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CONSTRAINTS TO EXPANSION OF COWPEA AND MUNGBEAN UNDER RAIN-FED FARMING IN ANURADHAPURA DISTRICT

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ABSTRACT

Cowpea and mungbean extents in Sri Lanka have declined over the last decade. This study analyzes the reasons for these declining trends under rain-fed farming, estimating the adoption percentages, preferences for variety attributes, profitability, and production functions. Primary data relevant to 2008/09 *maha* season were collected from random samples of 40 cowpea and 33 mungbean farmers of Anuradhapura district. The per hectare and per farm profitability estimates including (excluding) imputed cost of family labour were Rs 21,662 (Rs 81,423) and Rs. 3,682 (Rs. 14,420), respectively, for cowpea and Rs. -16,289 (Rs. 43,612) and Rs. -1,648 (Rs. 4,242), respectively, for mungbean. The share of family labour in total cost is 89% for cowpea and 76% for mungbean. The variety adoption rate was 38% for 'Bombay' cowpea, 33% for 'Arlington' cowpea, and 49% for 'MI 6' Mungbean. Largeness of seed, glossiness of seed coat, and indeterminate growth patterns are the variety attributes preferred by farmers of both cowpea, and mungbean. The production function estimates showed that cowpea varieties 'Bombay' and 'Arlington' significantly outperform ($p<0.05$) 'Dhawala', whereas mungbean varieties 'MI 06' and 'MI 05' significantly outperform ($p<0.05$) the local varieties. Family labour constraint is a critical determinant in deciding farm size of both crops.

KEYWORDS: Cost of cultivation, Family labour, Rain-fed farming, Variety attributes,

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) and mungbean (*Vigna radiata* L.) are the most important grain legumes cultivated in Sri Lanka. They are traditionally grown in both *yala* and *maha* seasons (DOAMAL, 2003). The average cowpea and mungbean extents cultivated in Sri Lanka during the period starting from1998 to 2009, were 11,980 ha and 11,366 ha, respectively whereas the annual average productions of these two crops were 16,623 mt and 10,270 mt, respectively (DCS, 1998-2009). In 2009 429 mt of cowpea worth Rs. 3.56 million and 14,183 mt of mungbean worth Rs. 1,224.58 million have been imported to Sri Lanka to bridge the gap between national production and requirement (Customs,2009). Efforts to increase local production of these two crops have been intensified by the Department of Agriculture (DOA), Sri Lanka, for nearly four decades through research and extension (Ediriweera, 2003). As a result, the DOA has been able to release several varieties of cowpea and mungbean with different favourable attributes, including high yield potential. However, it has been observed that the potential average yields of the recently released cowpea varieties 'Waruni' and 'Dhawala' are not superior to the earlier released varieties 'Bombay and 'Arlington' In contrast, the

potential yields of the recently released mungbean varieties 'Ari' and 'MI 06' are higher than that of the previous releases (DOA, 2000; MADAS, 2009).

Despite the high investment on research and development efforts on both crops, they have experienced declining trends of extents cultivated in Sri Lanka during recent years. From 1998 to 2009, the cultivated extent of mungbean declined from 17,509 ha to 8,570 ha that of cowpea decreased from 14,827 to 11,439 ha (DCS 1998-2009). These declining trends in the extents of these two crops warrant studying the reasons for such trends.

In terms of annual production of cowpea and mungbean, Anuradhapura district ranks fourth among the districts of Sri Lanka. Due to the relative proximity of the farms in the district to Field Crops Research and Development Institute (FCRDI) at Mahaillupppallama, the farmers in the Anuradhapura district have relatively easy access to seeds of new varieties and production technology. Therefore, new variety and technology adoption are expected to be high in this district. Hence, Anuradhapura district was selected for this study to elucidate the declining trends in extents of mungbean and cowpea cultivations. The analysis was confined to *maha* season in which grain legumes are mainly grown under rainfed conditions. The average of cultivated extents in maha seasons in relation to annual cultivated extents of cowpea and mungbean were 69% and 75%, respectively, during the period 1999 to 2009 are (DCS, 1999-2009). The study intended to quantify the profitability of two crops, measure the adoption rates of existing varieties of mungbean and cowpea, identify the farmer preferences on varietal attributes, ascertain the varietal contribution to the production, and other factors of production.

MATERIALS AND METHODS

Primary data used in this study were gathered from a farmer survey conducted in eight different Agrarian Service Centre (ASC) areas in Anuradhapura district of Sri Lanka *viz.* Tanthirimale, Medawachchiya, Rambewa, Elayapatthuwa, Ranorawa, Nochichiyagama, Rajanganya left bank and Rajanganya right bank, in *maha* season 2008/09 using a structured questionnaire. Stratified random sampling technique was adopted to draw forty cowpea-growing farmers and thirty three mungbean-growing farmers from the eight ASC areas. The numbers of sampling units under each ASC area in the two farmer groups was determined on the basis of cultivated land extent of each crop in respective ASCs. The total cultivated land extent of cowpea and mungbean in Anuradhapura district during *maha* season 2008/09 were 1089 ha and 639 ha, respectively (DCS, 2009). Cost and return calculations and cost-benefit analysis were performed to assess the financial viability of cowpea and mungbean production under traditional rainfed farming. Complete budgeting technique was adopted to estimate cost and profitability including and excluding the costs of farmer-owned inputs (imputed costs).

The analytical indicators used in assessing financial performance are return to man day (Equation 1) indicating the gross return per day of labour used (including imputed cost), return to capital (Equation A) indicating the gross return per unit of cash cost incurred (IRRI, 1991), benefit/cost (Equation 3) indicating the gross return per rupee spent, and the breakeven yield (Equation 4) indicating minimum yield levels to be achieved to cover total cost of cultivation including (excluding) imputed cost of the two crops.

$$\text{Return to manday} = \frac{\text{(Profit excluding imputed cost + cost of hired labour)}}{\text{Total mandays}} \quad \text{Eq. 1}$$

$$\text{Return to capital} = \frac{\text{Gross return}}{\text{Cost of cultivation excluding imputed cost}} \quad \text{Eq. 2}$$

$$\text{Benefit/cost ratio} = \sum_{j=1}^{n} B_j \Big/ \sum_{j=1}^{n} C_j = \frac{\text{Gross income}}{\text{Total cost of cultivation including imputed costs}} \quad \text{Eq. 3}$$

where, B_j= benefits(Rs/ha)of j^{th} farmer, C_j = costs (Rs/ha) of j^{th} farmer

$$\text{Break –even yield including (excluding) imputed cost} = \frac{\text{Total cost including (excluding) imputed cost}}{\text{Farm gate price}} \quad \text{Eq. 4}$$

The primary data collected for costs and profitability computation are season-specific, and hence, do not show the pattern of change in profitability. Therefore, the cost and profitability parameter estimates of these crops during past *maha* seasons, extracted from published data on cost of cultivation (COC) studies of the DOA, were transformed to real values I 2009 using GDP deflator (Central Bank, 2009) to facilitate comparison.

Adoption percentages were computed to measure popularity of varieties. The area adoption percentage of g^{th} variety is given in Equation 5;

$$\text{Adoption percentage} = 100 * \sum_{k=1}^{s} L_{gk} \Big/ \sum_{g=1}^{r} \sum_{k=1}^{s} L_{gk} \quad \text{Eq. 5}$$

where, L_{gk} is the land extent cultivated by k^{th} famer to g^{th} variety; k=1...s are the farmers growing g^{th} variety, and g=1.....r are the varieties grown by the sample.

Production functions of 'Cobb-Douglas' functional form were estimated separately for each crop to ascertain the contribution of varieties and other factors to production. In the selected model (Equation 6), total production was considered as the dependent variable and independent variables were land extent cultivated, seed amount used, labour used, amount of fertilizer applied, cost of plant protection(insect pests and disease control), and cost of chemical weed control and varieties cultivated (dummy variables).

$$\ln Y_j = b_0 + \sum_{i=1}^{6} b_i \ln X_{ij} + \sum_{g=1}^{r-1} d_g . Z_{gj} + \varepsilon_j \qquad \text{Eq. 6}$$

where, ln is the natural logarithm, Y_j is the out put of j^{th} farmer (yield of cowpea or mungbean crops) measured in kg, X_{ij} is the i^{th} input amount used by j^{th} farmer, [Land area (X_1) measured in hectare, amount of seed used (X_2) measured in kg, labour used (X_3) measured in man days[1], total fertilizer used (X_4) measured in kg, cost of plant protection (X_5) measured in Rs, and cost of chemical weed control(X_6) measured in Rs], g = 1....r is the number of varieties cultivated, d_g is the coefficient for g^{th} variety and exp (d_g) gives the portion of production due to g^{th} variety in comparison to reference variety, Z_{gj} are binary variables that take value of one for g^{th} variety and zero for all other varieties, and ε_j is the error term. The coefficient b_0 is the intercept and the coefficients of b_1 to b_6 are production elasticities of respective inputs. Hence, the coefficients b_1 *to* b_6 show the percentage change in production in response to one percent change in the respective input. The functions were estimated using Ordinary Least Squares.

As the main interest was to investigate the direction and the extent of various factors affecting yield of cowpea, the dummy variables created in the model for six varieties cultivated by farmers viz. 'Bombay', 'Arlington', 'MI-35', 'Dhawala', 'Waruni' and other local varieties were based on their average yield performance and rate of adoption by farmers. Similar varieties were pooled together to create single dummy variable representing all of them. Accordingly, the cowpea variety 'Waruni' and other local varieties were considered as 'Other varieties'. In order to assess the performance of old and more popular cowpea varieties, the variety 'Dhawala' was considered as the 'reference' variety in the model. Therefore, the average yield performances of all other significant varieties were expressed as compared to the variety 'Dhawala'. As for mungbean, the variety 'Harsha' and 'other local varieties' were pooled together and considered as the category 'other varieties' and also was considered as the reference variety in the model. The varieties 'MI 06', 'MI 05' and 'Ari' were represented by dummy variables.

[1] A man-day is considered eight working hours and one woman working day is considered equal to 0.7 man day , however, a woman day is considered as equal a` man day for specific operations as seeding, thinning, harvesting and weeding.

RESULTS AND DISCUSSION

Cost of cultivation of cowpea and mungbean in Anuradhapura district under rainfed condition

The total estimated Cost Of Cultivation (COC) of cowpea is Rs. 68,027/ha of which Rs.8,265/ha (12%) is spent as cash cost and the balance (Rs 59,762/ha; 88%) is the cost imputed to family labour used. The cost of hired labour contributed to about 7% of the total cost and that of purchasing material inputs is about 5% (Table 1). The slack family labour is the most important input used in cowpea production. The total COC of mungbean is Rs.77, 376/ha of which Rs. 18,474 (24% of total COC) is spent on purchase of inputs. Accordingly, the share of family labour cost is 76% in mungbean production. About Rs. 7,445/ha (10% of total COC) is incurred on purchasing material inputs. The relatively high seed rate, and usage of agrochemicals on plant protection and fertilizer have led to have higher material cost and its share in total COC of mungbean when compared to cowpea (Table 2). The number of hired labour units per hectare used in mungbean is higher than that in cowpea. Similarly, the share of hired labour and cash costs in total COC of mungben is higher than that in cowpea (Table 1 and 2). As the varieties with determinate growth habit are exclusively grown in mungbean cultivation, timely cultivation operations, and timely application of material inputs in harmony with rainfall and other climatic variables are important. Therefore, the flexibility of using slack family labour is low in mungbean cultivation when compared to cowpea cultivation.

Table 1. Cost of cultivation of cowpea under rainfed condition during 2008/09 *maha* season in Anuradhapura district

Parameter	*Unit*	*Quantity used/ha*	*Average price(Rs)*	*Cost of inputs (Rs/ha)*	*% Share of of total cost*
Labour					
Hired labour	mandays	9.23	503.13	4,643.89	6.83
Family labour	mandays	118.78	503.13	59,761.78	87.85
Total labour	mandays	128.01		64,405.67	94.68
Materials					
Fertilizer	kg/ha				
Seed	kg/ha	10.2	113.42	1,156.88	1.70
Agrochemical	Rs/ha			2,464.06	3.62
Total material cost				3,620.95	5.32
Total cost	Rs/ha				
Total cash cost *	Rs/ha			8,264.84	12.15
Total cost incl. imputed cost **	Rs/ha			68,026.62	100.00

*total material cost + cost of hired labour;**total material cost + cost of total labour

Table 2. Cost of cultivation of mungbean under rainfed condition during 2008/09 *maha* season in Anuradhapura district

Parameter	*Unit*	*Quatity used/ha*	*Average price(Rs)*	*Cost of inputs (Rs/ha)*	*% Share of total cost*
Labour					
Hired labour	Mandays	21.14	521.72	11,029.16	14.25
Family labour	Mandays	112.9	521.72	58,902.19	76.12
Total labour	Mandays	134.04		69,931.35	90.38
Materials					
Fertilizer	kg/ha	9.12	76.02	693.30	0.90
Seed	kg/ha	22.67	109.64	2,485.54	3.21
Agrochemicals	Rs/ha			4,266.22	5.51
Total material cost				7,445.06	9.62
Total cost	Rs/ha				
Total cash cost *	Rs/ha			18,474.22	23.88
Total cost including. imputed cost **	Rs/ha			77,376.41	100.00

*total material cost + cost of hired labour;**total material cost + cost of total labour

Accordingly, a relatively high commercial orientation in the resources use is required for mungbean production, which may partially be attributable to the relatively sharper decline in extent of mungbean cultivation during recent years when compared to that of cowpea (Figure 1).

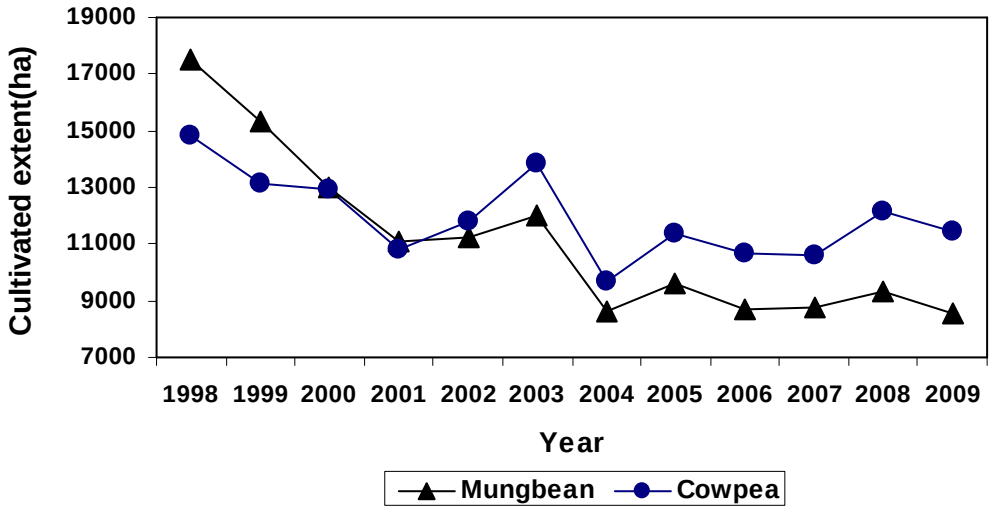

Figure 1: Annual national cultivated extent of cowpea and mungbean in Sri Lanka, 1998-2009 (Source: Department of Census and Statistics, 1998-2009)

Comparison of yield levels, farm gate prices and profits of cowpea and mungbean productions

The profit including (excluding) imputed cost of family labour is Rs 21,662/ha (Rs 81,423/ha) for cowpea and Rs -16,290 (Rs 42,612/ha) for mungbean (Table 3). Cost of production, farm-gate prices, and productivity are the main factors affecting (Herath and Suraweera,1987). Higher COC (including and excluding imputed costs) and lower yield in mungbean, whe compared to cowpea, have led to accruing relatively lower profits excluding imputed costs and accruing a loss when imputed costs are accounted in the former. The average farm-gate price received by farmers of cowpea and mungbean are 77 Rs/kg and 83 Rs/kg, respectively. The marginally higher price received for mungbean has not been adequate to compensate the effects of lower yield obtained and higher costs incurred in mungbean production. Both crops give reasonable returns to labour, when the average wage rate of slightly above Rs 500/man day (Tables 1 and 2) is considered.

The return to labour of Rs 400/man day in mungbean is noteworthy considering the fact that crop has incurred losses in this season. Both crops gave high returns to capital investment. At the present scales of cultivation and the level of technology used, these two crops are able to generate reasonable returns to labour and capital. The benefit cost (B/C) ratio, return to labor, and return to capital are also comparatively higher in cowpea than in mungbean production. Relatively lower cash investment requirement of cowpea, compared to mungbean has also contributed to the relatively high return to capital in cowpea. The break-even yield level (including imputed cost) of mungbean is 932 kg/ha. Therefore, at the given farm-gate prices, mungbaen crop would have given zero profit of at a yield of 932 kg/ha.

Table 3. Yields and returns of cowpea and mungbean cultivations under rain-fed system in Anuradhapura district

Yield and returns	*per ha*		*per farm*	
	cowpea	***mungbean***	***cowpea***	***mungbean***
Average Yield (Rs/kg)	1165.69	735.00	198.17	73.50
Farm gate price of produce(Rs/kg)	76.94	82.85	76.94	82.85
Gross income(Rs/ha)	89688.19	60894.75	15246.99	6089.48
Profit (Including imputed cost)(Rs/ha)	21661.57	- 16289.79	3682.47	-1648.17
Profit (Excluding imputed cost)(Rs/ha)	81423.35	42612.40	14420.51	4242.05
Per unit cost (Including imputed cost)(Rs/kg)	58.36	105.01	58.36	105.01
Per unit cost (Excluding imputed cost)(Rs/kg)	7.09	24.87	7.09	24.87
Benefit/Cost	1.32	0.79	1.32	0.79
Return to labour (Rs/manday)	672.35	400.19	672.35	400.19
Return to capital	10.85	3.33	10.85	3.33
Break even yield including imputed cost kg/ha	884.15	931.62	150.31	93.39
Break even yield excluding imputed cost kg/ha	107.42	220.67	10.74	22.30

The average farm sizes of cowpea and mungbean crops are 0.17 ha and 0.1 ha, respectively accordingly the profits including imputed cost of family labour is Rs

3,682.50 for cowpea and Rs -1648.20 for mungbean. The profit excluding imputed cost of family labour is Rs.14, 420.50 for cowpea and Rs 4,242 for mungbean, respectively.

Distribution of farmers' profitability in cowpea and mungbean productions during past *maha* seasons

Changes in cost and profitability of cowpea and mungbean productions during past four *maha* seasons in 2009 real values are shown Tables 4 and 5, respectively. The yield of cowpea in 2008/09 *maha* season is above the average of previous three years, thus indicating this is a better season for cowpea. The farm-gate price received in the 2008/09 *maha* season is similar to the average of the previous three years. The results (Table 4) indicate that increase of yield is the major contributor to the higher gross return of cowpea during a season.

Table 4. Distribution of costs and returns of cowpea production during past *maha* seasons in different districts of Sri Lanka

	Season				
Costs and returns	***2005/06***	***2006/07***	***2007/08***	***3 year average***	****2008/09***
Total cost incl. imputed cost (Rs/ha)	55,751.43	64,726.74	62,477.70	60,985.29	68,026.62
Total cost on labour(Rs)	46,085.85	45,949.89	53,458.42	48,498.05	64,405.67
Total man days used(mds)	106.21	111.15	123.50	113.62	128.01
Wage rate(Rs/manday)	438.37	416.46	436.11	430.32	503.13
Profit incl. imputed cost (Rs/ha)	7,152.48	26,319.79	25,421.77	19,631.35	21,661.57
Profit excl. imputed cost (Rs/ha)	49,401.93	63,363.72	65,455.60	59,407.08	81,423.35
Yield (kg/ha)	993	1,164.00	1,072.00	1,076.33	1,165.69
Farm gate price(Rs/kg)	63.35	78.22	82	74.52	76.94

Source: SEPC, publications of costs of cultivation of agriculture crops and survey results (2005-2009)

The total cost and labour cost in the 2008/09 *maha* season was grater than the average values recorded for previous three years, and the increase in labour cost is higher than the increase in total cost. Therefore, the rise in labour cost is the major contributor for the rise in total cost in the present production season. Higher labour usage and higher wage rate are the major causes for the total cost in *maha* season 2008/09, placing the total cost at a higher level than the average of previous three years. Due to the higher yield received in the reference season, the profits excluding and including imputed costs are higher than the average of previous three years.

The yield and farm-gate price received for mungbean in 2008/09 *maha* season (Table 5) are below the average values, but the total cost is above the average of the three previous years. Similar to the case of cowpea, the increase in labour cost in mungbean cultivation, which could be mainly attributed to higher labour rates used, is

higher than the increase in total cost. Apparently, 2008/09 *maha* season is worse than an average season for mungbean in terms of yield, prices and costs incurred. All these three factors have contributed to incurring losses when imputed costs of family owned inputs also are accounted.

Table 5. Distribution of costs and returns of mungbean production during past *maha* seasons in different districts of Sri Lanka

Costs and returns	*Season*				
	2005/06	*2006/07*	*2007/08*	*3 year average*	**2008/09*
Total cost incl. imputed cost (Rs/ha)	60,978.56	58,287.75	63,510.56	60,925.62	77,376.41
Total cost on labour(Rs)	49,268.49	48,589.82	51,150.13	49,669.48	69,931.30
Total man days used	106.21	91.39	93.86	97.15	134.00
Wage rate(Rs/manday)	463.59	527.03	556.49	515.70	521.72
Proft incl. imputed cost (Rs/ha)	16,602.89	23,579.57	17,104.10	19,095.52	-16,289.79
Profit excl. imputed cost (Rs/ha)	44,924.86	54,557.74	50,917.28	50,133.29	18,474.22
Yield (kg/ha)	887	833	843	854.33	735
Farm gate price(Rs/kg)	87.46	98.28	95.63	93.79	82.85

Source: SEPC, publications of costs of cultivation of agriculture crops and survey results (2005-2009)

Distribution of varieties of cowpea and mungbean among farmers

Although a number of cowpea varieties and selections have been released by the DOA, the varieties 'Bombay' and 'Arlington' (released 79 years and 34 years before, respectively; MADAS 2009) are still the mostly adopted varieties in Auradhapura district, followed by the variety 'Dhawala'. Among the mungbean varieties 'MI-06' is the most popular followed by 'MI 05 and 'Harsha' (Table 6).

Table 6. Adoption rate of cowpea and mungbean crops in terms of cultivated extent and number of farmers adopting the varieties

Cowpea Variety	*% of cultivated extent*	*% of cultivated farmers*
Bombay	36.88	37.5
Arlington	36.61	32.5
Dhawala	13.99	12.5
MI 35	2.2	5.0
Waruni	2.94	2.5
Other local varieties	7.38	10.0
Mungbean Variety	*% of cultivated extent*	*% of cultivated farmers*
MI 06	50.14	49.0
MI 05	16.52	18.0
Harsha	19.94	18.0
Ari	8.55	9.0
Other local varieties	4.84	6.0

Preferences of farmers for attributes of cowpea and mungbean varieties

As depicted by Table 7, 87.5% of cowpea-growing farmers and 58% of mungbean-growing farmers have expressed their preference for large seeded varieties, as small seed size have led to low market values for the produce.

Table 7. Preferences of farmers for characters of new cowpea and mungbean varieties

Expected attributes from a new variety	*% of Responses from*	
	Cow pea farmers	*Mungbean farmers*
Size of seed		
Small	2.5	3.0
Medium	10.0	39.0
Large	87.5	58.0
Appearance of seed /Seed coat		
Gloss appearance	65.0	73.0
Matt appearance	35.0	27.0
Growth pattern		
Determinate	10.0	25.0
Indeterminate	90.0	75.0

Seed appearance, which determines the consumer preference, is also an important character in selecting varieties in both crops and hence, 65% of cowpea-growing and 73% of mungbean-growing farmers have expressed their willingness to cultivate varieties having seed coats with glossy appearance.

Indeterminate growth pattern was preferred by 90% of cowpea-growing farmers and 75% of mungbean-growing farmers (Table 7). Under rain-fed environment where time and amount of rainfall is not certainly known, farmers prefer varieties with indeterminate growth habits that can recover with a spell of rainfall after any setbacks due to inadequate or surplus water availability.

Nature of farming by farmers of cowpea- and mungbean-growing farmers in Anuradhapura district

About 26 kg (13% of total yield) of cowpea and 15 kg (21% of total yield) of mungbean were consumed at home and the balance was sold (Table 8). These levels of consumption are above the average per-family consumption levels of the country. Both crops incurred small cash costs to the farm families at present scales of production. The net cash income per family was less than Rs 12,000 from cowpea, and less than Rs 3000 for mungbean per season (Table 8). Thus, it is clear that these farmers are engaged in semi-subsistence level farming, and production of these crops is not their major sources of income.

Table 8. Mean cash income and cost of farmer of cowpea and mungbean cultivations per season

Crop	*Average farm size (ha)*	*Average yield kg/farm*	*Sold portion kg/farm*	*Home consumed kg/farm*	*Average Gross income Rs/farmer*	*Total cost Rs/farmer*	*Net Income Rs/ farm*
Cowpea	0.17	198	172	26	13,234	1,405	11,829
Mungbean	0.1	74	58	16	4,805	1,847	2,958

Contribution to the yield by varieties and other factors of production of cowpea cultivation under rain-fed farming system

The estimates of regression analysis indicated that the total number of labor used and cost on chemical weed control significantly influence average yield performance of cowpea, whereas varieties 'Bombay' and 'Arilington' significantly out-yielded($p<0.05$) the reference variety, 'Dhawala'. The 'MI 35' and 'other varieties' including 'Waruni' did not show significantly higher yields ($p>0.05$) when compared to the reference variety (Table 9).

Table 9. The results of the estimated production function for cowpea

Dependent variable	*Predictor variables*	*Coeff.*	*SE[1]. coeff.*	*'p' value*	VIF[2]
LnY-Yield (kg)	Constant	***3.197	1.100	0.007	
	LnX_1-Farm size (ha)	0.0165	0.3129	0.958	5.1
	LnX_2-Seed amount used(kg)	0.4251	0.2635	0.117	3.9
	LnX_3-Total labour used (mds)	**0.4172	0.1812	0.029	3.3
	LnX_4-Quantity of fertilizer used (kg)	-0.0033	0.0326	0.919	1.2
	LnX_5-Cost on plant protection(Rs)	0.01685	0.0159	0.301	1.2
	LnX_6-Cost on chemical weed control (Rs)	**0.028	0.0124	0.031	1.8
	Z_1-Bombay (Dummy variable)	**0.5832	0.2454	0.024	1.9
	Z_2 - Arlington (Dummy variable)	*0.5338	0.2663	0.054	2.1
	Z_3 -MI 35 (Dummy variable)	-0.1372	0.4518	0.764	1.3
	Z_4 -Other Variety (Dummy variable)	0.3822	0.4540	0.407	1.3
No. of observations= 40	R^2 = 76.4%	R^2(adj) = 68.3%	F value 9.4	(P=0.000)	

[1]SE- Standard error; [2]VIF- Variance inflation factor ***significant at p=0.001; **significant at p=0.05, * significant at p=0.1

The results imply that varieties 'Bombay' and 'Arlington' give 161% [(exp (0.5832)-1)*100%] and 149% [(exp (0.5338)-1)*100%] higher yield, respectively than the variety 'Dhawala' under rainfed condition. The preferences of farmers (Table 6) for varieties

'Bombay' and 'Arlington' are thus justified by these results.The slope coefficients of the production function are production elasticities. The slope coefficients of labour and weed control indicate that 1% increases in each parameter 'labour inputs used', and 'cost on chemical weed control used' would contribute to 0.42% and 0.028% increases of cowpea yield, respectively. In traditional farming systems, labour is the major input and hence, it is the most significant variable (LnX_3) when there is a constraint on availability. As weed control is inadequately attended in traditional farming systems, chemical weed control (LnX_6) has a significant effect on yield.

Contribution to the yield by varieties and other factors of production of mungbean cultivation under rain-fed farming system

In the production function of mungbean, constant, slope coefficient for labour, and coefficients of dummy variables were statistically significant($p<0.05$),only for varieties MI 05, and MI 06, while the slope coefficient for fertilizer variable and coefficient for dummy variable for variety 'Ari' were significant only at p=0.1(Table 10).

Table 10. The results of estimated production function for mungbean

Dependent variable	*Predictor variables*	*Coeff.*	*SE. coeff*	*'p' value*	*VIF*[2]
LnY-Yield (kg)	Constant	**2.962	1.057	0.01	
	LnX_1-Farm size (ha)	0.4021	0.284	0.171	6.8
	LnX_2-Seed rate(kg)	0.264	0.233	0.269	5.9
	LnX_3-Total labour (mandays)	**0.309	0.145	0.044	2.5
	LnX_4-Quantity of fertilizer used(kg)	*-0.036	0.019	0.076	2.2
	LnX_5-Cost on plant protection (Rs)	-0.012	0.019	0.542	2.0
	LnX_6-Cost on chemical weed control (Rs)	-0.023	0.014	0.113	1.8
	Z_1 –MI 06 (Dummy variable)	***0.958	0.288	0.003	3.3
	Z_2–MI 05 (Dummy variable)	**0.683	0.303	0.035	2.2
	Z_3 -Ari (Dummy variable)	*0.706	0.405	0.095	2.2
No. of observation 33	R^2 = 81.3%	R^2(adj) = 73.7%	F value 10.64	(P=0.000)	

SE-standard error, [2]VIF-Variance Inflation Factor *** Significant at 1% probability level, ** Significant at 5% probability level, *significant at 10% probability level

The coefficient of total labour indicates that 1% increase in the total number of labour applied will increase the mungbean yield by 0.30%. The mungbean varieties 'MI 06', 'MI 05' and "Ari' outperformed the reference category of other varieties by 160% [(exp(0.958)-1)*100%], 98% [(exp(0.683)-1)*100%], and 103% [(exp(0.706)-1)*100%], respectively.

The coefficient of quantity of fertilizer used (LnX_4) was -0.036. The direction of the effect of this variable is in contrary to the expectation, due to that the mungbean farmers were over-using nitrogen fertilizer (Table 2). As in the case of cowpea crop, the total number of labor used (LnX_3) showed a positive effect on average yield performance in mungbean crop. It was observed that increasing the labour usage is not economically worthwhile[i] at current wage rates, farm-gate prices of output and mean resources use levels.

CONCLUSIONS

Mungbean and cowpea extents in Sri Lanka have been declining over the years despite several high yielding varieties of both crops have been released in the recent past. A analysis of the cost of production, profitability and use of the final produce in Anuradhapura district (A main district in the country where these two crops are grown) indicated that both crops are cultivated as semi-subsistence income avenues giving a marginal additional farm income. Apparently, the limited family labour is critical in determining cultivated land area of both crops.

The real costs of production of both crops in 2008/09 *maha* season were above the average. Increase in labour cost is the major contributor for the increase in cost of production. Seasonal profitability has been dependent on the variable average yields. 'Bombay' and 'Arlington', two indeterminate cowpea varieties that have been released before 1976 are the most popular varieties. They out performed (in terms of yield) more recent released varieties 'Dhawala' and 'Waruni", which are less popular among farmers who cultivate these crops under rain-fed conditions. The mungbean varieties 'MI 06' and 'MI 05', and 'Ari' outperformed variety 'Harsha' and other local varieties. The variety MI 06 was the most popular mungbean variety among farmers in the Anuradhapura district.

The semi-subsistence orientation of the crops that give low profits, having limited family labour, and poor performance of recently released varieties of cowpea, and below-potential yield performance of mungbean variety, 'MI 06' are the major

[i] $\varepsilon_S = \delta Q/\delta L * L/Q$, $\varepsilon_S * Q/L = MP$, MP* Price of produce= MVP, if MVP/MFC >1 increasing labour is worthwhile. Where; ε_S -elasticity of labour (coefficient of labour in production function), Q-average yield of the crop, L-average labour used in mandays, MP-Marginal product of labour, MVP- marginal value of product (MVP=MP* average price of produce) MFC-Marginal factor cost (average labour wage rate). Although labour is a significant variable on yield, increasing labour is not worthwhile in terms of allocative efficiency computation.

constraints for expansion of these crops. Research should be geared towards releasing a high yielding mungbean variety with indeterminate growth pattern.

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REFERENCES

Central Bank,2009, Annual report for the year 2009, Central Bank of Sri Lanka, 30, Janadhipathi Mawatha Colombo,Sri Lanka.

Customs, 2009. External trade statistics report, 2009 Sri Lanka Customs, Colombo, Sri Lanka.

DCS, 1998-2009, Various issues of Statistical Abstracts of 1998-2009, Department of Census and Statistics, Colombo, Sri Lanka.

DOA, 2000, Recommended field crop varieties (variety catalogue Part-1) pp 4, Department of Agriculture, Peradeniya, Ministry of Agriculture and lands, Battaramulla, Colombo, Sri Lanka.

DOAMAL, 2003; Fifty years of research 1950-2000, pp 67,85 Field Crop Research and Development Institute, Mahailluppallama, Department of Agriculture, Peradeniya, Ministry of Agriculture and Livestock, Battaramulla, Sri Lanka

Ediriweera N.D, 2003; Processing and utilization of legumes, pp 235, Asian Productivity Organization Tokyo, Japan, Edt. S. Shanmugasundaram, Asian Vegetable Research and Development Centre, Tinan, Republic of China.

Herath H.M.G. and D.E.F. Suraweera, 1987 Socio economic aspects of food legume production in Sri Lanka, pp7, Proc. Improved Productions and Utilization of Food Legumes in Sri Lanka, Editors. H.P.M. Gunasena and H.M.G. Herath, Faculty of Agriculture, University of Peradeniya, Sri Lanka.

IRRI. 1991. Basic Procedures for Agroeconomic Research revised edition, pp.38, International Rice Research Institute, Manila, Philippines.

MADAS. 2009. Department of Agriculture' Profile pp 27, Ministry of Agriculture Development and Agrarian Services, Battaramulla, Colombo, Sri Lanka

SEPC (various issues). 2005-2009. Cost of cultivation of agricultural crops, Socio Economics and Planning Centre, Department of Agriculture, Peradeniya, Sri Lanka.