy for men. Overall, men were much more highly educated than women. A multinomial logistic regression model found that age and gender both had a statistically significant effect on education level, with gender having a stronger effect (in the analysis of variance table, gender had a p -value of 8.545×10^{-11} whilst age had a p -value of 4.881×10^{-7}).

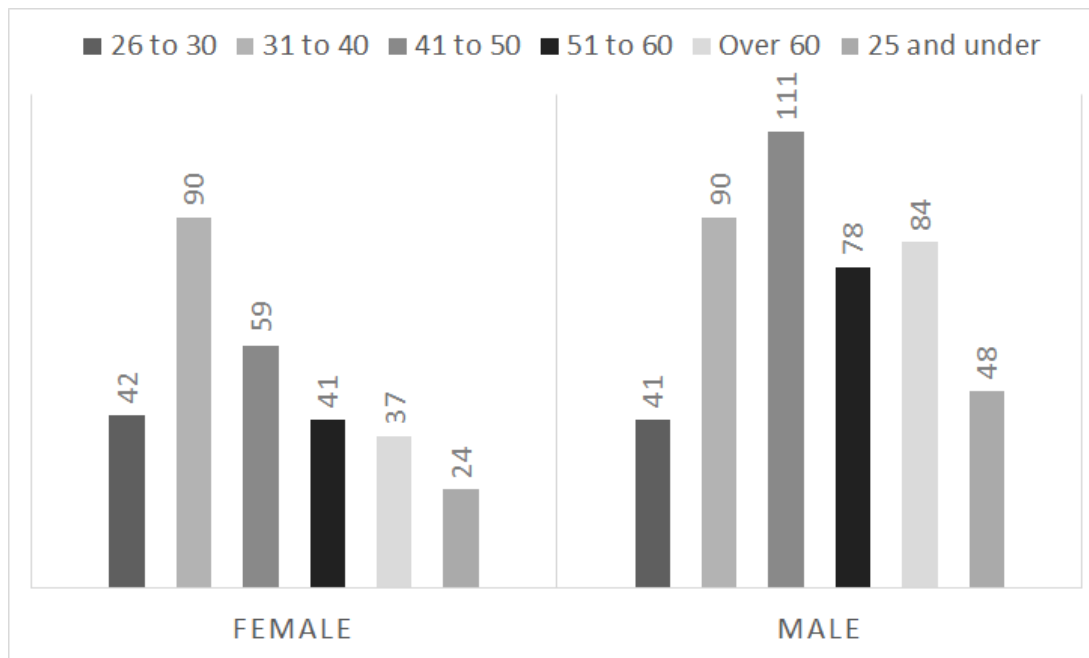


Figure 1. Age profiles of female and male participants (N = 745).

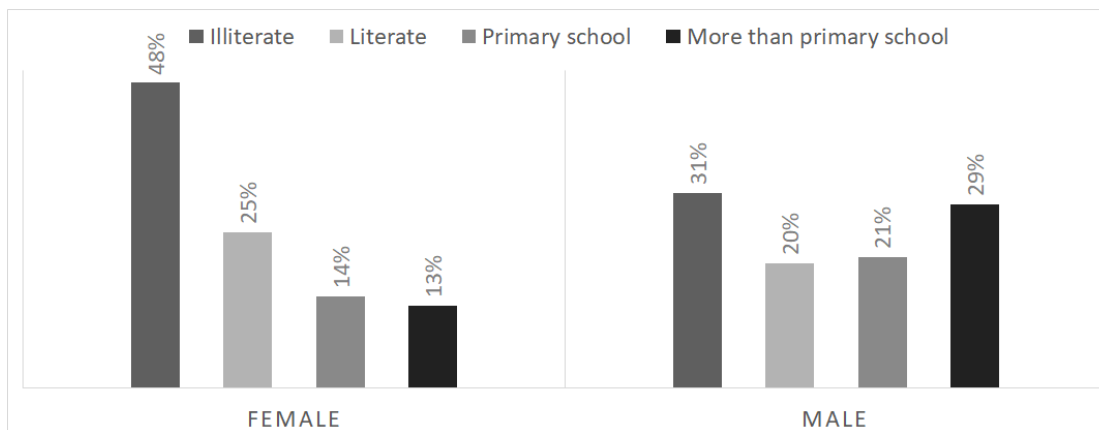


Figure 2. Education profiles of female and male participants (N = 745).

4.2. Gender-Related Differences in the Embrace of New Practices

An important aspect of the agrarian transition involves the adoption of new agricultural practices. These changes in practices are variously supported by agricultural researchers, but more often by Lao government extension officers who provide training and advice to farmers. New practices also gather momentum and often become adopted by farmers independently through a process of innovation diffusion.

Through our survey, farmers in the villages were asked specifically about the extent to which they, as individuals, had been participants in activities that involved evaluating new practices (here referred to as projects), and also the number of new practices (here referred to as technologies) that they had adopted; and whether they still used those practices; and whether they found the practice change to be useful.

As shown in Table 1, there were no statistically significant differences in how many new practices women and men adopted (NumberOfTechs), or in their involvement in trialling new agricultural practices (ProjectInvolvement). There were however other differences:

- Men tended to adopt more new practices, but this difference was not statistically significant.
- Women tended to participate more often in trials of new practices, but this difference was not statistically significant.
- Women who adopted new practices more often reported that the adopted practices were useful, and this difference was statistically significant.
- Women who adopted new practices tended to adopt more practices than men, and this difference was statistically significant.
- A total of 17% of women who adopted new practices compared with 11% of male adopters reported to have entirely abandoned all their new practices, and this difference was statistically significant.

Table 1. Summary statistics on the differences in adoption patterns between men and women.

Summary Statistic	Women	Men	<i>p</i> -Value of Chi-Square Test
Percentage of respondents who have adopted at least one technology (% NumberOfTechs > 0)	43%	42%	0.06 .
Average number of technologies adopted (NumberOfTechs)	0.79	0.97	
Percentage involved in testing new practices (ProjectInvolvement)	48%	43%	0.17
Average number of technologies still being used (StillUsing)	0.93	0.88	<0.001 ***
Average number of useful technologies per adopter (BeingUseful)	1.9	1.5	<0.001 ***
Percentage of adopters who are using at least one useful technology (BeingUseful)	83%	89%	

Note: The chi-square tests are set up to test the hypothesis that men and women respond differently to the associated question. A *p*-value below 0.05 indicates a statistically significant result, i.e., the null hypothesis of no difference due to gender is rejected. The names of the variables in the statistical analysis are shown in brackets (as a reference to data reports in the repository). Statistical significance levels are indicated by stars where “****” means the highest level of significance with a $p < 0.001$. “***”, $p < 0.01$ and “**” means $p < 0.05$ and “.”, means $p < 0.1$.

As women tended to abandon new practices more frequently than men, we explore the reasons given for not continuing. Results in Figure 3 are in response to the question “Why did you stop using the technologies?” The multiple-choice options to answer were: (1) I did not stop. I am still using them (Still using); (2) I didn’t try any of them (Didn’t try); (3) They were not worth the effort (Not worth the effort); (4) The benefit was too small (Benefit too small); (5) I can use the time better by getting an off-farm job (Time better spent). The *p*-value for the chi-square test exploring whether women and men tended to respond differently to the question, “Why did you stop using the technologies?” was 0.07, which is statistically significant only at the 0.1 level, i.e., indicating a relatively weak association. As illustrated below, women more often tended to note that the benefits were too small to warrant continuous use.

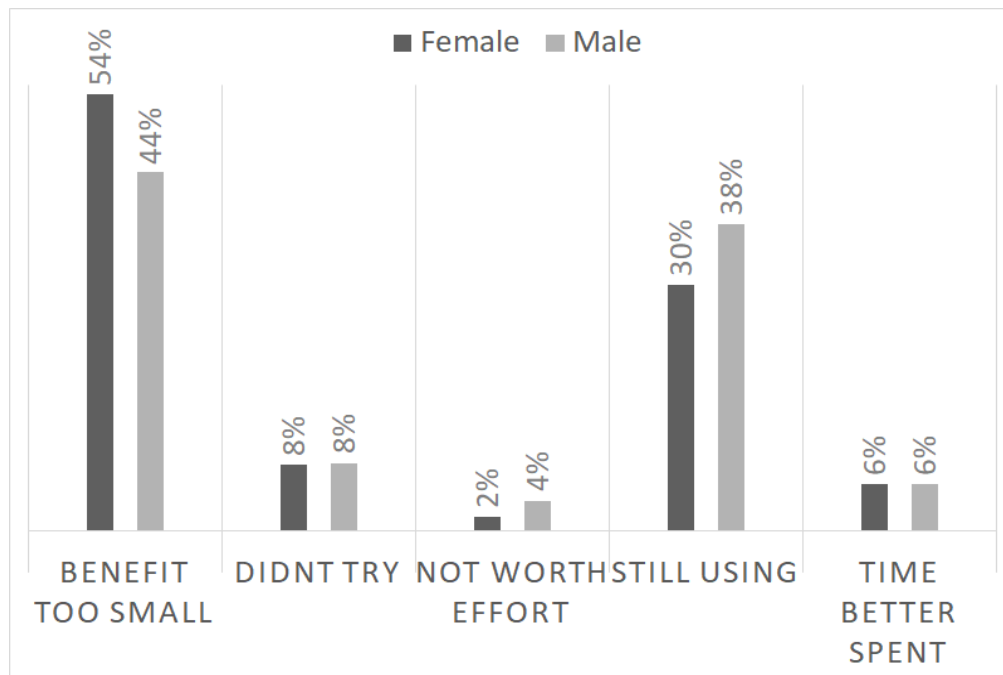


Figure 3. Stated reasons for no longer using an adopted practice (N = 745).

4.3. Gender-Related Differences in Strategy and Attitudes towards Rice Selling

When asked about which best describes the participants' strategy as a head of household, participants were presented with the following multiple-choice options based on our analytical nomenclature as well as survey descriptions:

Feed family: As head of the household I need to feed my family. I try to make some extra money from selling surplus produce. My farm is my priority.

- 1) **Maximize farm income:** As head of the household, I need to feed my family and make some extra money. I plan to have surplus rice for sale every year and I sell animals when I need extra money. Sometimes I get an off-farm job to make a bit more money.
- 2) **Maximize off-farm income:** As head of the household, it is my job to maximize labour time for off-farm jobs because this maximizes our income. It is not worth our effort to increase rice production much more than what we need to feed my family. Rice, animals, and cash crops are important, but off-farm jobs are the best way to maximize income.
- 3) **Not head of household.**

Whilst 172 (23% of all participants including 40% of female, and 12% of male participants) respondents answered "Not head of household"; amongst those who were able to respond to this question, there was a clear difference between female and male respondents. Male heads of households were much more likely to focus on feeding the family or maximizing farm income and were significantly less focused on maximizing off-farm income. In fact, whilst 65% of men had strategies that were primarily focused on farming (FeedFamily + MaximizeFarmIncome), 62% of women adopted strategies that were focused on maximizing off-farm income. Numbers are shown in Table 2.

Furthermore, individual participants were asked about their openness to change in their farming practices in terms of on-farm agricultural production decisions including rice, cash crops, small and large livestock, non-forest products; as well as off-farm income. As shown in Table 2, participants had the following multiple-choice options and responses (our analytical nomenclature as well as survey descriptions):

- 1) Modern farmer: I farm like most other farmers around here. There must be a very good reason for me to do something very different from what most other farmers do.
- 2) Pragmatist: I am interested in what other farmers do but if it suits me, I will do things differently to other farmers.
- 3) Traditionalist: I farm in the way that my parents and grandparents did. I do not want to change because farming in this way is part of who I am.

Small proportions of both men and women reported little openness to change (i.e., were traditionalists), but amongst the non-traditionalists the difference was more pronounced: women to a greater extent than men were pragmatists and men to a greater extent than women were modern farmers, indicating that on average women were more open to changing practices.

When asked about their attitude towards selling rice, as individuals, participants were given the following multiple-choice options and responded as per Table 2, with multiple-choice options being:

- 1) “Feed family: I am a farmer. I grow rice mainly to feed my family and sell any surplus.
- 2) Sell surplus: I am a farmer. I grow rice to feed my family and sell the surplus. I am always looking for opportunities to improve my income.
- 3) Entrepreneur: I am a farmer and entrepreneur. I grow rice to feed my family and for income. I am interested in anything that might help me make more money from growing rice.”

Table 2. Gender differences in farmer strategy, openness to change and attitude towards selling rice.

Question	Response	Female Respondents (%)	Male Respondents (%)
Attitude towards selling rice	Feed family	9%	12%
	Entrepreneur	65%	52%
	Sell surplus	27%	36%
Openness to change	Modern farmer	23%	29%
	Pragmatist	49%	42%
	Traditionalist	28%	29%
Household farming strategy *	Feed family	10%	19%
	Maximize farm income	27%	44%
	Maximize off-farm income	62%	36%

* This is the strategy perceived by the individual.

Figure 4. Shows the statistical levels of significance between the variables: openness to change in farming practices, gender, level of education and age.

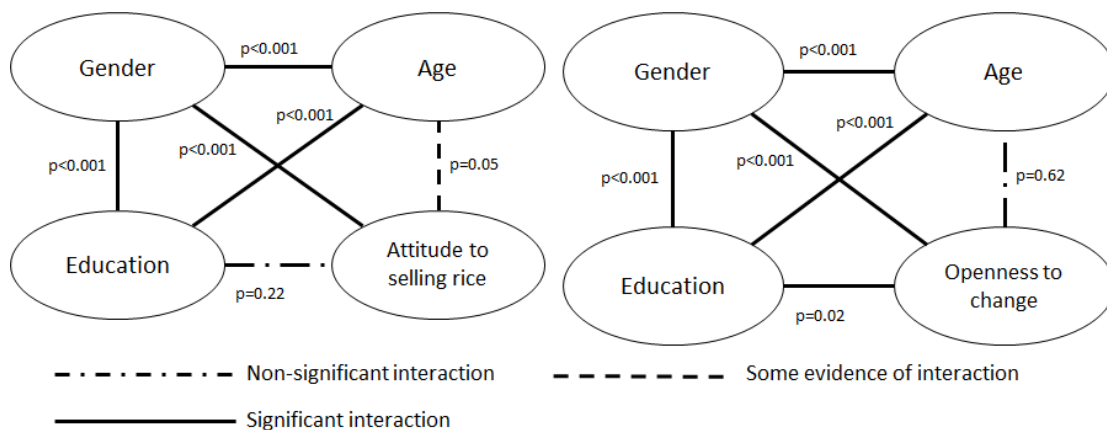


Figure 4. Chi-square based significance of the association of plausible causative factors for (a) openness to change farming practices and (b) attitude towards selling rice ($n = 745$).

4.4. Gender-Related Differences in Household Income

We explore the question of whether there are differences between men and women, if any, in the ability to generate income and engage with farming markets. To explore this, we (1) explore whether there are any gender-related differences in household income, and (2) which key factors that influence household income. Our results indicate that for most of the survey participants, agriculture serves the primary purpose of generating an income. The question we posed was: are household incomes influenced by gender? We explored associations of self-reported household incomes, as described in comparative terms by members of poor, medium-income and wealthy households, as well as other variables. Based on chi-square tests (Figure 5), we found that there was an association between education and household incomes but no similar association for age and household income. There was however an even stronger and statistically significant association between gender and household income (Figure 5) indicating that the difference was not simply based on education. This was the case even if the lower education levels of women may be a factor in women reporting lower incomes. These are unexpected results considering that female participants reported the income on behalf of their household—not their income—during the survey.

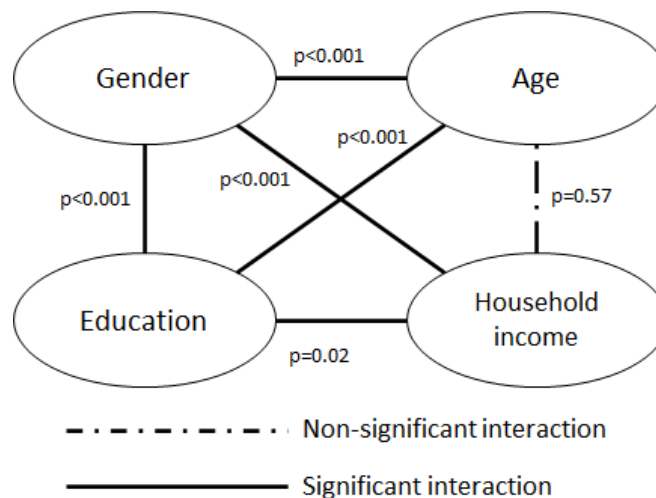


Figure 5. Chi-square-based significance of the association of plausible causative factors for household income.

Hence, we set out to further explore the association of gender, age, education and household income, employing chi-square tests to filter out the survey variables most strongly associated with household income. The following variables emerged with the strongest association (Table 3):

- 1) **Access to the market price for rice.** “I can easily get the local market price for rice”. Stronger agreement with this statement was correlated with a higher household income. This factor was significantly associated with gender, with women being more likely to disagree with this statement.
- 2) **Access to multiple buyers.** “If I want to sell rice, I have several buyers available”. An agreement with this statement was generally associated with a higher household income and vice versa. The average access to multiple buyers was not statistically different for men and women; however, a statistically significant larger proportion of women reported strong disagreement with the statement that they “have access to multiple buyers”, indicating a small but important group that was particularly vulnerable.
- 3) **Access to a fair price for seeds and other inputs.** There was a statistically significant difference between women and men in response to question “I know I pay a fair price for seed, fertilizer and pesticide”, with women more likely to agree with this statement.

- 4) **Priority for selling livestock.** “How much do you prioritize selling livestock?” A higher stated priority of selling livestock was generally associated with a higher household income and vice versa. Women reported on average a lower priority for selling livestock.
- 5) **Future-orientation.** “When I think about improving my farm the most that I look ahead is x”. Participants responded to timeframes from “this season” to “more than three years”. Individual future orientation was strongly associated with household income. The level of future orientation revealed an interesting set of nuances. Most men and women considered productivity benefits season by season, and rarely did participants consider benefits a year or two into the future. However, on average women reported a higher level of longer-term future-orientation (>3 years); and the individuals with this long-term view reported the lowest average household incomes. As many as 15% of women looked more than 3 years into the future, compared to only 6% of the men. On the other hand, men reported a higher proportion of future-orientation in the middle range of one or two years—and the individuals with such a future-orientation reported the highest average household income.

The differences in average priorities and *p*-value of chi-square tests against these variables are shown in Table 3. Average scores were based on converting Likert scales to numbers distributed in an equidistant manner between 0 and 1.

Table 3. Summary of gender differences in key variables from the survey that were found to be significantly associated with self-reported household income.

Question	Men—Average Score	Women—Average Score	<i>p</i> -Value (for Chi-Square Test Against Gender) ^a
Access to market price for rice	0.33	0.28	<0.01 ***
Access to multiple buyers	0.86	0.86	<0.01 ***
Access to fair price when selling rice	0.11	0.24	<0.01 ***
Access to a fair price for seed and other inputs	0.23	0.35	<0.01 ***
Priority of selling livestock	0.84	0.77	0.02 *
Future-orientation	0.63	0.84	<0.01 ***

^a **Note:** The chi-square test checks reported in this table are for gender-based differences in the distribution of responses across all the multiple-choice options, rather than differences in average scores. This means that for example, there is a clear gender-based difference in the distribution of responses to the question on multiple buyers, but no discernible gender-based difference in the average scores. Statistical significance levels are indicated by stars where “***” means the highest level of significance with a *p* < 0.001. “**”, *p* < 0.01 and “*” means *p* < 0.05 and “.”, means *p* < 0.1.

The attitudes and openness to change concerning farming have also been found to be statistically associated with household income. Household incomes of low, medium and high were translated to numerical scores of 0, 0.5 and 1. This allowed the calculation of average household income scores for different groups of participants. For example, farmers reporting different attitude towards farming and different levels of openness had markedly different average household income scores. For the various attitudes to rice farming, the entrepreneurs had the lowest average household income score (0.31), followed by modern farmers (0.32) and those reporting focus on feeding family had the highest average income score (0.47). In terms of openness to change, traditionalists had the lowest average household income score (0.31), followed by modern farmers (0.32) but the pragmatists had the highest average score (0.37).

In an attempt to remove confounding variable effects, we then explored the combined influence of previously discussed factors on household incomes in a linear regression model. The summary

results of the generalized linear model calculated in R (family = Gaussian, link = identity) are shown in Table 4. The model was applied at the level of individual responses.

Table 4. Summary of logistic regression analysis of key variables.

Factor	Estimate	Pr (> t)	% of Deviance Explained
Future orientation	−0.18	2.27×10^{-5} ***	2.9%
Access to multiple buyers	0.067	0.014 *	2.4%
Access to market price	0.054	0.033 *	0.7%
Household farmer strategy: Max. farm income	0.080	0.027 *	1.7%
Household farmer strategy: Max. off-farm income	0.058	0.10	
Household Farmer strategy: Feed family	0	N/A	
Openness to change: Pragmatist	0.017	0.53 .	0.7%
Openness to change: Modern farmer	0	N/A	
Openness to change: Traditionalist	−0.043	0.14	
Attitude towards selling rice: Feed the family	0	N/A	0.6%
Attitude towards selling rice: Sell surplus	−0.066	0.069 .	
Attitude towards selling rice: Entrepreneur	−0.11	0.0030 **	
Gender: Male	0.053	0.032 *	0.5%
Gender: Female	0	N/A	
PriorityFarmIncome	−0.092	0.029 *	0.4%
PriorityOffFarmIncome	0.060	0.078 .	0.4%
PriorityLivestock	0.0018	0.96	0%
Education	0.0144	0.61	0%

Note: The dependent variable in the logistic regression model is the income score (high = 1, medium = 0.5, low = 0) and the independent variables were categorical variables (farmer strategy, openness to change, attitude towards selling rice, gender) and numerical variables based on the conversion of Likert-scales (for access to multiple buyers, access to the market price, future-orientation, priority to farm income, off-farm income and livestock; and education). Pr(>|t|) refers to associated *t*-test of the multinomial regression analysis and represents the level of significance of the independent variable's contribution within the model. Statistical significance levels are indicated by stars where "****" means the highest level of significance with a $p < 0.001$. "****", $p < 0.01$ and "***" means $p < 0.05$ and ".", means $p < 0.1$.

We found that gender is correlated with household income. However, the gender-related effect was also linked to several other factors, namely, future orientation; inequitable access to market relating to having access to multiple buyers and being able to sell rice at market price; differences in farming strategy (maximizing farm income) and an entrepreneurial attitude towards selling rice. A focus on farm-income was correlated with a lower household income.

5. Discussion

In this paper, we have explored gender dynamics and household decision making in the context of agrarian transition. It is clear from our research that there were several important differences in how men and women approached the agrarian transition that is currently underway in Lao PDR. The apparent differences relate to several behavioural areas, as discussed below.

5.1. Gender-Related Differences in Education Level

In the villages that were surveyed, we found that low levels of literacy were common. Furthermore, women reported significantly lower levels of education, with nearly half the female participants being illiterate. This is consistent with the literature, where it has been found that poor education and low literacy of women is also linked to unequal access to benefits and opportunities, reinforcing rural women's lower levels of confidence [25]. de Schutter [54] argues that lower education

levels of women also imply they are more constrained in their capacity to abandon agricultural work and seek waged employment on large farms or find income-generating activities in other sectors. Low education and low literacy amongst women also indicate structural disadvantage because it limits their access to information and services [25].

5.2. Gender-Related Differences in the Embrace of New Practices

Adoption has been described as the decision to utilize innovation, often by iterating through several phases towards adoption [55]. Feder, et al. [56] have discussed the theoretical models that have traditionally been used to explore adoption. In sociological research, an individual's choice to adopt arises from the potential adopter's attributes as well as the perceptions about the innovation, as well as the learning and communications that occur as part of deciding to adopt [57]. In line with this, the chance of adoption is a function of the individual's attributes, the attributes of the innovation and the context [58]. Reimer, et al. [59] found that farmers can be influenced by a series of attitudinal factors that can promote adoption behaviours. These factors may include the presence of individuals who promote change, general attitudes towards change, what people believe about the technologies and farming, and what the farmers want to achieve. Differences in commitments and personal assumptions all may influence changes in sectorial practices as well as farmers' choices to adopt new practices [26,60–62].

In our analysis, there were surprisingly few differences between men and women in terms of the number of new practices that participants had adopted, or their participation in agricultural research projects. However, further exploration revealed that the way men and women adopted technologies and practices was significantly different in terms of (1) the extent to which women and men kept using technologies, with women more likely to abandon new practices; and (2) women represented a larger proportion of “super adopters” who had adopted four or more technologies. Men were generally more likely to accept technologies with only marginal benefits for farming and were more commonly single outcome optimizers, whilst women tended to focus on the bigger picture, implying that they were more concerned about how the adoption of these technologies detracted from their other activities. When asked why women abandoned the technology, the dominant reason was that the benefits were considered too small, or, in other words, that the benefits did not justify the cost in terms of effort and labour. When women are also keen to engage in off-farm income generation or agriculture of alternative crops, it is not surprising that they were more likely to abandon technology, as we have found in our data. It is worth considering whether men and women adopt different types of technology and whilst we did not collect specific data in our survey, we recommend that this issue be explored in the future. Our data also suggest that it is likely that men and women have different drivers for technology adoption and thus might be drawn to different types of technology. A key decision-making driver, for which there is likely to be a gender-based difference, is the general concern for labour expenditure [34]. Given women's greater focus on off-farm income, it is likely that they see new practices in agriculture requiring additional labour in terms of the opportunity cost of other choices of activities such as generating off-farm income.

Finally, we reflect on experiences during the research team's gaming activities [52] focused on growing rice for export into the Chinese market [63]. Findings indicated that women were more likely to experiment with new technologies until they found the best combination to achieve maximum income, whilst men were generally slower to change their practices and therefore slower to increase their income. We posit that the explanation that best fits our data is that women have a less emotional attachment to traditional farming practices and are more open to generating farm income in more non-traditional ways. This aligns with data from our survey which show that women were significantly more likely to be pragmatists, as seen by high responses to the openness to change question in the survey (i.e., they chose the option “I am interested in what other farmers do but if it suits me, I will do things differently to other farmers.”). These results echo the uneven power relations that are associated with traditional gender roles in agriculture in many parts of the world such as Africa and Eastern Europe, where men maintain power and control over the farming activities whilst women's

contributions are primarily with housework [64]. Women's agricultural contributions tend more be seen as 'just helping' and therefore become under-valued, and where they instead usually undertake time-consuming labour such as weeding and planting rather than male tasks such as using machinery or ploughing fields (this was often observed during the project fieldwork).

5.3. Gender-Related Differences in Livelihoods Strategy and Attitudes towards Farming

Subsistence farming was the preferred livelihood strategy for fewer than 20% of men, and 10% of women; indicating that there is an existing widespread aspiration for a transition to a modern agricultural economy in Lao PDR. We found that women and men in the case study villages tended to have different priorities regarding the best strategy for households to improve livelihoods. Whilst nearly two-thirds of women preferred to focus on maximizing off-farm income, nearly two-thirds of men preferred to focus on either growing rice for subsistence or maximizing the income-generating capacity of their rice farming activities.

Our interpretation is that the gendered approach to livelihood strategies is likely to reflect power dynamics, given that rice farming is primarily a male occupation, where men are responsible for ploughing and using machinery, and where female contributions such as weeding and planting are mostly seen as secondary tasks. Thus, men continue to earn more status from farming and hence assign greater intrinsic value to traditional farming practices. We, therefore, propose that there is a need to better understand the gendered livelihoods implications of shifting away from traditional rice-based agriculture and suggest that further, highly targeted gender-based research in this area would benefit policymakers, extension staff and agricultural researchers. Women's focus on maximizing off-farm income is likely to be just one manifestation of the broader transformative change. Rapid industrialization and ensuing economic migration have driven social changes in gender roles, identity, and status [31]. Women have historically been unpaid family workers in rural villages due to government restrictions on how farmers can move between the regions and cities, as well as the traditional limits on female movement which occurs both in matrilineal and patrilineal ethnic communities [31].

It is also known that power dynamics can change when non-traditional farming activities involve women as seasonal paid-labourers [43]. For example, coffee-production with many inclusive activities has improved livelihoods and purchasing power for women, as well as increasing their self-esteem and enhancing social reputations [43,44].

Now, more than ever, higher status is being afforded to women who perform industrial or service work or who have become self-employed traders in urban areas. Women's migration can be seen as an economic survival strategy, and through commitments to rural kin and communities, remittances can afford education or improved household livelihoods [31]. However, for women, economic independence may be short-lived when marriage leads to a loss of independence and a return to traditional gender norms and family obligations [31]. Besides, women's economic independence might precipitate broader social and cultural change. Districts that are bordering other countries in Lao PDR are particularly subject to migration and assistance through remittances to increase living standards [35,65,66]. Young adults aged 20–35 years tend to be the most mobile group, migrating for economic gain, or for education, as well as in response to family movement and marriage [67]. Thus, another important aspect of out-migration is a reduction in available farm labour. In many parts of the world, this increases pressure on women to play a greater role than ever before as food producers [54]. From our results, it appears that women in southern Lao PDR may be reluctant participants in maintaining traditional lifestyles and are looking for more income-generating opportunities to improve overall livelihoods.

5.4. Gender-Related Differences in Economic Outcomes and Access to Market

A rather complex picture of the interplay of factors emerged from our explorations of perceptions of household wealth position and income. Overall, it appears that women face greater challenges when engaging in the farming marketplace. For example, women reported having less access to multiple

buyers when selling rice, yet this was among the most significant factors shown to influence the household income level. On the other hand, women reported greater ability to get the market price. The importance of poor access to multiple buyers when selling rice reflects observations that there is often a monopsonist market in Lao PDR [38]. The insufficient levels of competition combined with government influence mean that traders generally control the price and the market. Self-reported future orientation and attitude towards entrepreneurship also played a role in influencing wealth and income discrepancies. We suggest that valuable insights could be gained from further research into gendered decision-making and attitudes in terms of not only agricultural production and income, but also impacts of other factors on agricultural change. Although a range of factors influences household incomes, there appeared to be a residual ‘gender effect’, meaning that even after accounting for other factors, there was an unexplained effect that is simply associated with gender. Therefore, if we are to truly understand the dynamics of change, any future studies need to be sensitized to gender factors. Additionally, there is a need for studies that explore barriers (including lack of motivation) for women to engage in the seemingly male-dominated rice markets. If possible, new mechanisms should be developed so that households can more easily access a fair market price for their agricultural products. These mechanisms should be available to all, not just the women and not just the men.

We also note that land ownership, which may be an important factor in other contexts, is unlikely to be as important in Lao PDR. In Laos, the land belongs to the population as a whole, the state administers the resource and the people can access the land-based on certain land-use rights [39].

Another key result in our data was that those with a more entrepreneurial mindset towards rice farming have reported the lowest household incomes, whilst those with a more straightforward goal of feeding the family, reported the highest household incomes. This is an unexpected result, but it aligns with anthropological research in other parts of the world where it has been found that economic pressures have been associated with the adoption of new agricultural practices through positive feedback loops, as exemplified by the ‘technology treadmill’ described by Luna [68]. The concept of a technology treadmill is also consistent with our field observations and experience. The mechanism of the technology treadmill is that increasing debt associated with the adoption of new technologies leads to the need to increase agricultural outputs which, in turn, leads to labour shortages that can best be addressed by the adoption of new practices [68]. However, easing such financial pressures by increasing agricultural productivity tends to require a further investment which perpetuates the cycle. This cycle of debt and an ever-increasing need to increase productivity through the adoption of new practices is intensified by the transition to a market-based agricultural economy and may be undesirable to both men and women. However, as found in our survey, women may resist more strongly as they place less importance on, and have a less emotional attachment to agricultural lifestyles. Apart from distinctly different livelihood strategies, the technology treadmill may provide a further explanation as to why men and women have different technology adoption profiles. This may also explain why households were often commonly found to prefer remittances and wages to secure their livelihoods rather than investing in new technologies, crops or production methods [33,34]. This was particularly so if there were considerable risks associated with agricultural investments [26,51].

An alternative explanation for this result may be that Lao women farmers are aware of a key role they may play in the agrarian transition, as they seek opportunities to be incorporated in non-farm sectors of the economy, as occurs in Thailand [69]. Rather than driven by the technology treadmill, [69] posits that rural households (in Thailand) can combine rural and urban livelihoods, by keeping family farms for subsistence production of rice and goods while taking up opportunities, should they arise, for non-farm work and integrating subsistence and commercial livelihood activities. Similarly, [70] p. 87 sees the family farm in Vietnam as an “adaptive pivot between the past and the future” as rural farmers adapt to changing circumstances, confronted by “transformations in land laws, family dynamics, working opportunities, infrastructure, and education”. Peasant farmers continue to have strong ties to their land and balance their kinship responsibilities and relationships with emerging off-farm opportunities [71].

5.5. Implications of Our Results for Research and Policy

The introduction of new technologies may alter and possibly interfere with gender-related power relations. The literature tells us that women may act as gatekeepers within their households to protect their traditional roles and standing in the household [71]. In the context of Lao PDR, if such gatekeeping is present, it may involve a tendency to be protective of female domains and undermine activities that reduce their control over those domains. New technologies may also burden women in a way that detracts from generating alternative income and producing other benefits for the household (negative labour productivity). New technologies introduced through poverty reduction programs may cause suspicion and disillusionment and influence uptake due to inter-cultural responses involving doubts about the intentions of policies and planners involved [72]. Another likely key factor is that women's access to information is confined by low literacy rates. The direct, indirect and opportunity costs to households and different household members, therefore, need be considered, as well as the fact that the decision-maker in the household may or may not consider the interests of other household members. Yet, women and men are making different decisions on their income priorities. Thus, when introducing new technologies, there is a need to be cognizant of the impact on women and other businesses, including more attractive livelihood options. There is an opportunity for researchers and decision-makers to explore how the innovation interacts with other household activities, i.e., to look at households more holistically and with the gender lens. The issue of migration and resulting labour shortages and increased opportunity costs associated with the uptake of new agricultural practices also need comprehensive consideration from a gender perspective. Our findings indicate that men are more attached to farming as a part of their identity. Thus, attention should be given to specific measures to help men cope with the rapid and transformational change in farming systems and practices [73].

6. Conclusions

In the context of agrarian transition amongst smallholder farmers in Southern Lao PDR, this paper explores differences in how women and men embrace new technologies, their preferred farming strategies and their capacity to engage with modern markets. The most important difference relates to livelihood strategies and we found that women tend to focus on off-farm income, whilst men tend to focus on rice-farming. Both men and women adopt new practices at a similar rate, but women tend to abandon technologies more often, and on average female adopters tend to adopt more practices. There are indications that women to a greater extent tend to evaluate the new practices in terms of their potential negative impact on labour productivity or off-farm income opportunities. The marked difference between male and female education and literacy could also very well be a factor in accounting for the different outlooks revealed by our study. Men tend to engage more strongly with rice markets and generally gain more reward from doing so, as they, on average, report higher incomes. The complex reasons for perceptions of lower household incomes by females include having less access to multiple buyers for their produce, having generally lower education levels, a different pattern of future-orientation, a greater openness to change, and focus on different livelihood strategies. However, even after all these factors are accounted for, there is a gender-based effect which shows that women may not have equal opportunity in the primarily male-dominated rice markets. We have shown that the introduction of new technologies influences livelihood strategies and possibly gender-related power relations. We argue that the current changes to agricultural systems and increased commercialisation strongly interact with gender dynamics in the household and, hence, international development agencies and local governments need to be cognizant of the gendered complexities when introducing change. We have presented an exploratory gender study, highlighting several knowledge gaps and complexities associated with the gender implications of agrarian transition.

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