

## Tables

Table A1.1: Summary of household-level statistics (mean and standard deviation) for each case study area (CSA). The values reflect conditions in December 2017 unless otherwise noted.

Household variable	Oudomsin CSA (N=60)	Prang CSA (N=50)	Wilcoxon p-value*
Age of head of the household	45 (11)	49 (13)	
Number of persons (count)	6.7 (2.6)	5.5 (2.2)	***
Number of labor (count)	3.2 (1.3)	2.2 (0.8)	***
Education of head of the household (0 = none, 1 = primary school, 2 = secondary school, 3 = high school or higher)	0.9 (0.8)	1.1 (0.7)	*
Year the household was established in the village	1990 (10)	1990 (9)	
Average distance to all household plots, minutes	17 (13)	20 (14)	
Average distance to all household plots, kilometers	1.6 (1.0)	1.4 (0.7)	
<b>Total income (1000 USD)</b>	4.0 (3.5)	1.2 (1.0)	***
Income from agricultural wages (1000 USD)	1.0 (1.9)	0.1 (0.2)	***
Income from agricultural production (without wages) (1000 USD)	2.3 (2.3)	0.9 (0.8)	***
Net rice income‡ (1000 USD)	0.8 (0.8)	0.7 (0.4)	
Income from remittances (1000 USD)	0.002 (0.01)	0.03 (0.2)	
Other nonagricultural income (1000 USD)	0.6 (1.3)	0.03 (0.2)	***
Income in 2005 (1000 USD)	1.9 (1.2)	0.4 (0.4)	***
Labor in 2005 (count)	2.7 (1.3)	2.2 (1.0)	**
<b>Total agricultural area (ha)</b>	5.6 (2.8)	2.9 (1.2)	***
Rubber area (ha)	4.0 (2.2)	1.1 (0.8)	***
Cardamom area (ha)	0.07(0.2)	0.4 (0.4)	***
Rice paddy area (ha)	0.6 (0.6)	0.5 (0.3)	
Paddy land under banana (ha)	0.0 (0.2)	0	
Paddy land under sugarcane (ha)	0.9 (1.0)	0	***
Upland rice area (ha)	0.03 (0.1)	0.5 (0.8)	***
<b>Total rice production (metric tons)</b>	2.7 (2.3)	2.3 (1.2)	
Paddy rice production (metric tons)	1.9 (2.0)	1.7 (1.3)	
Upland rice production (metric tons)	0.1 (0.3)	0.6 (0.8)	***
Other upland rice production (metric tons)	0.3 (0.7)	0	***
Rice sold (metric tons)	0.7 (1.5)	0.0 (0.1)	
Rice purchased (metric tons)	0.2 (0.5)	0.0 (0.2)	
<b>Rubber yield (ton/ha)</b>	1.4 (1.0)	1.4 (0.7)	
Paddy rice yield (ton/ha)	3.6 (1.6)	3.8 (1.3)	
Upland rice yield (ton/ha)	1.6 (0.4)	1.3 (0.7)	
Cardamom yield (ton/ha)	na	0.9 (0.3)	nd
<b>Rubber farm-gate price (USD/kg)</b>	0.7 (0.1)	0.7 (0.1)	
Rice price, nonhulled, farm-gate (USD/kg)	0.3 (0.02)	0.3 (0.03)	
Cardamom price (USD/kg)	0.7 (0.6)	0.9 (1.0)	
<b>Rubber revenue† (1000 USD/ha)</b>	1.7 (1.6)	0.2 (0.2)	nd
Fraction of rubber revenue over total household income†	0.4 (0.3)	0.4 (0.3)	nd
Cardamom revenue† (1000 USD/ha)	0.5 (0.4)	0.3 (0.2)	nd
Fraction of cardamom revenue over total household income†	0.1 (0.1)	0.5 (0.3)	nd
Paddy lease revenue (1000 USD/ha)††	1.3 (0.9)	na	nd
Fraction of paddy lease revenue over total household income††	0.3 (0.3)	na	nd
Paddy rice revenue (1000 USD/ha)‡‡	1.1 (0.4)	1.1 (0.3)	nd

Notes: A conversion of 8000 LAK = 1 USD is used for 2017 and 2005. nd=not determined. na=not applicable.

†Averaged only over those households having productive cardamom or rubber plantations. Calculated as the factor of the reported yield and farm gate price.

††Averaged only over those households who produce sugarcane in paddy land. Calculated as the factor of yield and farm-gate price (own production) or plot area and paddy lease price (lease).

‡Theoretical, equal to net rice production (production minus purchases) multiplied by an average rice price of 0.3 USD/kilogram.

‡‡ Theoretical, equal to rice production multiplied by an average rice price of 0.3 USD/kilogram.

\* Compares group means using the nonparametric Wilcoxon signed-rank test: \*p<0.10, \*\*p<0.05, \*\*\*p<0.01.

Table A1.2: Description of the variables in the BN and parameterization

Variable name in BN	Description	Unit	Type and subtype	Parameterization	Scale	Temporal range of the data	Mean (SD)†
CSA	Case study area	NA	D, L	S	CSA	NA	-
HHaP	HH ha of paddy rice	ha	C, I	S	H	2017	0.6 (0.6)
HHaUR	HH ha of upland rice	ha	C, I	S	H	2017	0.4 (0.8)
HHaLeaseP	HH ha of leased paddy	ha	C, I	S	H	2017	0.9 (1.1)
HHaR	HH ha of rubber	ha	C, I	S	H	2017	2.8 (2.4)
HHaC	HH ha of cardamom	ha	C, I	S	H	2017	0.3 (0.5)
Yield_P_obs	Yield, paddy rice (observed)	ton/ha/yr	C, I	S	P	1990–2017	3.6 (1.3)
Yield_P	Yield, paddy rice	ton/ha/yr	C, I	$P(\text{Yield}_P   \text{Yield}_{P\_obs}) = \text{NormalDist}(\text{Yield}_P, \text{Yield}_{P\_obs}, \text{SD} = 0.34)$	P	1990–2017	3.6 (1.3)
Yield_UR_obs	Yield, upland rice (observed)	ton/ha/yr	C, I	S	P	1990–2017	1.3 (0.8)
Yield_UR	Yield, upland rice	ton/ha/yr	C, I	$P(\text{Yield}_{UR}   \text{Yield}_{UR\_obs}) = \text{NormalDist}(\text{Yield}_{UR}, \text{Yield}_{UR\_obs}, \text{SD} = 0.20)$	P	1990–2017	1.3 (0.8)
Yield_R	Yield, rubber	ton/ha/yr	C, I	S	P	2017	1.3 (0.8)
Yield_C	Yield, cardamom	ton/ha/yr	C, I	S	P	2017	0.9 (0.3)
UR_HH_Kg	HH production of upland rice	ton/yr	C, I	$\text{UR}_{HH\_Kg} = \text{UR}_{Oth\_HH\_Kg} + \text{HHaUR} * \text{Yield}_{UR}$	H	2017	0.8 (1.4)
UR_Oth_HH_Kg	Other HH upland rice production	ton/yr	C, I	S	H	2017	0.3 (0.7)
P_HH_Kg	HH production of paddy rice	ton/yr	C, I	$P_{HH\_Kg} = \text{HHaP} * \text{Yield}_P$	H	2017	2.1 (2.2)
Price_Rice_Local	Price of rice (unhulled), local	USD/kg*	C, I	$P(\text{Price}_{Rice\_Local}   \text{Price}_{Rice\_Market}) = \text{NormalDist}(\text{mean} = \text{Price}_{Rice\_Market} * 1.46e-3, \text{SD} = 0.027)$	P	2000–2017	0.2 (0.1)
Price_Rice_Market	Price of rice (unhulled), market	USD/kg*	C, I	Frequency count of annual averages, FAOSTAT (2020)	CSA	2000–2016	140 (48)
Price_R	Price of rubber latex, local	USD/kg-wet*	C, I	$P(\text{Price}_R   \text{Price}_{R\_CHN}) = \text{NormalDist}(\text{mean} = \text{Price}_{R\_CHN} * 0.42, \text{SD} = 0.11)$	P	2003–2017	1.1 (0.5)
Price_R_CHN	Price of rubber latex (raw), China	USD/kg-dry*	C, I	Frequency count of annual averages, Indexmundi (2019)	CSA	1995–2017	2.4 (1.2)
Price_C	Price of cardamom (with hull)	USD/kg	C, I	S	P	2007–2017	0.8 (0.1)
Price_LeaseP	Price of paddy lease	USD/ha/yr	C, I	S	P	2011–2017	984 (670)
R_HH_Inc	HH income from rubber latex	USD/yr	C, I	$R_{HH\_Inc} = \text{Yield}_R * \text{Price}_R * \text{HHaR} * 1000$	H	2017	3940 (5500)
C_HH_Inc	HH income from cardamom	USD/yr	C, I	$C_{HH\_Inc} = \text{Yield}_C * \text{Price}_C * \text{HHaC} * 1000$	H	2017	261 (490)
LeaseP_HH_Inc	HH income from leased paddy	USD/yr	C, I	$\text{LeaseP}_{HH\_Inc} = \text{Price}_{LeaseP} * \text{HHaLeaseP}$	H	2017	854 (1500)
Total_HH_Ag_Inc	HH revenue from cash crops	USD/yr	C, I	$\text{Total}_{HH\_Ag\_Inc} = R_{HH\_Inc} + \text{LeaseP}_{HH\_Inc} + C_{HH\_Inc}$	H	2017	5060 (5800)
HHPers	Number of persons in the HH	count	D, N	S	H	2017	6.9 (3.4)
HHRice_cons	HH rice consumption	kg/yr	C, I	$\text{HHRice\_cons} = 1.11 + \text{HHPers} * 0.185$	H	2017	2.4 (0.7)
Net_Rice_Prod	HH net rice production	kg/yr	C, I	$\text{Net}_{Rice\_Prod} = \text{UR}_{HH\_Kg} + P_{HH\_Kg} - \text{HHRice\_cons}$	H	2017	0.5 (2.7)
Net_Income	HH net agricultural production income	USD/yr	C, I	$\text{Net}_{Income} = \text{Total}_{HH\_Ag\_Inc} + (\text{Net}_{Rice\_Prod} * \text{Price}_{Rice} * 1000)$	H	2017	5160 (5800)

Abbreviations: HH=household; ha=hectares; yr=year. Type=Discrete or Continuous, Subtype=Labeled, Boolean, Numbered, or Interval. Parameterization=Survey data; other sources or deterministic equations are indicated. Scale=Case Study Area, Household, or Plot.

\*USD=US Dollar; CNY=Chinese Yuan; LAK=Lao Kip. Fixed currency conversions corresponding to 2017 levels were used: LAK/USD=8000; CNY/LAK=1255.

†Indicates the mean and standard deviation (SD) of the variable calculated by the BN when no nodes are instantiated.

Table A1.3-A: Empirical mean and standard deviation of household variables for households in the lower (0–25%), medium (25–75%), and higher (75–100%) income quantiles based on household survey data.

Case Study Area	Prang			Oudomsin		
	75–100% (High-income)	25–75%	0–25% (Low-income)	75–100% (High-income)	25–75%	0–25% (Low-income)
Total income (1000 USD)	2.3 (1.0)	0.98 (0.65)	0.48 (0.59)	8.0 (3.9)	3.4 (2.3)	1.1 (0.75)
Agricultural income (1000 USD)	1.9 (0.80)	0.67 (0.28)	0.16 (0.08)	5.5 (2.1)	1.7 (0.69)	0.25 (0.23)
Rice production per person (ton)	0.43 (0.13)	0.42 (0.22)	0.47 (0.25)	0.54 (0.51)	0.43 (0.29)	0.25 (0.16)
Rice purchase per person (ton)	0	0.02 (0.04)	0.002 (0.01)	0.02 (0.06)	0.04 (0.10)	0.04 (0.07)
Rubber (ha)	1.56 (0.58)	1.2 (0.80)	0.61 (0.49)	5.9 (2.4)	3.7 (1.6)	2.6 (1.7)
Paddy (ha)	0.72 (0.26)	0.42 (0.24)	0.27 (0.26)	0.91 (0.4)	0.52 (0.7)	0.27 (0.5)
Upland rice (ha)	0.18 (0.41)	0.45 (0.75)	1.0 (0.97)	0.01 (0.05)	0.01 (0.04)	0.11 (0.22)
Cardamom (ha)	0.51 (0.58)	0.34 (0.25)	0.39 (0.50)	0.09 (0.13)	0.1 (0.22)	0.02 (0.04)
Paddy lease (ha)	0	0	0	1.2 (1.1)	1.1 (0.89)	0.31 (0.34)
Household persons	6.9 (2.7)	5.0 (2.0)	4.8 (1.3)	7.9 (2.9)	6.7 (2.7)	5.4 (1.3)

Table A1.3-B: Values of household variables instantiated in the BN to represent low-income and high-income households in each case study area. The values correspond to the variable state in the BN that best matches the values in Table A3-A.

Case Study Area	Prang		Oudomsin	
	High-income	Low-income	High-income	Low-income
HHaR	1.5	0.5	5.5	2.5
HHaP	0.75	0.25	1	0.25
HHaUR	0.125	1	0	0.125
HHaC	0.5	0.5	0	0
HHaLeaseP	0	0	1.25	0.25
HHPers	7	5	8	5

Table A1.3-C: Values of household variables instantiated in the BN to represent low-income and middle-income households across case study areas.

	Middle-income	Low-income
Upland hectares (HHaR, HHaC, HHaUR*, or a mix) *only for low-income household	4	2
Lowland hectares (HHaP or HHaLeaseP)	1.5	0.4
HHPers	6	5

Table A1.4: Household livelihood conceptualization: the sum of a household's material and economic stocks and flows

<i>Household livelihood components</i>		<i>Livelihood stocks and flows relevant to the study</i>	<i>How it is addressed in the BN model</i>
<i>Flows</i>	Material	Food production and consumption	Production and consumption of rice, as the main household food item, is included in the BN model; it is converted into net cash flow depending on whether net household rice production is positive or negative for the year
		Other household consumption (e.g., fertilizer, school supplies, etc.), including regular and unforeseen expenses (e.g., medical services)	Not included in the BN model.
	Economic	Cash income	Agricultural production income is included in the model; other income sources are not included.
		Cash expenses	Rice purchases are included in the model (see <i>material flows</i> ); other expenses are not included.
<i>Stocks</i>	Material	Capital assets: house, motorcycles, tractor, cattle, and so forth	Not included in the BN model.
	Economic	Cash savings	Not included in the BN model.

Figures

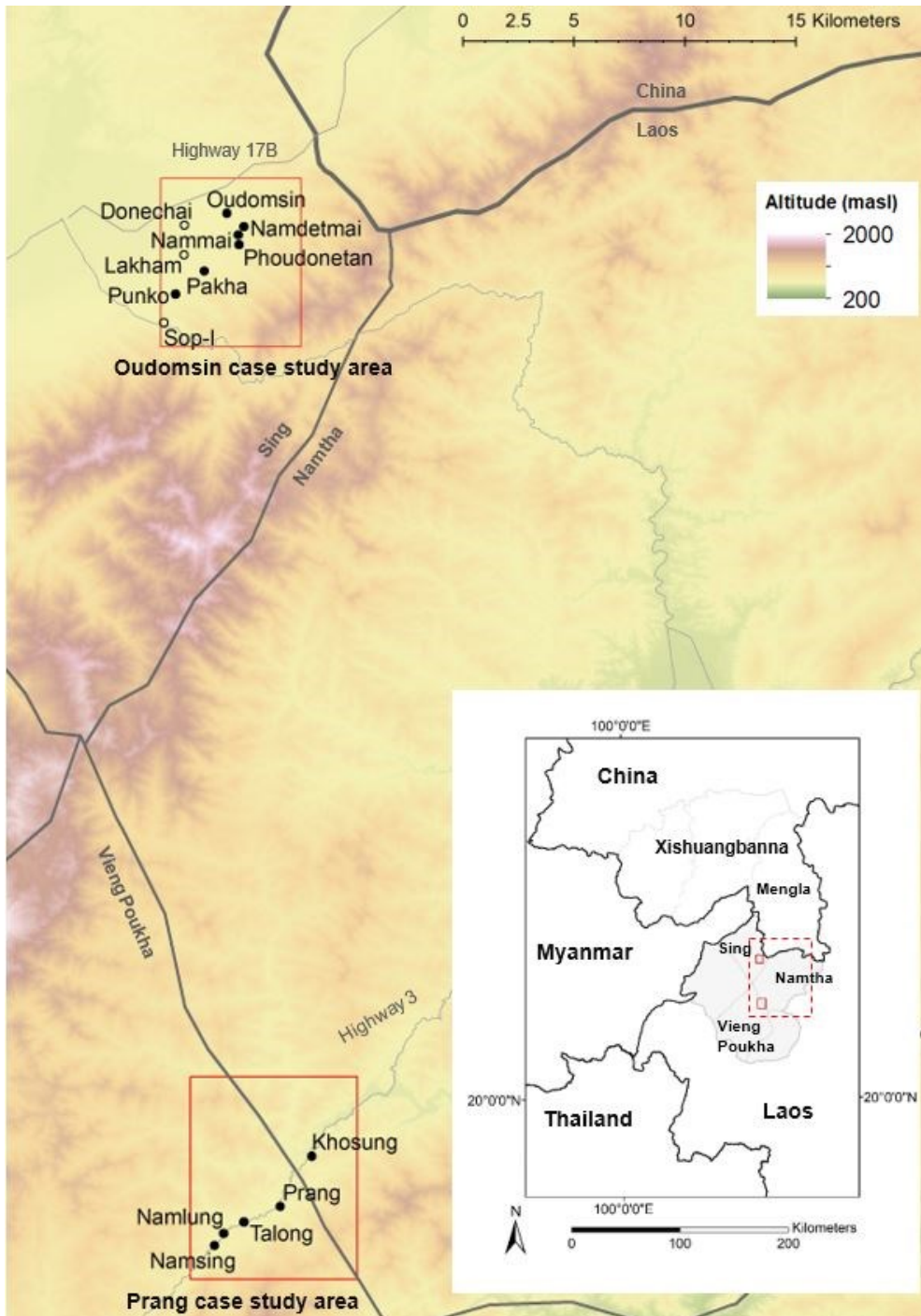


Figure A1.1: Map of the two case study areas and villages studied (solid points). Luang Namtha Province is shaded in gray in the lower map.

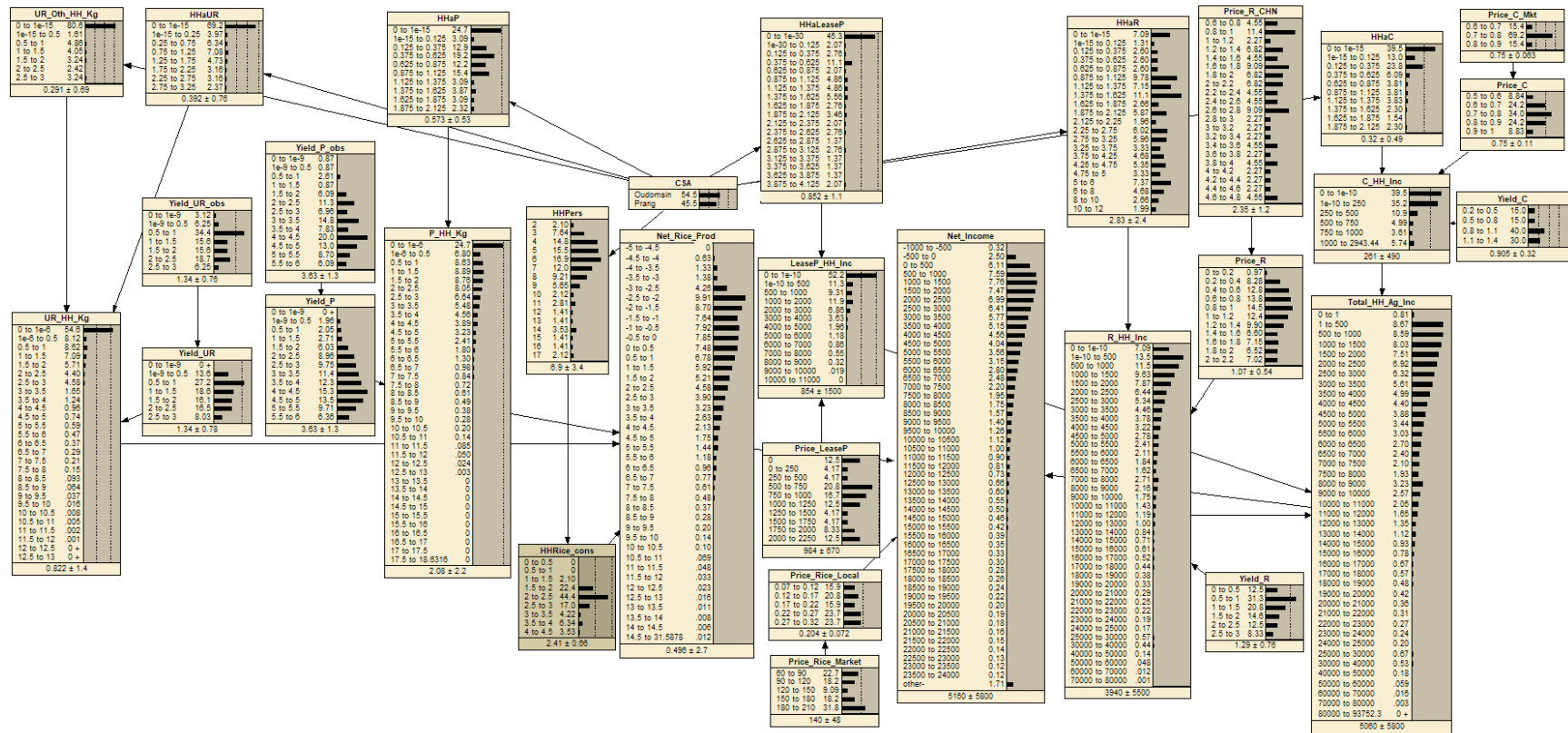


Figure A1.2: Bayesian network model. Details are shown on the next two pages.

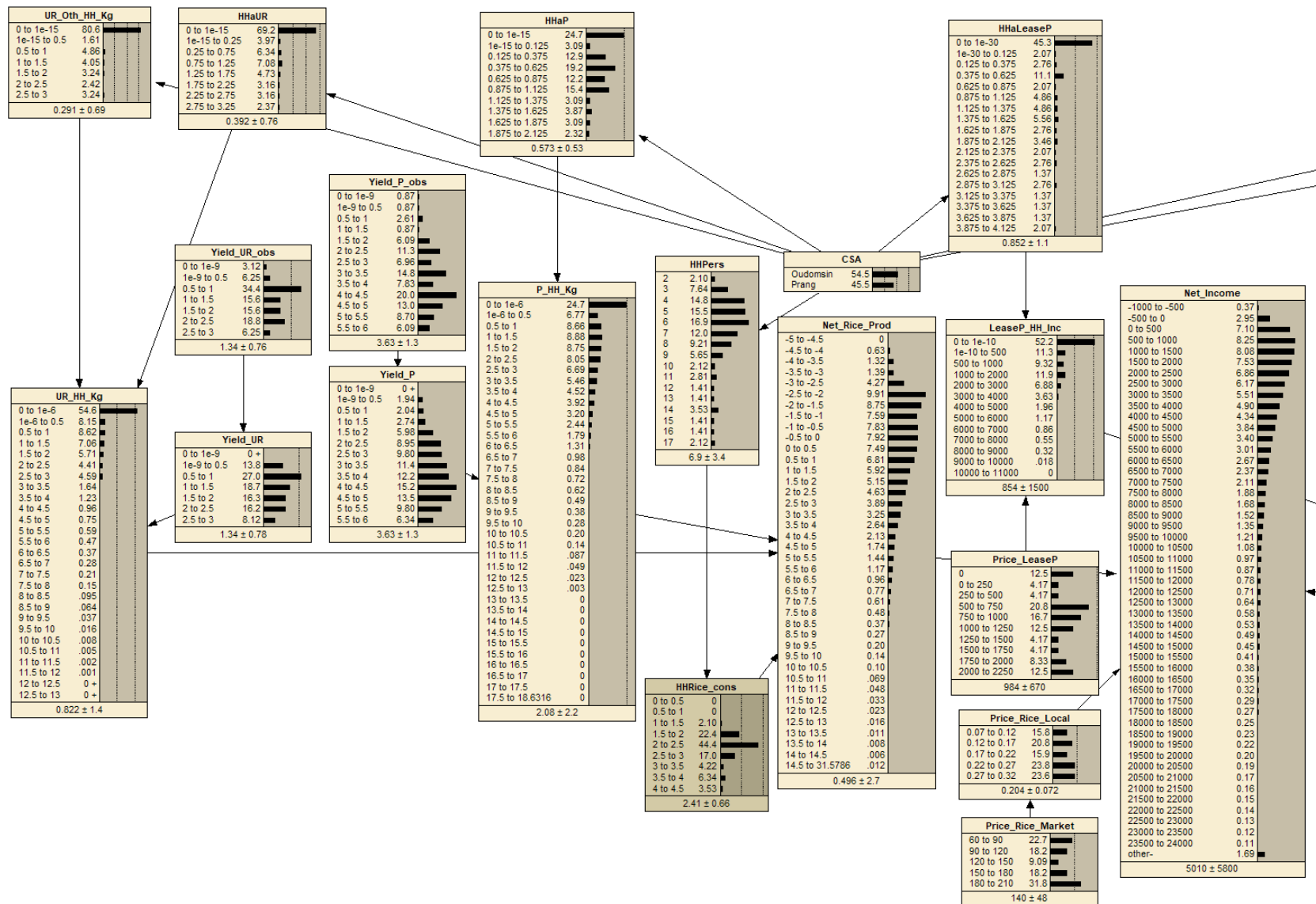


Figure A1.2 (Cont.)

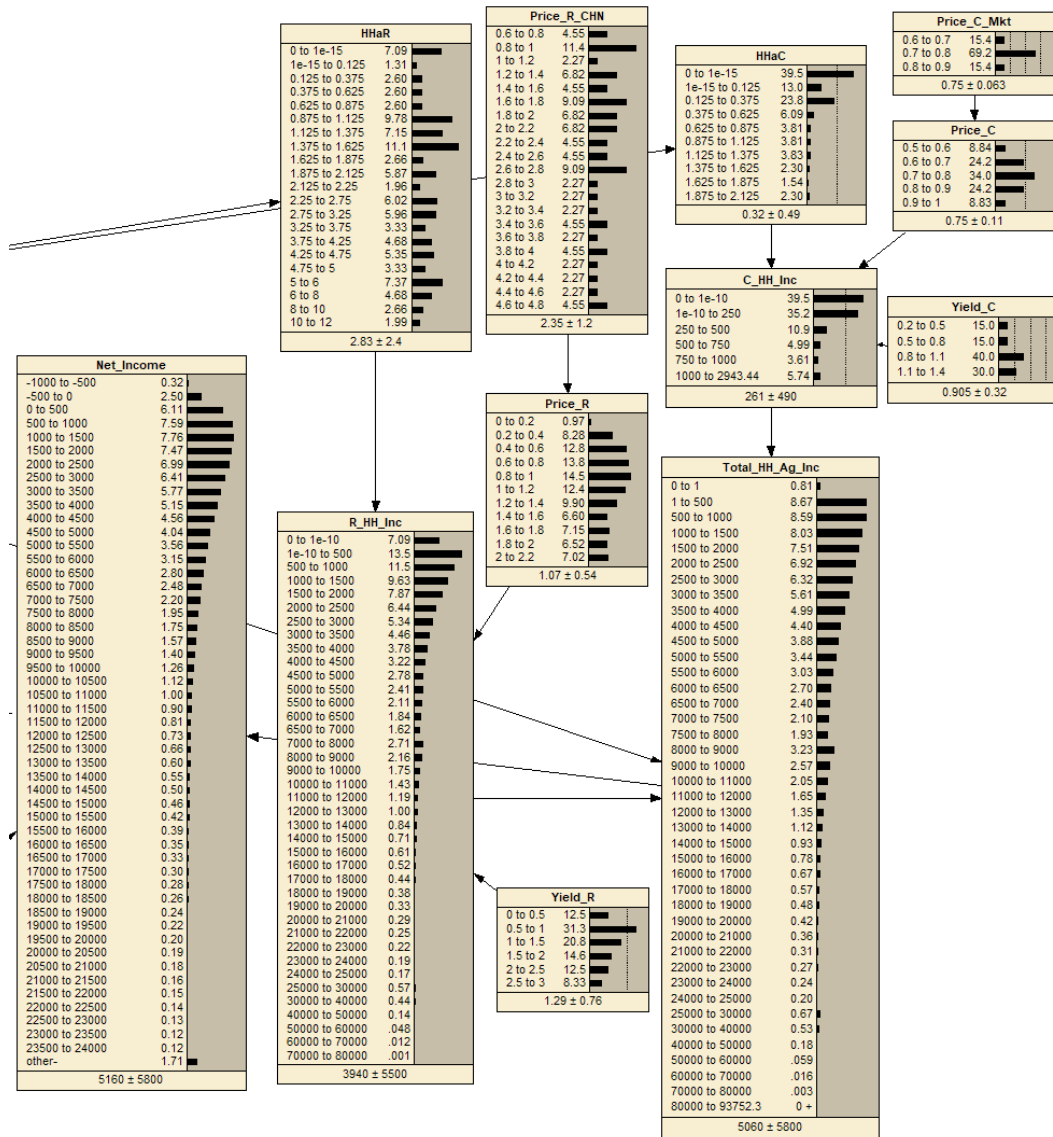


Figure A1.2 (Cont.)



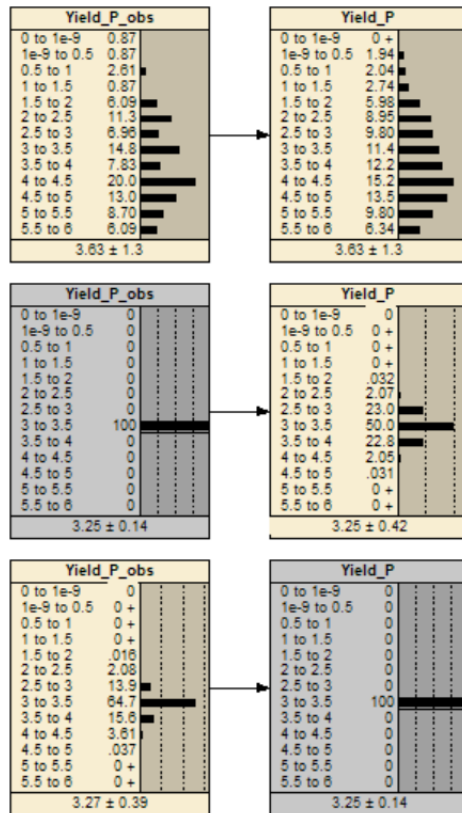


Figure A1.3: Details of forward and backward propagation of information in the BN in two selected nodes. The yellow boxes reflect the probability distribution of the node in the BN. The gray boxes reflect nodes that have been “instantiated”, that is, fixed or “given evidence”; any change to the probability distribution of a node is then forward- and back-propagated across nodes in the BN.

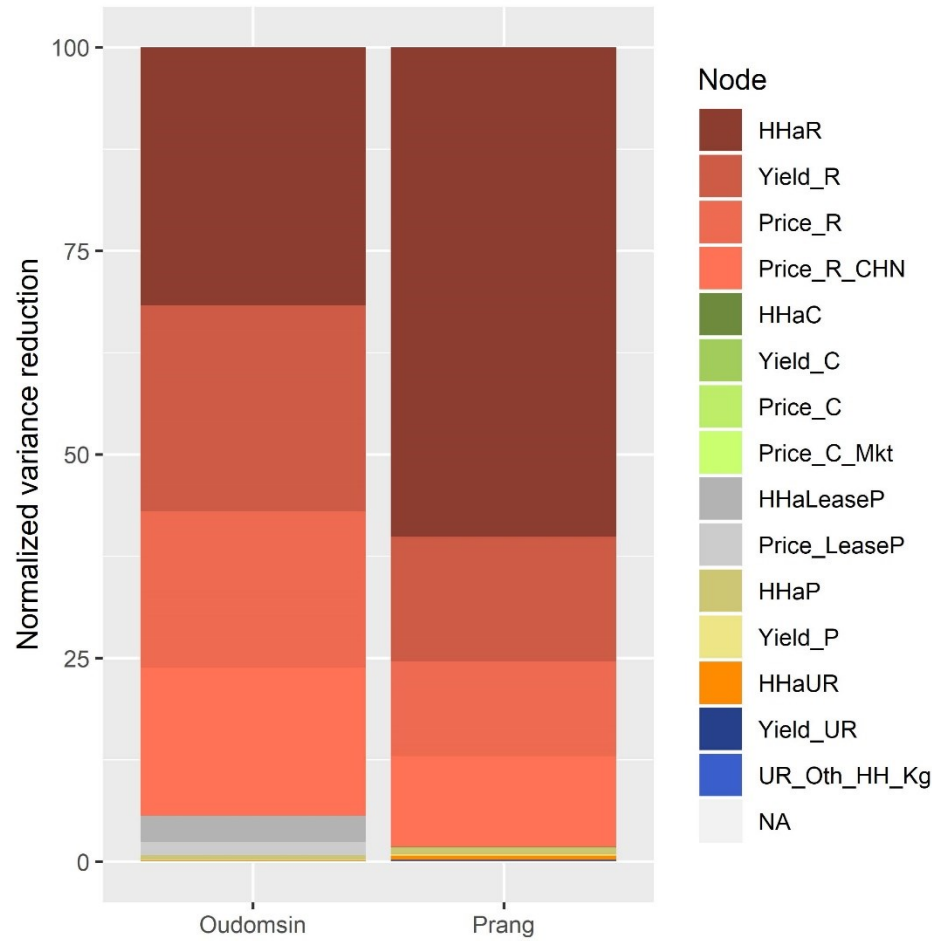


Figure A1.4: Sensitivity of net household agricultural production income to other variables (nodes) in the BN, calculated as the percent reduction in variation of the node when the value of another node is fixed.