Rice farming systems in Southern Lao PDR: Interpreting farmers' agricultural production decisions using Q methodology

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Highlights

- Visual Q methodology techniques have been adapted to explore smallholder rice farmers' propensity to adopt technologies to improve productivity based on their production goals.
- The analysis revealed Lao farmers view their productivity largely through two key viewpoints: 'labour saving productivity maximization' and 'traditional labour productivity using improved techniques'; two positions that represent an array of issues currently guiding production decisions among farmers.
- Substantial increases in rice production and agricultural sector transformations require inputs of specialized support for farmers, tailored to their livelihood and production goals.
- Scientists, extension workers, farmers and policy makers could all benefit from shifting the focus of attention away from conventional preoccupations with *introduced technologies* towards *users*' dispositions, perceptions and preferences.

ABSTRACT

The agricultural sector in Lao PDR is forecast to move from subsistence rice production to a more modernized and market-oriented sector with greater focus on commercialization of agricultural production. Intensification of agricultural production in the southern and central rice growing regions of Lao PDR is problematic as dryland farmers rely on rainfall and soils are poor, yet rural households have been experiencing rapid change in their farming and livelihood systems. This paper employs Q methodology techniques to explore 35 farmers' viewpoints when contemplating their production goals and potential to adopt technologies to improve productivity. Findings describe the two emerging viewpoints among farmers as 'labour saving productivity maximization' and 'traditional labour productivity using improved techniques'. The two viewpoints describe the different issues currently guiding production decisions. While the Lao Government forecasts substantial increases in rice production in the southern plains, farmers will require specialized and tailored support, accounting for their envisaged livelihood and production goals, to allow the sector transformation that many stakeholders currently envisage.

Key words: Q methodology; farmers' viewpoints; Lao PDR; agriculture; attitudes

1. Introduction

In South-East Asia, rice based farming systems underpin rural livelihoods. Rice intensification to improve farmers' livelihoods, maintain food security and for export has been on the forefront of government policies. While some South-East Asian nations currently aspire toward rice intensification with multiple annual crops, market-linked diversification and off farm opportunities may prove to be more sustainable transition pathways to improve farmers' livelihoods, maintain ecosystems and protect human health (Berg et al., 2017; Condon, 2017; Pittock and Nguyen, 2017). Lao PDR is a country primarily focused on agricultural production, with 78% of the population contributing to agricultural production (MAF, 2015 p1). Over a quarter of the population is still considered to be living in poverty with urban incomes increasingly exceeding rural incomes (Lao Statistics Bureau, 2014). Although overall poverty continues to decline, two thirds of the population lives on less than two dollars purchasing power parity (PPP) a day with all human development measures, still lagging behind most other countries in Asia (Belloni, 2014) .

The country is following general agrarian trends in South East Asia with ambitions to transform from subsistence rice production into a more modernized and market-oriented sector with two rice cropping seasons per year, an increase in the area of paddy production and more dry season cropping (MAF, 2015). The Lao government anticipates that paddy rice production will increase in selected rice growing provinces by an average annual growth of 5% to 2020 through cropping expansion, using selected varieties and improved yields (MAF, 2015 p9). By 2025 the Ministry of Agriculture and Fisheries (MAF) also envisages increased volumes of cash crop production such as maize, coffee, sugarcane, cassava, beans, roots and tubers, fruit and other crops and vegetables MAF, 2015 p10). To meet the Crop Sector's 2025 Vision and Development Strategy's goals, detailed regional action plans and incentive policies have been developed (MAF, 2015). While the Lao government plans for intensification of agricultural production, supported by the international aid community, risk averse subsistence smallholder farmers are contemplating their production goals and returns to labour productivity (ACIAR, 2017; Goto and Douangngeune, 2017; Larson and Alexander, 2016).

The agricultural production environment in the southern and central rice growing regions of Lao PDR is in general, harsher than the fertile lowlands of other countries in the region. Soils are generally poor, often becoming waterlogged during the wet season, and three-quarters of the agriculture is rainfed (Denton and Bell, 2014; Vote et al., 2015). The predominance of rice-based farming systems on infertile, poorly structured soils means that current agriculture has rather low productivity on both a labour and a land area basis (Denton and Bell, 2014). In addition, dryland farmers are experiencing climate variability, with floods and droughts, adding to their burden of risk (Roth and Grunbuhel, 2012).

Many rural households have been experiencing rapid change in their farming and livelihood systems. Rural households have been adopting individual livelihood strategies, diversifying production and maximizing labour productivity, with migration and remittances becoming attractive alternatives (Alexander and Larson, 2016). Agricultural diversification strategies are available to farmers, as international organizations provide specialized advice on non-rice field crops, horticultural crops, ways to improve rainfed cropping and information on raising ruminant livestock (Clarke et al., 2016; Manivong et al., 2014; Newby et al., 2013; Vote et al., 2015).

In theory, adoption of technical innovations and interventions provide a mechanism for smallholder farmers to improve household livelihoods, food security and achieve farm productivity goals. Adoption of technical innovations is more likely if the use of inputs increase overall productivity for smallholder farmers without requiring excessive labour demands (Berkhout et al., 2015). Larson and Alexander (2016) describe the new technologies and agricultural practices that have been generally introduced to smallholder farmers in southern Lao PDR, such as: drought resilient rice and crop varieties; use of appropriate inputs (e.g. varieties, fertilizer, time of planting, etc.); direct seeding of rice to reduce the labour requirement for planting; weed management; efficient irrigated water use; and more appropriate dry-season irrigated crops. Cash crops such as maize and grain legumes (mung bean and/or soybean) have also been introduced to sites with reliable irrigation. Extension systems have been targeted to scale out knowledge-based technologies such as new rice varieties and livestock and water management techniques. Projects have also been dedicated to developing effective and supportive agricultural policies for rice-based farming systems. Yet despite these positive scientific developments and support networks, smallholder farmers are not always taking advantage of the opportunities and adoption rates are disappointingly low (ACIAR, 2014; Cramb, 2015; Stür and Gray, 2014).

When farmers contemplate adoption of new technologies and management innovations their decision making processes are influenced by many factors including; economics, politics, technology, social tradition and the biological environment (Feder et al., 2011; Jobard, 2010; Manivong et al., 2014; Sacklokham et al., 2017; Srisopaporn et al., 2015). In this complexity, farmers' decision-making has been approached by investigating attitudes, values and behaviours known as the behavioural approach (Davies and Hodge, 2012). Farmer typologies and farming styles have also been developed as constructs to view farmers' behaviour, attitudes and values (Fairweather and Klonsky, 2009). Sulemana and James Jr. (2014) and McGuire et al. (2015) have explored farmer 'identity' through their attitudes to ethical issues and responses to the social and biophysical environment. However, it is difficult to determine how a farmer will respond to competing motivations within their farming systems, in terms of their preconceived 'identity' and their attitudes, values, behaviours. Davies and Hodge (2012) have used Q methodology to explore combinations of attitudes in situations of competing motivations to describe farming styles, to gain insight into farmer decision-making.

The primary objective of our research project was to identify the drivers and constraints affecting smallholder farmers' decision-making when considering introduced technologies.This paper reports on a bilingual Q study of smallholder farmers' shared viewpoints of possible diversification strategies smallholder farmers may be considering as ways to enhance their livelihoods. The paper proceeds as follows. We begin by outlining the research design and study site and introduce Q methodology, used to explore the complexities of farmers' shared viewpoints on production decisions. Q methodology was employed in order to shift emphasis away from the actual technology, and, instead, give privilege to the perspectives of potential users. We then discuss the process of applying Q Sort and analysing data generated by this method. The emergent findings are based on narrative descriptions. Although wet season rice paddy production is farmers' primary concern, different issues guide their production decisions and we show these to be underpinned by two distinct narratives. We designate these two viewpoints as follows: 'labour saving productivity maximization' and 'traditional labour productivity using improved techniques'. Finally, we conclude by reflecting on the implications of our findings for Lao government policy.

2. Research details

In response to lower than expected adoption rates of new technologies by smallholder farmers in southern Lao PDR, a study was commissioned by the Australian Centre for International Agricultural Research (ACIAR)[1] to better understand conditions influencing farmer decisions on the adoption of new technologies. Research activities involved a review of the literature, focus group discussions, interviews, surveys, Q methodology, a Bayesian Network and agent–based modelling activities. Findings about the issues surrounding adoption of new technologies were synthesised from the qualitative and quantitative research exercises undertaken by Lao and Australian research teams in February and May 2016 Alexander and Larson, 2016; Alexander et al., 2016; Greenhalgh et al., 2017; Moglia et al., 2016). Villages in predominantly lowland rice-growing agricultural systems in southern Lao PDR and with recent agricultural projects, 10 in Savannakhet Province and 10 in Champasak Province were purposively selected as research sites in southern Lao PDR. In the sampled villages, rice production and livestock were the main sources of sustenance and income, with production of crops, vegetables and fruit also contributing, as well as remittances, wages and sources of off-farm income. While rice, vegetables, maize and cassava were grown and sold commercially, all villages had significant numbers of villagers working outside the village.

When interrogating the qualitative data from the overall research activities on the two regions, Savannakhet and Champasak Provinces, several similarities and differences were noted. Generally, farmers in both areas were interested in improving rice productivity with new seed varieties and fertilizer, improving soil conditions and improving livestock productivity. Notably, farmers expressed an interest in improved vigorous seeds that would yield palatable rice of high quality, disease resistant, with good qualities of aroma, shape, and with good milling characteristics. Higher quality rice resulted in higher returns. The local District Agricultural and Forestry Officers (DAFO)- the 'front line' of government support for smallholder farmers in Lao PDR-were often the source of information and worked with international agencies to supply new technologies and technical information.

Champasak Province participants were more engaged in generating cash income, markets and non-agricultural activities to generate income and hence Champasak participants were generally more concerned about access to markets to sell their agricultural produce. There was less water available in Champasak Province and, as a consequence, fewer people were interested in dry season cropping in this area. Water efficient methods of cultivation or ways to find water for paddy land to grow other crops, and ways to prevent evaporation for dry season cropping were more important to Champasak farmers.

Alexander and Larson (2016) provide demographic and production details recorded during the study. Households of an average of 6 people were producing on areas of 2.2 to 4.5 hectares (Ha). All farmers produced wet season rice with average yield of 3.1 tonnes/Ha across the two Provinces. Limited dry season rice production took place. Surveys, interviews, focus group discussions and ranking exercises were conducted in the villages to elicit information on statistical trends and to provide rich descriptions and more specific explanations where necessary. In addition, we conducted an exercise involving Q Methodology to understand the viewpoints or mental frameworks that

[1] ASEM/2014/052 'Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints'

farmers were using when making decisions on farm productivity and the findings are presented in the form of shared narratives.

3. Using Q methodology: a novel approach to understanding agricultural production decisions

Q methodology can be used to elicit a variety of accounts or discourses about or around a particular discourse domain, theme, issue or topic (Stainton-Rogers, 1995). Q methodology allows for perspectives on a given issue to be grouped into typologies, representing different frameworks within which decisions and attitudes towards that subject are typically formulated (Browne et al., 2008). The number and variation of typologies can indicate whether ways of thinking about an issue are diverse and complex, or homogenous and aligned with popular conceptions. Q captures 'the way a particular individual, in particular circumstances and at a particular time, relates to, and forms conceptions of, certain aspects of the world' (Barry and Proops, 1999 p338). Upon interpretation, these shared subjectivities have the structure and form of a discourse or shared narrative (Brown, 1986).

Ways of thinking about a topic are captured in a diverse range of items which participants Q-sort by ranking on a continuum, from most important to least important, from their point of view. These items – termed the 'Q-set' – can be textual or visual and are gathered by the researcher from a 'concourse' of communicable information on the topic of study. The concourse aims to be representative of the range of viewpoints on the topic. From this, the 'Q-set' is selected for sorting by participants. Q methodology uses factor analysis to establish emerging patterns of thinking within and across individuals, unlike standard survey analysis that establishes patterns across individual traits, such as gender, age, class, etc. (Watts and Stenner, 2012).

Q Methodology comprises six steps: (1) define the research question; (2) design the Q-set of statements/photographs; (3) select participants; (4) administer the Q-sort; (5) conduct a factor analysis using specialized Q software; and (6) interpret the qualitative meaning of the factor structure, by developing accompanying narratives (Stevenson, 2015).

3.1 Research Question

The research question arose from the need to interrogate smallholder farmers' productivity and lifestyles, in the context of Lao government policies to increase productivity and improve livelihoods (Ministry of Planning and Investment, 2016). The form that the statement would take was discussed in detail with Lao researchers and modified from English language into a statement that Lao farmers would likely understand and tested in the pilot village. The following statement was read to participants in Lao language: "*This study is about your farming lifestyle. We are interested in what might <u>be important</u> for you to have a better household income and living improvements".*

3.2 Designing the Q-set

In this study we used photographs as the preferred method to engage semi-literate Lao farmers (Bumbudsanpharoke et al., 2010; Forouzani et al., 2013; Hardy and Pearson, 2016; Naspetti et al., 2016; Watts and Stenner, 2012; Zanoli et al., 2015). We relied on previous research, a review of the general literature, a review of ACIAR project documents and Lao government documents outlining government directives and agricultural investment and planning, to construct the concourse and select the Q-set (Previte et al., 2007; Swaffield and Fairweather, 2000; Van Exel and de Graaf, 2005;

Watts and Stenner, 2012). Representative photographs reflecting Q-set statements were finalized after discussions with Lao and international in-country researchers. Hardy and Pearson (2016) provide an example of the use of photographs in their Q study, and claim that by presenting the same picture, a standardized 'question' is presented to the participant for interpretation (Jacobsen, 2007. In all, 16 photographs were selected representing many of the options that farmers could introduce into their farming systems or use to improve their livelihoods. We chose 16 photographs, to avoid complexity and confusion and to fit a quasi-normal distribution (Figure 1). Random numbers were assigned to each of the photographs to facilitate data recording. Following Jacobsen (2007), we developed proxy statements for each photograph, seen in Table 1 below. A pilot study was conducted in one village to ensure that the Q-set was representative and to practice the method. The analysis did not include this data.

3.3 Selecting Participants

Seventeen farmers (9 males/8 females) from 10 villages in Savannakhet Province and 18 farmers (10 male/8 female) from 10 villages in Champasak Province in southern Lao PDR were selected specifically for this project activity from groups of villagers who attended the research activities. In each village two villagers, one of each gender, were approached and asked in Lao language if they would contribute to the research activities. Selection was based on advice from village leaders and Lao district officers. The main criteria were that participants were village residents, and of various ages and ethnic groups. Selected participants ranged in age from 25 to 66 years, were largely from the Lao Loum ethnic group, with 6 participants from Mungkong, PhouThai or Suay ethnic groups. Education levels ranged from no schooling (9%), primary school (48%) and secondary school (38%) and high school diploma (5%).

Q methodology typically utilises small participant numbers. The recommended number of participants for a Q study varies in the literature, with Watts and Stenner (2012 p73) suggesting a ballpark figure of around 40, whilst others emphasize the number of participants should be proportional to the number of items in the Q-set (e.g. (Webler et al., 2009). However, Brown (1980) suggests that there need only be sufficient diversity in the participants to establish the existence of shared viewpoints. Therefore our total participant sample (N= 35) is within the acceptable parameters of Q methodology.

3.4 Administering the Q-sorts

Q-sorts were carried out face-to-face with selected participants during research exercises at each village. Q-sorts were conducted in Lao language by a Lao and an international researcher fluent in Lao language. Throughout the sorting process discussions elicited participants' reasoning about the importance of each photograph to their vision of their future livelihood. Researchers read instructions to participants to guide them through the exercise in a step by step process (Alexander et al., 2016). Researchers responded to questions and recorded notes as the participant assessed the photographs and sorted them into priority piles: a pile for statements the participant found very important, a pile for cards the participant tended to find not important and a pile for cards about which the participant held neutral opinions. All cards were then transferred onto the board provided in a form of ranking exercise known as a Q-sort (Figure1). Interactions between researchers and participants were fluid throughout the process. Where participants had difficulty in placing photographs researchers assisted with further explanations and provided clarification. In particular,

participants were asked to explain how they felt about the statements they had ranked at most important and least important (i.e. to explain the most important and unimportant photographs representing their livelihood goals) (Stevenson, 2015). This allowed for rich descriptions of participants' experiences, adding to the research narratives. The Q-sorts took under an hour to complete. The Q-sort with notes was photographed and final observations recorded.

Table 1 Q-Sort statements and corresponding photographs

Q-Sort Statements	Corresponding photographs
Livestock /Raising livestock (all types) Raising livestock, not just pigs but all animals, cattle, buffalo, goats, chickens, etc. to give the family income (i.e. emphasising income rather than for draft or consumption)	
Staff/Staff (District Agricultural and Forestry Officers (DAFO) or project staff) to advise farmers on production techniques e.g. Dry Season Machines, fertilizer, vegetable crops, forages	
Off-farm work away from village (factories, construction Thailand etc.)	
Improved variety of rice seed for high yielding rice crop	
Vaccination of all livestock cattle, pigs, chickens- to prevent disease and loss.	
Cash for use in agriculture production inputs-for production, things you would like to do or improve	

Mechanical harvester to save time and labour harvesting rice	
Markets purchasing farmers' agriculture produce; rice, vegetables , livestock	
Soil/Planting of legume crops to improve soil condition or fertility and harvest legumes	
Chemical fertilizer for rice and other crops to improve yield	
Forages or grasses planted for use as feed to cattle when not enough feed or to fatten	
Non-agriculture activities in village, e.g., selling goods form shop, furniture making, selling labour, remittance	
Dry season vegetable crops for consumption or sale for household income	
Dry direct seeding machines to save labour and or time when transplanting rice	

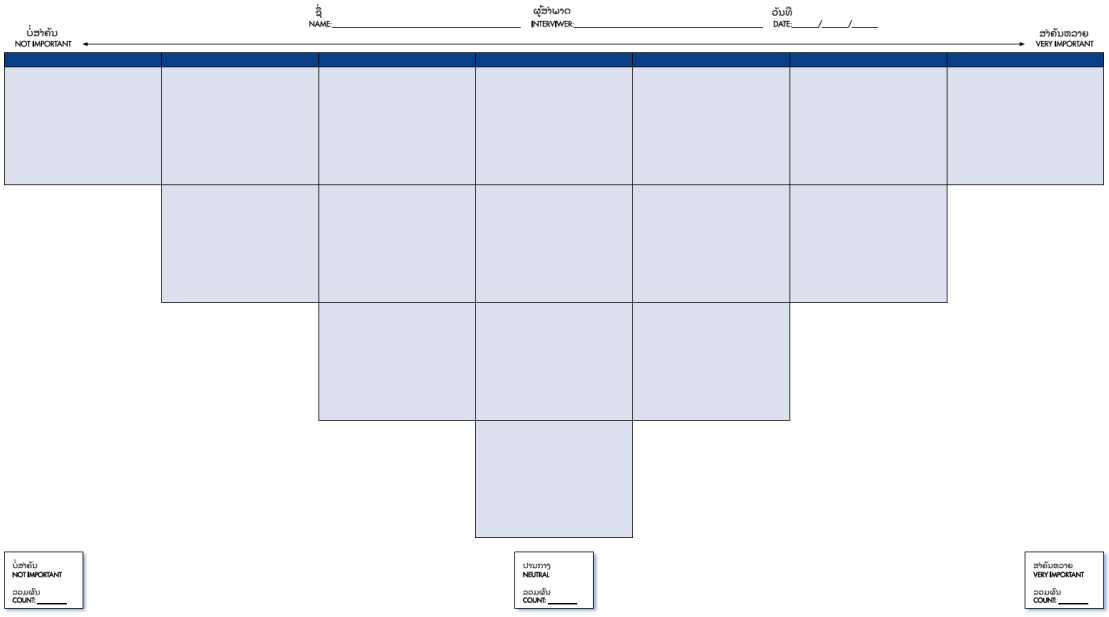
Dry season cash crops such as maize, beans, etc., to sell for income	
Water/Water efficient methods of cultivation Ways to find water in paddy land to grow other crops, and ways to prevent evaporation so you can grow a crop in dry season	

Source of Photographs: International in-country researchers Dr Tamara Jackson and Dr Camilla Vote provided many of the photographs in Table 1. The photographs represent new technologies introduced through their project activities commencing in 2005.

A forced frequency distribution -an inverted normal or quasi-normal distribution (Figure 1) board - was used to place the 16 photographs according to the relative importance/non importance of each issue. A subsequent factor analysis established two factors or perspectives/typologies where individuals have similarly sorted the statement items, and hold a generally similar perspective.

The columns in Figure 1 for statistical interpretation are numbered from -3 through to +3. Whilst the column value was different, the row was of equal importance.

Figure 1 Q-sort quasi-normal distribution



3.5 Analysis

Following recommendations by Watts and Stenner (2012), data from the two Q studies were analysed in PQMethod 2.35 with PQRot 2.0 for Windows (Schmolck, 2014), a free software package designed specifically for factor analysis in Q. Factor analysis in Q is 'by-person' (Watts and Stenner, 2012 p180), with each individual Q-sort functioning as a variable. The first step in the analysis is

factor extraction using Principal Components Analysis (PCA) to extract 'portions of shared meaning' (Watts and Stenner, 2012 p98). PQMethod offers the option of both Centroid factor extraction and PCA, with Centroid being the method of choice for many Q methodologists. Nonetheless, PCA is the most popular choice for researchers outside the Q community and provides the best mathematical solution. According to Ramlo (2016), PCA and Centroid are likely to produce very similar results.

Several statistical criteria can be used in Q analysis to determine how many factors to retain for the final analysis. Typically, factors with an Eigenvalue (EV)>1 should be retained at the outset as stated by Watts and Stenner (2012). In our study, however, the higher ratio of participants to items (35:16) makes EVs a less reliable criterion. Whilst there is no theoretical barrier to increasing the participant number relative to the items, this may have a skewing effect and result in chance correlations, inflated EVs and spurious factors (Watts and Stenner, 2012). These problems can be mitigated by using parallel analysis (Horn, 1965). From the PCA, 8 components had EVs >1. A parallel analysis suggested that only one factor should be retained. A further guide that can indicate how many factors to retain is a scree test (Watts and Stenner 2012, p108). This plots a line through the descending EVs, and the point at which the line changes slope indicates the cut-off point for the number of factors to extract. In our case the scree test suggested retaining two factors.

In addition to the above criteria used more generally in mainstream statistics, there are additional criteria specific to Q. Humphrey's rule suggests that if the product of the two highest loading Q-sorts on each factor are greater than twice the standard error (S.E.), then that factor should be retained (Watts and Stenner, 2012). In our case, the S.E. was 0.25, whereby Humphrey's rule would allow only the first factor to be retained. A further suggested criterion is to retain factors that have two or more significant loaders. Significance was determined to be >0.645 ($p<0.01$). Based on this, only one factor should be retained. At $p<0.05$, however, two factors should be retained.

No single criterion is definitive and Brown (1980) emphasizes the importance of judgement and understanding of the topic more so than objective criteria when deciding on the factors. Thus, the research teams' knowledge gained from intensive research using a variety of methods, including literature reviews, Bayesian Network Analysis, surveys, focus group discussions, interviews, and agent-based modelling exercises in all villages provided an in-depth knowledge and understanding of the topic (Alexander and Larson, 2016; Greenhalgh et al., 2017; Larson and Alexander 2016, Moglia et al., 2016). All information was used to underpin how many factors to retain. Ultimately, we retained two factors for the next step in the analysis, factor rotation.

There are two possibilities for the rotation of the extracted factors in Q methodology: varimax and manual rotation. Varimax rotation provides the most mathematically suitable rotation to account for as much of the study variance as possible (Watts and Stenner, 2012). Since manual rotation is both difficult (Watts and Stenner, 2012, p124) and proffers a more subjective solution (Akhtar-Danesh 2017), we used Varimax rotation for the most reliable and robust solution.

The aim of factor rotation in Q is to align the Q-sorts (participants) as close as possible to the factor axes. The axes are rotated to form the most coherent viewpoint from which to observe the data. Following rotation, the final step in the analysis is to 'flag' Q-sorts to form factor arrays. Factor arrays are the primary source for interpretation of factors in Q. They are essentially hypothetical Q-sorts: what a sort would look like if it loaded 100% on one factor. Factor arrays differ slightly from actual

Q-sorts, as a factor array is always the best estimate of the factor's viewpoint (Watts and Stenner, 2012). Factor arrays are calculated in PQMethod by automatically flagging the Q-sorts with significant loadings ($p<0.05$) that are then used to construct factor arrays.

4. Results

The final two factor solution is detailed in Table 2, representing the relative importance of a given statement from placement on the sorting board (Figure 1 columns numbered from -3 through to +3.) in relation to other sorted statements and the Z score[2]. See Watts and Stenner (2012 p9) for more detail on standardization of scores. Overall the two-factor solution explained 40% of the variance in this study.

Table 2 Relative importance and Z scores for Factor 1 and Factor 2

Q-set Statements	Card number	Factor 1: Relative importance & (Z scores)	Factor 2: Relative importance & (Z scores)
Livestock /Raising livestock (all types) Raising livestock, not just pigs but all animals, cattle, buffalo, goats, chickens, etc. to give the family income (i.e. emphasising income rather than for draft or consumption)	1	1 (0.694)	2 (0.808)
Staff (District Agricultural and Forestry Officers (DAFO) or project staff) to advise farmers on production techniques e.g. Dry season machines, fertilizer, vegetable crops, forages	2	0 (0.008)	1 (0.262)
Off-farm work away from village (factories, construction Thailand etc.)	3	-3 (-1.851)	-2 (-1.803)
Improved variety of rice seed for high yielding rice crop	4	2 (1.136)	3 (1.756)
Vaccination of all livestock cattle, pigs, chickens- to prevent disease and loss.	5	0 (0.433)	2 (0.913)
Cash for use in agriculture production inputs-for production, things you would like to do or improve	6	2 (1.489)	0 (0.11)
Mechanical harvester to save time and labour harvesting rice	7	-2 (-0.953)	-3 (-1.948)
Markets purchasing farmers' agriculture produce; rice, vegetables , livestock	8	0 (-0.111)	-1 (-0.039)
Improved soil/planting of legume crops to improve soil condition or fertility and harvest legumes	9	0 (-0.293)	1 (0.488)
Chemical fertilizer for rice and other crops to improve yield	10	1 (0.547)	1 (0.699)
Forages or grasses planted for use as feed to	11	-1 (-0.837)	0 (0.086)

[2] A Z-score is a standardized score, considered characteristic of a factor and is used to create a 'level playing field' for cross-factor comparison. The Z-score shows how participants ranked each statement/photo among the 16 statements.

cattle when not enough feed or to fatten			
Non-agriculture activities in village, e.g., selling goods form shop, furniture making, selling labour, remittance	12	1 (0.514)	-2 (-1.587)
Dry season vegetable crops for consumption or sale for household income	13	-1 (-0.734)	0 (0.118)
Dry direct seeding machines to save labour and or time when transplanting rice	14	3 (1.727)	-1 (-0.008)
Dry season cash crops such as maize, beans, etc., to sell for income	15	-2 (-1.021)	0 (0.185)
Water access/Water efficient methods of cultivation Ways to find water in paddy land to grow other crops, and ways to prevent evaporation so you can grow a crop in dry season	16	-1 (-0.749)	-1 (-0.04)

For interpretation, we followed the procedure by Watts and Stenner (2012) as a first step to understanding the two viewpoints. This method considers how each factor array ranks the Q-set items relative to each other, and relative to other factors, enabling a holistic approach to interpretation. From this, we considered the significance of each item's Z-score, and incorporated qualitative data gathered during the Q-sorts, and translated into English from Lao language. Below we present narrative accounts of the two factor solution. Note that 21 participants had viewpoints that loaded on a factor interpreted as Labour saving productivity maximization. Of these, 5 viewpoint perceptions overlapped with the second factor, Traditional labour productivity using improved techniques suggesting that some participants subscribe to both narratives. Note that the gender of participants does not appear to be a significant influence on the factors. However, due to the small number of participants, it would be speculative to draw any conclusions based on this. Q methodology seeks primarily to generalize about shared viewpoints around a topic, rather than the prevalence of those viewpoints across demographic groups or amongst the general population (Thomas and Baas, 1992, p23).

4.1 Factor 1 – Labour saving productivity maximization

Factor 1, 'labour saving productivity maximization' referred to as *'Labour saving'* has an EV of 11.98 and accounts for 34% of the study variance. This viewpoint represents a prioritization of photographs (Table 1) depicting ways to maximize farm productivity. The most important activity for *Labour saving* farmers[3] was the use of dry direct seeding machines to save labour and/or time when transplanting rice (Table1: Photo 14 with factor array score +3; conveniently referred to as (14,+3)). In hand with procuring mechanization, *Labour saving* farmers were prepared to use cash to buy agricultural inputs to improve production (6, +2). This was coupled with the need to use improved rice seed varieties for high yielding rice crops (4, +2). *Labour saving* farmers also value livestock production (1, +1) as a primary source of family income. The use of chemical fertilizer to improve yields of rice and other crops (10, +1) and engaging in non-agriculture activities in village, e.g., selling goods from shop, furniture making, selling labour, remittance (12, +1) were considered important livelihood activities. Hence, these farmers interact with the cash economy to procure inputs to improve wet season rice productivity and are looking for ways to generate income locally.

[3] We are discussing the shared viewpoints or shared perspectives rather than actual farmers

For *Labour saving* farmers, several activities or new technologies were of neutral value or of no particular interest, including: vaccination of all livestock to prevent disease and loss (5, 0), the presence of DAFO/project staff or projects to advise farmers on production techniques (2, 0), the presence of markets for farmers' agriculture produce (8, 0) and improving soil fertility by planting crops (9, 0). Hence, these farmers were ambivalent about the value of vaccination, advice from DAFO and were not concerned about markets or soil improvement through tillage. These activities and sources of information were not considered important to their labour productivity or livelihoods. Sufficient traders were available to take surplus produce to local markets, so market access was not deemed problematic or a concern, as evidenced in accompanying qualitative data.

Labour saving farmers were far less concerned about the following activities (as revealed by photographs placed on the negative side of the board): growing dry season vegetable crops (13, -1); planting forages or grasses for cattle (11, -1); using water efficient methods for cultivation (16, -1). Hence, these farmers were not particularly interested in activities that required their labour and effort in the dry season and were likely not to have access to irrigation for dry season cropping according to qualitative data. Rather, these farmers were interested in concentrating their labour on improving wet season rice crop yields using planting machinery, new seeds and chemical fertilizer. They look for other ways to maximise their labour productivity, such as, engaging in local non-agricultural activities.

Dry season cropping of maize, beans etc. to sell for income was of even less importance for labour saving farmers (15,-2). Hence, these farmers did not consider dry season cropping as a viable use of labour or time. Using a mechanical harvester to save time and labour to harvest rice was also not important from this viewpoint (7, -2). A further explanation provided by participants was that the mechanical harvester is an expense to be avoided by using family labour. In addition, harvesting machinery can damage rice kernels and reduce the overall seasonal yield. Off-farm work further from the village, located in towns with factories, or venturing further to Thailand and neighbouring countries was considered of least importance to these farmers (3,-3). Interestingly, significant numbers of young people (over 18 years) in the 20 villages we visited work elsewhere, particularly in Thailand, inducing a labour scarcity in many villages and pushing up the price of labour. The Government of Lao considers cross border migration illegal, so there may have been some reticence by villagers to express their opinions on this topic.

4.2 Factor 2 – Traditional labour productivity using improved techniques

The second viewpoint, designated *traditional labour productivity using improved techniques* (abbreviated in the discussion here as *'Traditional labour')* has an EV of 4.21 and accounts for 12% of the study variance. Farmers who framed their decisions in terms of *Traditional labour* showed strong views about the importance of diversified on-farm activities as primary sources of their income. Their focus was on improving production of rice, improving soil fertility, and investing in livestock and disease prevention. The most important activity for *Traditional labour* farmers was using improved rice seed varieties for high yielding rice crops (4, +3). Also of great importance was livestock raising (1, +2): cattle, buffalo, goats, pigs and chickens, etc., as a source of income, followed by vaccination of all livestock to prevent disease and stock losses (5, +2). The emphasis on livestock production is supported by Alexander and Larson (2016), who found that low rice prices or production difficulties with low rice yields could increase farmers' interest in raising livestock. For example, selling a cow could yield the same return as selling a tonne of rice. While livestock rearing

may take longer, it can be easier than the work required to produce a hectare of rice (qualitative data). Livestock disease protection is also important in order for livestock production to be a successful livelihood diversification strategy.

Traditional labour farmers also valued the use of chemical fertilizer for rice and other crops to improve yields (10, +1), increasing soil fertility using legumes (9, +1) and having DAFO/ project staff to advise farmers on production techniques (2, +1). *Traditional labour* farmer viewpoints indicated an interest in improving production using new varieties of seeds and soil improvement supported by advice from DAFO /project staff. This indicates a general interest in improving on-farm productivity of crops and livestock through traditional methods, without a focus on using new techniques or machinery.

For *Traditional labour* farmers, several activities or new technologies were of neutral value or not particularly interesting. These included: using cash to purchase inputs that improve agricultural production (6, 0), dry season cash crops such as maize, beans, etc., to sell for income (15, 0), dry season vegetable crops for consumption or sale for household income or (13, 0) forages or grasses planted for use as cattle feed (11, 0). These farmers were not that concerned about agricultural activities in the dry season to generate income, preferring a traditional livelihood arising from paddy rice and livestock production. These farmers were also less interested in the cash economy, in general. Nor were these farmers interested in efforts to plant forages for livestock, preferring traditional grazing techniques. In villages with limited access to water in the dry season, less interest in dry season production appears rational.

Traditional labour farmers do not consider dry direct seeding machines to save labour and or time when transplanting rice (14, -1), markets for farmers' agriculture produce (8, -1) and water efficient methods of cultivation, to grow a crop in dry season (16,-1), as important to their production systems. We suggest this perspective comprises a 'traditional viewpoint', where crops and livestock are the mainstay. These farmers continue to plan for subsistence livelihoods, while hoping for improved rice crop yields through information from DAFOs, access to fertilizers and opportunistic access to improved techniques without necessarily investing in improvements. This attitude appears more prevalent in remote villages with less access to water, fewer alternatives and stronger cultural ties.

Of even lesser importance to *Traditional labour* farmers is engaging in the cash economy. They show less interest in: incomes resulting from non-agriculture activities in village, e.g., selling goods from a shop, furniture making, selling labour, remittances etc. (12, -2) or from off-farm work away from village (e.g. factories and construction work in Thailand, etc.) (3, -2).This attitude reflects traditional subsistence modes of achieving livelihood goals, with less reliance on the cash economy while maintaining traditional labour for farming activities.

Of least importance to *Traditional labour* farmers was the mechanical harvester that could be used to save time and labour when harvesting rice (7, -3). The mechanical harvester was considered an expense to be avoided by using family labour, similarly to *Labour saving* farmers. Mechanical harvesters can damage the harvested rice and reduce the overall yield. Some farmers also stated that they were unfamiliar with the depicted machine (7), and hence showed no interest in this

activity. Paddy fields were generally small, of less than 5 Ha, and mechanized harvesters may not be particularly useful.

4.3 Differences and commonalities across viewpoints

Several photographs were ranked higher for *Labour saving* farmers than for *Traditional labour* farmers. *Labour saving* farmers' rankings revealed aspects of the cash economy to be of greater importance. For instance, accessing dry direct seeding machines, wanting to purchase agriculture production inputs, access to markets, engaging in non-agricultural activities in their local area were more important to *Labour saving* farmers than *Traditional labour* farmers viewpoints. This suggests that *'labour saving'* attitudes are associated with modernizing planting techniques and engaging in the cash economy, as ways of achieving their livelihood goals and aspirations.

Conversely, *Traditional labour* farmers rankings reflected the importance of traditional production goals as they ranked improved variety of rice seed for high yielding rice crops, improving soils, livestock raising with vaccination and planting forages, engaging with DAFO/project staff and off-farm work away from village more highly than did *Labour saving* farmers. Hence, *Traditional labour* farmers were more interested in rice production, raising livestock, interacting with DAFO/project personnel and the prospect of remittances, than were *Labour saving* farmers.

Water efficient methods of production were of little interest from either viewpoint with all farmers showing a general disinterest in using water for activities in the dry season. Some farmers considered they had enough water to grow rice in the wet season and were generally not interested in accessing more water to increase productivity (qualitative data). Others did not have access to irrigation, with one farmer from Savannakhet province commenting that, 'in his village, only 20 households out of 200 households had access to irrigation and they could not use the water canals providing water'. Without access to irrigation systems or wells, dry season cropping is highly problematic. One farmer had not previously seen the water saving apparatus (photograph 16) and hence was not interested in the activity as it looked a complicated technique. If in need of water, farmers tended to pump from ponds to irrigate crop, and, as farmers cultivated small plots, the effort seemed inappropriate and expensive. Farmers were inevitably reluctant to increase production costs (qualitative data).

The use of chemical fertilizer was of equal important to both *Labour saving farmers* and *Traditional labour* farmers, as fertilizers increased rice yields. New variety rice seeds with fertilizer could achieve yields as high as 6 tonnes/Ha, approximately double the usual yield (Alexander and Larson, 2016). Traditional rice varieties do not respond as well to fertilizer application, hence farmers were more interested in combining fertilizer with new seed varieties. For example, a farmer indicated that she used 5 bags of fertilizer per year for wet season rice production, though none was used for dry season production. While chemical fertilizers increase wet season rice productivity, farmers were unsure of the correct amounts to apply and they had concerns about the cost of chemical fertilizer, particularly the risk of increasing production costs without increasing yields.

5. Discussion

We use Q methodology to shift emphasis away from the actual technology, and rather gain insight on potential users and their behaviours (Pereira et al., 2016). We have adapted Q methodology for use with semi-literate smallholder Lao farmers by using photographs as Q-sort items. Thirty-five

participants in two Provinces participated in the Q-sort and discussions to clarify their production and livelihood goals and attitudes to new techniques. The two narratives, constructs of different approaches to labour productivity, are akin to the 'mental models' discussed by Jones et al. (2011). Farmers participating in this study assess their productivity and lifestyle goals and weigh up benefits and possible negative outcomes when assessing the potential of new technologies.

When farmers contemplate their farming systems their decision making processes have been found to be influenced by many factors. Pannell et al. (2006) suggest that farmers undergo a learning process - collecting, integrating and evaluating new information in situations of uncertainty when considering their farming system decisions. Improved knowledge, practice and experiences all assist the farmer to evaluate 'technologies' that could support their production goals. Farmers consider the relative advantage that a technology or a practice may provide in the context of some or all of the following issues; i) short term input costs, (ii) yields, (iii) output prices of the innovation or of other activities that it affects, (iv) medium to long term profits, (v) impacts on other parts of the system, (vi) adjustment costs, (vii) impacts on the riskiness of production, (viii) system compatibility, (ix) complexity, (x) government policies, (xi) replacement activity costs, (xii) existing beliefs and values, (xiii) family lifestyle, (xiv) self-image and brand loyalty, (xv) environmental credibility, and (xvi) time scale (Pannell et al., 2006). Other factors such as, climate, diseases, pests and information flows are important (Aguilar-Gallegos et al., 2015). Hence, decision-making about agricultural production is complicated for resource poor, risk averse smallholder farmers.

Labour saving farmers showed an interest in modernization and use of new technologies. Greater farm productivity was envisaged using direct seeding machines to plant rice and investing in inputs such as improved seed varieties and fertilizer to improve yields. Livestock was considered a key source of income and farmers showed interest in the cash economy. *Traditional labour* farmers were not necessarily 'market-oriented' rice producers; rather, they viewed rice production as a platform on which to construct a diversified livelihood strategy using family labour. These farmers were primarily interested in using improved rice seed varieties for high yielding rice crops. Rice production and livestock are the main sources of sustenance and income and *Traditional labour* farmers are most interested in maintaining their lifestyle through traditional crop/livestock practices. The importance of the two narratives is to validate that while all farmers will respond to opportunities to increase rice production in the wet season and raise livestock, farmers will continue to take into account a range of factors to guide their decisions and production goals.

In general, farmers expressed disinterest in activities that required their labour on their farms in the dry season. Irrigation for dry season cropping was not considered important, nor was there much interest in growing forges in the dry season to supplement livestock diets. Interest in dry season production is dependent on farmers' current farming system, water availability, crops and livestock interactions and returns to labour. Changes to agricultural practice in the dry season might therefore appeal to fewer farming families, and hence selection of the families to be involved in the introduction of dry season technologies trials might benefit from better targeting of suitable participants.

Labour productivity is a key issue and labour is known to be increasingly scarce in rural areas in southern Laos (Manivong et al., 2012; Manivong et al., 2014), as many are drawn to towns, cities and international labour forces to engage in the cash economy. Furthermore, remittances can be used to

improve livelihoods and farm productivity without the risks associated with dryland farming. Hence, labour productivity is a key driver of decisions on whether or not to invest in new technologies. For example, time, labour and economic savings can be made through the use of dry direct seeding machines in the rice planting season by reducing labour requirements and costs incurred for hired labour. One farmer explained that planting rice could take up to 30 days and requires two labourers whereas direct seeding techniques can ensure that 2 Ha of paddy can be planted in 4 days. Yet direct seeding methods require changes to farming systems with earlier planting (before rainy season) requiring restricted grazing of cattle and buffaloes. This illustrates the complex and dynamic situation in which farmers' make production decisions and choose whether or not to trial new technologies.

New technologies do play a significant role by providing farmers with new techniques to modify their traditional labour productivity outcomes, thereby continuing to sustain livelihoods and cultural activities and normative values. New technologies can also enable significant savings in labour particularly if associated inputs are available and affordable.

By design, projects need to respect and approach farmers firstly acknowledging their cultural worldviews (Abel et al., 1998; Fforde, 2009) and proceed to allay fears by investing time and energy into this selection of participants. Encouraging farmers who are unsure about or are concerned about the risks of changing their agricultural production systems may lead to greater uptake.

6. Conclusions

In this study we have used Q methodology to distil two narratives that describe viewpoints that farmers use to decide on their production and livelihood goals. Q methodology has not been used previously in village studies in Lao PDR, and the visual approach- important in a multilingual situation- was particularly interesting to both Lao researchers and participants. It is useful to view the two farmer types of *Labour saving* and *Traditional labour* within a larger framework, for example, the Agricultural Innovation System framework. Scientists, extension workers, farmers and policy makers could all benefit by shifting the emphasis from the introduced technology to greater emphasis on potential users and their preferred behaviours. Q methodology also provides a way to unpack the complexity of identity and attitudes, values, beliefs and behaviours of farmers. By describing two groups of farmers with subtle differences in their labour, livelihood and production goals, it's important to reflect on the approaches that would benefit farmers accordingly. Rural households are adopting individual livelihood strategies, diversifying production and are concerned about labour productivity, with migration and remittances becoming attractive alternatives. While the Lao Government forecasts substantial increases in rice production in the southern plains, farmers will require specialized and tailored support, accounting for their envisaged livelihood and production goals, if they are to meet government production targets. Findings from this study will help inform Government of Lao policy makers in the agricultural sector as they seek to increase future smallholder production in targeted areas.

Acknowledgements

Research reported in this paper was funded by the Australian Centre for International Agricultural Research, Project no. ASEM/2014/052: 'Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints'. We are grateful to ACIAR for their generous support. Dr Tamara Jackson and Dr Camilla Vote provided expert knowledge and

photographs from their fieldwork activities that underpinned our Q research concourse and activities. Fieldwork conducted for the study was approved by James Cook University's Human Ethics Research Committee: Approval H6109. The authors have no financial interest or benefit arising from the direct applications of this research. The authors have no competing interests to declare.

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