International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Labour And Capital Productivity Under Shifting Cultivation: A Case Study of Siang Regions of Arunachal Pradesh

Dr. Margum Ado[1], Dr. Limo Ete[2]

[1]Assistant Professor, Department of Economics, CDOE, RGU.
[2]Associate professor, Department of Higher and Technical Education, A.P

Abstract

A study on shifting cultivation in a state heavily reliant on agriculture found that over 80% of current production is organic, indicating a strong potential for a full transition, despite currently low productivity due to unsuitable conventional inputs for the region's challenging terrain and climate. The study defined labour productivity as output per unit of labour and capital productivity based on output yield relative to the cost of capital, identifying village and district variations in both measures linked to factors like household size, workforce, cultivation days, yield, and capital availability. Two regression models examined productivity in shifting cultivation. The first model, explaining 94.3% of variance in output per unit of labour, found positive correlations with area under cultivation , percentage of workers in self-cultivation , and output per unit of capital, suggesting labour and capital complementarity. Negative correlations were found with average person-days, percentage of labour in shifting cultivation and average household size, indicating that increased labour engagement on a fixed plot size can reduce productivity. The second model, explaining 94.9% of variance in output per unit of capital, showed positive relationships with average person-days, average household size, average age of household head, and labour productivity, again supporting labour-capital complementarity. A negative relationship was observed with the percentage of workers in self-cultivation, potentially due to higher capital productivity in alternative activities.

Keywords: Shifting cultivation, NSVA, Depreciation, Capital productivity, labour productivity & Output.

1. Introduction

Arunachal Pradesh has a total population of 13.83 million as per the 2011 census, 70 per cent of which depended on agriculture for their livelihood. The state is positioned in a suitable Agro-climatic zone and gifted with vast natural resources. Therefore, agriculture became the central strategy for planned socio-economic development to achieve self-reliance and the household's food security. The diversity of crops in the state is the crucial factor for the suitable food supply chain, and most crops are organic. More than 80 per cent of the state agricultural production is organic and had an excellent opportunity for moving towards the organic farming exercise. The productivity remained low in the state and the high-yielding Seeds and other chemicals were not appropriate for the farming community, as most of the population (77.06 per cent) lived in rural areas and farmers practising Jhum cultivation. This low productivity of crops was primarily due to the negligence of chemicals and other fertilisers in the past, but in the present scenario, it has becomes the major strength in the organic agricultural movement. Most of the land is hilly terrain and Jhum cultivation is the major agricultural activity of the state to sustain their livelihood (Dept, of Agriculture)

Kalita, et al (2017), most of the gross cropped area was under Jhum cultivation. The difficult topography, hilly terrain, persistent rain and severe climatic condition in hilly regions compelled the indigenous tribes to adopt old-age Jhum cultivation. The traditional Jhum cultivation was found to be efficient and economically suitable for this region, whereas, the other alternative is not suitable.

2. Methodology

The primary data was collated from a field survey conducted during 2019-20. The research began with a preliminary observation (pilot survey) to identify and understand the on-field dynamics, followed by a brief ethnographic mapping of the region. This initial phase was crucial for comprehending the field context and effectively structuring the data collection instruments (schedules and questionnaires).

Quantitative data was gathered using a structured schedule, while more qualitative, non-quantifiable information was obtained using a semi-structured questionnaire. After the pilot survey and the subsequent refinement of these tools, intensive data collection was undertaken using the ethnographic method.

To determine the optimal sample size, various sampling techniques were considered. The pilot survey revealed that while shifting cultivation is prevalent in many villages of the Siang region, the number of households and the ratio of shifting cultivators in many areas were too low to extract comparable data. It was also noted during this preliminary phase that no villages currently practice 100 percent shifting cultivation. Consequently, to maintain a minimum standard for comparing villages, the study employed a purposive sampling strategy, selecting only those villages where 35% or more of the total households practice shifting cultivation. This approach resulted in a total sample size of 368 households.

2.1. Net State Value Added (NSVA) Deflators

The NSVA price deflator helps in comparing the real economic output level from one year to another. The NSVA price deflator, or NSVA deflator, measures the fluctuations in price for all goods and services produced in an economy. The NSVA deflator is calculated using the formula:

NSVA deflator = (Nominal NSVA / Real NSVA) X 100

Nominal NSVA measures the current price, and real NSVA measures the constant price. As such, the NSVA deflator shows how much the change in NSVA depends on the change in price. Therefore, the Real NSVA is calculated using the formula:

Real NSVA = (Nominal NSVA / Deflator) X 100

In measuring any output, a physical quantity is more preferable. However, the study is also intense to undertake the inducement to petty transactions and marketable surpluses. Further, the crops from shifting cultivation also vary from a location (sampling districts), both intra- as well as inter-location. Hence, it is more suitable to convert the output to real value terms to make a comparative analysis. It is therefore required as a standard measuring yard exclusive of the price differential. For these reasons, the NSVA deflator was created using the data for the financial year 2019-20, specifically for the state of Arunachal Pradesh.

2.2. Price of the crops

The price value of the crops is taken from the nearest market of the villages, and for the crop items that are not available in markets, the value has been imputed on the basis of the amount of labour time involvement in management of that seed inventory by per day wages of the concerned area.

2.3. Various measures of output

The gross output here refers to the summation or aggregation of all the output produced in physical quantity in one production cycle.

Value of output here refers to the product of a particular commodity and its respective price.

$GO = \sum_{i=1}^{n} Xi$

Where,

$i = 1, 2, \ldots\ldots\ldots n$

$n = 34$

GO = Gross output

X_i is the i^{th} crop

Value of output (Vo) = (G_i) X (P_i)

Where,

G_i is the Gross output of the i^{th} commodity

P_i is the price of the i^{th} commodity

2.4. Yield per acre

Crop yield is the amount of agriculture production actually harvested per unit of land. In the study the yield of crops is measured as

$Y = Q/A$

Where,

Y = Yield per acre

Q= Quantity of output actually harvested in quintals

A = Total Area in acres.

For the respective districts, the yields is computed as,

$Y = \sum_{i=1}^{n} Qi/Ai$

Where,

Y = Yield per acre

Q_i = Quantity of output actually harvested in the sample villages in quintals.

A_i= Total Area of land in acres in surveyed villages of a district.

$i = 1,2\ldots\ldots n$

2.5. Value of Output per acre

Since many Crops are grown on a piece of jhum land, the output per acre is the value of agricultural production per unit of land. The output per acre is measured by;

$Y = \sum_{i=1}^{n} Qi\ Pi/Ai$

Where,

Y = output per acre

Q= Quantity of output actually harvested in quintals

P= Market price of the product

A = Total Area in acres

$i= 1,2,\ldots\ldots n$

2.6. Depreciation

Depreciation in standard conceptualization refers to the wear and tear of the fixed capital. In this study, it is, however, perceived in a broader way so as to account for the used-up capital. The used-up capital here includes axes, machetes, etc. (Dao, inclusive of iron knives and weeders). As fixed capital spreads out evenly, the cost of fixed capital is taken at a deflated or real value, distributed evenly across its lifetime. The fixed capital is, therefore, presumed to spread across 10 years equally. Hence, the value of depreciation is taken only for one year.

2.7. Output per unit of capital

Capital productivity refers to the capacity of capital to generate output. It reflects the influence of capital inputs, which in turn reflects overall production efficiency. In this study, the value of fixed capital, working/circulating capital, or else are all at the deflated value or in real terms.

Fixed capital here refers to the used-up or depreciated equivalent of fixed capital during one crop cycle. The working capital refers to the significant/circulating capital; for simplicity and analytical convenience, these include the weeders (bamboo or wooden), wooden sticks, and a few miscellaneous expenditures during the operation of shifting cultivation. Miscellaneous expenses include the value equivalent of the cost incurred in the operation of the pursuit, such as refreshment/food items incurred during rites, making huts, and other petty expenses, whether actual or imputed.

So, the output per unit of capital is the ratio of the total value of output divided by the total capital used in production.

Kp = $\sum_{i=1}^{n} Qi\ Pi/TCi$

Where, Kp = output per unit of capital

TC = Total value of capital Capital

Q = total value of Output

P= price of the product

i= 1, 2…….n

Where, TC = FC+WC

In other words the Total Capital (TC) comprises of Fixed Capital (FC) and Working Capital (WC).

2.8. The density of crops

In the measurement of yield, often the whole acreage is considered. This is a logical fallacy which can be applied to a situation where only one crop is grown. Shifting cultivation, unlike single cropping, involves multiple crops—often ensuring mutual crop insurance among the basket of crops. As such, using simple acreage to measure crop yield per acre in a consolidated manner is a misnomer.

The study, therefore, delves upon the density approach for arriving at crop yield. The relevant literatures in this regard are Reynolds et al. (2015), Wineman et al. (2018), and FAO (2017). This approach to crop yield takes into account not the gross area but the density within the cropped area for each crop. Such a quantification approach highlights a more accurate area actually covered by a particular crop and reflects a better grasp of the yield therein.

2.9. Labour productivity

Labour productivity refers to the output per unit of labour. Labour productivity is the ratio of the volume measure of output to a measure of input used, i.e.

PL = Q/L

Where,

PL = Labour productivity

Q = volume measure of output

L = Labour units.

Whereas, in terms of value, Labour productivity is the value of output per unit of labour. It is the ratio of total value of agricultural output to total labour input.

$P_L = \sum_{i=1}^{n} Qi\ Pi/Li$ Where,

P_L = Labour productivity

Q = volume measure of output

P= Market price of the product

L = Labour units.

i= 1,2,…..n

The standard measure of labour is the total days engaged in a pursuit. However, literature on labour productivity suggests standardized productive labour as 8 hours of continuous work with a break. In the case of set standards in India, it ranges from 9 to 12 hours of productive work. The study does not intend to contest the two extremes, but rather find a middle path. As such, the study averages the mid-value of 10 hours of productive work as the standard labour unit (person-day).

The total man-day is the product of total labour and the number of days engaged in one crop year.

The total labour hours is a product of the total number of days engaged in the year with the average working hours of the particular surveyed areas.

The person-day is measured by the ratio of total labour days to standardized labour hours based on the Indian labour law context. The Indian labour law categorizes the labour hour from 9 to 12 hours in a day, but in the study, we undertake a standard of 10 hours of labour, as most of the cultivators are working in their own field and wage labourers are merely prevalent in the area.

2.10. Regression analysis

In study the following regression model were used to determine the out per unit of labour and Capital used, production cost per rupee of output etc. Following Ordinary least Square (OLS) method were applied such as

$Y = \alpha + \beta iXi + Ui$

Or, $\alpha + \beta_1 X_1 + B_2 X_2 + \ldots\ldots\ldots\ldots.. + \beta nXn$

Where, Y= Dependent variable

α = Constant value of model

X=Independent variables

β = Coefficient value of the variables

i= 1, 2…….n

U= Error term

3. Data analysis:

3.1. The productivity of Labour under shifting cultivation.

Labour productivity refers to the output per unit of labour. In agriculture, labour productivity is a crucial feature of the overall return to labour per unit. The measurement of labour productivity, as is found in the study of Shanmugan and Baria (2019), is the ratio of total agricultural output to total labour input. Freeman (2008) stated that labour productivity is the relationship between production and factors of production. Labour productivity is the ratio of the volume measure of output to a measure of input used.

$P_L = Q/L$

Where,

P_L = Labour productivity

Q = volume measure of output
L = Labour units.
Further, the gross output per capita is the ratio of total output distributed evenly to all the workers involved in shifting cultivation, irrespective of actual production. As per the International Labour Organization (ILO), the actual hours worked relate to the time that a person devotes directly to productive activities, and the mean actual worked hours are calculated by dividing the total number of hours worked per week.
Here, the output refers to the goods and services produced by the workforce, and input refers to the total number of hours worked by all persons employed or total employment (head count). Therefore, to analyse the labour productivity, the gross output is generated and the number of labour engaged in shifting cultivation for surveyed villages is given in Table. 1.

Table: 1
Labour Productivity (Man days) per unit of output
(Output in quintals)

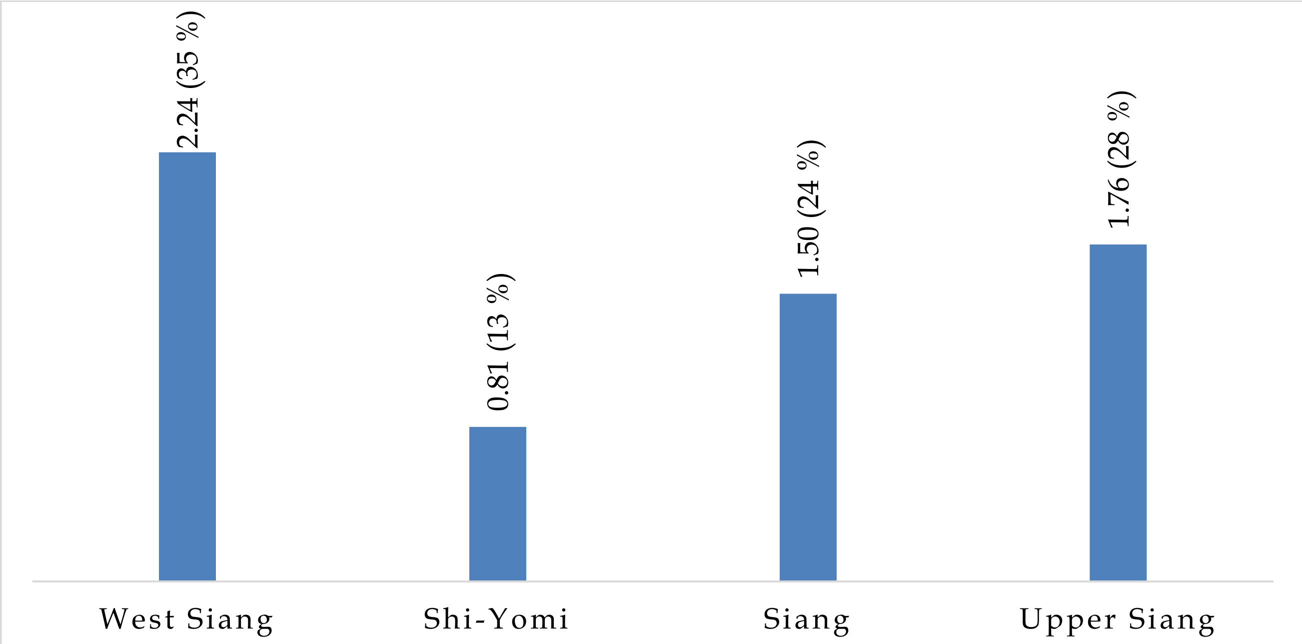
Districts	Villages	Total Labour (Person)	Average Working Hours In A Day	Average Working Days For Household In A Year	Average Person Day In A Year	Mean Value Of Total Labour Hours	Mean Value Of Person Day (Standardise 10 Hours Per Day)	Output (In Quintals)	Labour Productivity (Output Per Unit Of Labour)
West Siang	Jinyo Tarsu Mobuk	64	5.5	76	117.22	1414.11	141.41	226.12	1.6
	Degi Potom	59	5.5	153	214.03	3250.13	325.01	428.89	1.32
	Kambu	63	5.5	81	127.46	1535.42	153.54	192.56	1.25
	Lipu Bagra	99	5.5	79	167.22	1134.74	113.47	484.83	4.27
	Karbak Geyi	94	5.5	154	296.65	2423.17	242.32	856.35	3.53
Shi-Yomi	Rapum	52	5	139	227.88	2111.76	211.18	243.14	1.15
	Purying	38	5.5	160	254.01	3070	307	179.41	0.58
	Gapo	49	5.5	155	260.97	2808.67	280.87	233.25	0.83
	Rego	56	5.5	157	324.6	2283.81	228.38	295.89	1.3
	Hiri	22	5.5	163	285	2801.07	280.11	103.88	0.37
Siang	Molom	57	5.5	114	186.71	2111.03	211.1	325.99	1.54
	Yosing	76	6	113	160.82	2853.33	285.33	310.72	1.09
	Yogong	67	6	107	162.72	2528.12	252.81	294.52	1.16
	Gameng	51	5.5	160	310.05	2458.19	245.82	426.37	1.73
	Gasheng	41	5.5	140	318.6	1853.82	185.38	418.24	2.26
Upper Siang	Kolung	40	6	105	204	1922.31	192.23	259	1.35
	Gobuk	40	5.5	109	239.53	1492.22	149.22	265.03	1.78
	Simong	55	5.5	99	158	1871.72	187.17	238.52	1.27
	New Millang (A)	54	5.5	111	248.72	1490.25	149.03	390.45	2.62
	New Millang (B)	51	5.5	113	255.59	1519.05	151.9	308.43	2.03

Source: Data computed from field survey 2019-20.

Note: Average working day of household = Total working days/Total household
Average Person day in a year = (Total working day/Total labour) X (Average working hour of the area)
Mean value of Total labour hours = (Total labour X Total labour day X Average Working hour of the area)/ Total household
Mean value of Person day (Standardise 10 hours per day) = Mean value of Total labour hours/ 10 hours.
It was observed during the survey that due to cultural events, rites/rituals, and other such events, the majority of the households do not engage themselves the whole year in the agricultural field. It was noted that the respective size of the household determines the output of work days. The relatively

smaller household size had to put in more labour and effort. This relative size of the family also determines the exchange of labour. A larger family size is associated with a larger exchange for labour.
In the above data, Average Working Days for Households is the ratio of total labour days in one crop year by total households. The total person-day is the product of the total number of persons (labourers) and household total day engagement in agriculture during one agricultural year. The total working days is the total number of days engaged in shifting cultivation. Total labour hour is the ratio of the total number of working days to the average working hours.
The mean value of labour hours is a product of the average working hours of the concerned village with the number of days engaged under shifting cultivation in one crop year; (Total labour x total working day x average working hours of the concerned village). The person's day is standardized by 10 hours of productive work in a day. It is rationalized and standard to use the ratio with total labour hours as the numerator and 10 hours as standard person-day labour as the denominator. As per the labour rules in India, the working hours comprises 9 to 12 hours daily. But in our study, 10 hours has been taken as a measure to determine a person-day, because most of the surveyed households were self-cultivated and self-subsistence rather than as wage labourers. The productivity of labour is measured by output per unit of labour.
In Table 1, it is clear that the total number of labourers was highest in Lipu Bagra and Karbak Geyi with 99 and 94 people, respectively, followed by Yosing and Yogong with 76 and 67 people, respectively. The lowest number of labourers was found in Hiri and Purying with 22 and 38 persons, respectively.
The average working hours in a day was 6 hours in the highest-ranking villages amongst all the surveyed villages. The highest was found in villages Yosing, Yogong, and Kolung village. The lowest working hour in the day was found for the village Rapum with 5 hours a day. The average working days of a household in one crop year was highest in Hiri with 163 days, followed by Gameng and Purying with 160 (159.72) and 160 (159.55) days, respectively. The lowest working day of a household in one crop year was found in villages Jinyo Tarsu Mobuk and Lipu Bagra with 76 and 79 days, respectively, under shifting cultivation.
The person-day is the total number of labourers engaged in agriculture during a crop year and its household size. In terms of average person-days in a year, village Rego was highest with 325 days, followed by villages Gasheng and Gameng with 319 and 310 days, respectively. The lowest person-day was observed for village Kambu with 117 days, followed by Jinyo Tarsu Mobuk and Simong with 127 and 158 days, respectively.
The mean value of total labour hours was highest in Degi Potom with 3250 hours, followed by Purying and Yosing with 3070 and 2853 hours, respectively. As we already mentioned the standardized 10 hours a day as the productive working hours. This mean value of person-day is the ratio of total labour hours in a crop year to 10 hours (as a person-day). For the mean value of person-day in a year, Degi Potom was highest with 325 person-days, followed by Purying and Yosing with 307 and 285 days, respectively.
The productivity of labour was highest for village Lipu Bagra with 4.27 quintals per unit of labour; it was followed by villages Karbak Geyi and New Millang (A) with 3.53 and 2.62 quintals, respectively, per unit of labour. The lowest productivity of labour was observed for villages Hiri and Purying with 0.37 and 0.58 quintals, respectively, per unit of labour.
After village wise analysis of labour productivity, the district wise comparison of labour productivity is explain in chart 1.

Chart: 1
District-wise comparison of Labour Productivity under shifting cultivation
(Output in quintals)



Source: Data computed from field survey 2019-20.

Labour productivity under shifting cultivation was compared across districts by combining the mean value of person-days and output from all surveyed villages within each district. West Siang district recorded the highest productivity at 2.24 quintals per unit of labour, accounting for 35 per cent of the total output among the surveyed districts. It was followed by Upper Siang and Siang districts, with 1.74 and 1.50 quintals per unit of labour (28 per cent and 24 per cent, respectively). Shi Yomi district exhibited the lowest labour productivity among the four districts, at 13 per cent.

3.2. Capital Productivity under shifting cultivation

Capital productivity quantifies the capacity of capital to generate output, reflecting the combined impact of capital inputs and overall production efficiency. This study defines capital inputs under shifting cultivation exclusively as fixed capital (e.g., axe, machete, dagger) and working capital (e.g., weeder, wooden stick, miscellaneous expenditures).

Fixed capital is accounted for by its depreciation per crop cycle. Working capital items (wooden sticks, weeders, etc.) are consumed either during or by the end of the production cycle. Miscellaneous costs encompass expenses such as refreshments/food items utilized during hut construction, fence making, ritual performances, and all other operational costs within a single crop cycle (from sowing to stocking crops).

The real cost of capital is computed by deflating the nominal capital value using the NSVA deflator (161.66), derived as follows:

NSVA deflator = (Nominal NSVA/Real NSVA) X 100

Real Cost of Capital = (Nominal value of capital/ NSVA deflator)

Therefore, the output per unit of capital is the ratio of total value of output divided by the total capital used in production.

Kp = $\sum_{i=1}^{n} Qi\ Pi/TCi$

Where, Kp = output per unit of capital

TC = Total value of capital

Q = total value of Output

P= price of the product

i= 1, 2…….n

Where, TC = FC+WC

In other words the Total Capital (TC) comprises of Fixed Capital (FC) and Working Capital (WC). And the productivity of capital per acre is computed in Table. 2.

Table: 2

Capital Productivity for surveyed village

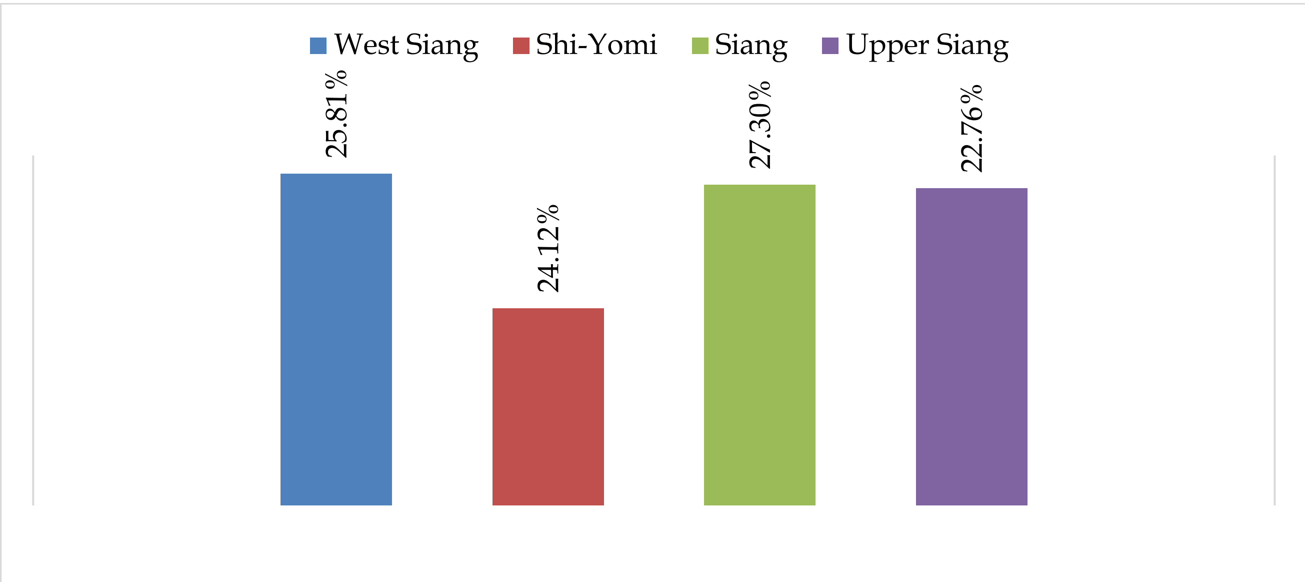
(In Rupees)

Districts	Villages	Real cost of capital	Area in acres	Capital intensity per acre (Cost of Capital/ Total area)	Output (In Kilogram)	Capital productivity (Total Output/Total Capital)
West Siang	Jinyo Tarsu Mobuk	8709.64	10.81	805.82	22611.92	2.60
	Degi Potom	6594.09	20.42	322.99	42888.85	6.50
	Kambu	8697.27	8.51	1022.42	19255.78	2.21
	Lipu Bagra	13509.84	23.02	586.93	48483.00	3.59
	Karbak Geyi	11363.36	41.53	273.60	85634.60	7.54
Shi-Yomi	Rapum	6123.96	16.61	368.63	24313.78	3.97
	Purying	4589.88	12.61	363.99	17941.35	3.91
	Gapo	5697.14	16.11	353.59	23324.78	4.09
	Rego	5975.50	19.92	300.04	29589.15	4.95
	Hiri	2833.11	7.01	404.42	10387.78	3.67
Siang	Molom	7868.37	12.81	614.24	32598.86	4.14
	Yosing	8016.83	11.01	728.24	31072.00	3.88
	Yogong	7422.99	10.41	713.20	29452.11	3.97
	Gameng	7027.09	16.91	415.48	42637.13	6.07
	Gasheng	7150.81	16.21	441.07	41823.79	5.85
Upper Siang	Kolung	5653.84	11.41	495.57	25899.67	4.58
	Gobuk	6804.40	11.51	591.23	26502.62	3.89
	Simong	7194.11	10.21	704.76	23852.30	3.32
	New Millang (A)	8740.57	19.62	445.60	39045.44	4.47
	New Millang (B)	8610.66	13.41	642.09	30843.00	3.58

Source: Data computed from field survey 2019-20.

The real cost of capital exhibited the highest values in Lipu Bagra (₹13,509.84) and Karbak Geyi (₹11,363.36), while the lowest costs were observed in Hiri village (₹2,833.11) and Purying (₹4,589.88).
Capital intensity per acre peaked in Kambu village, reaching ₹1,022.42 across 8.51 acres of operational shifting cultivation area. This was followed by Jinyo, Tarsu, Mobuk, and Yosing, with intensities of ₹805.82 and ₹728.24 over operational areas of 10.81 and 10.41 acres, respectively.
The lowest capital intensity per acre was recorded in Karbak Geyi village (₹273.60 per acre), followed by Rego (₹300.04 per acre) and Degi Potom (₹322.99 per acre). These latter two villages had operational areas of 19.92 and 20.42 acres, associated with real capital costs of ₹5,975.50 and ₹6,594.09, respectively.
Regarding capital productivity, Karbak Geyi demonstrated the highest return at ₹7.54 per unit of capital, followed by Degi Potom (₹6.50) and Gameng (₹6.07). The lowest productivity was found in Simong village (₹3.32), followed by Jinyo, Tarsu, Mobuk, and Kambu (₹2.60 and ₹2.21, respectively).
Overall, the study observed that output yield in conjunction with a low cost of capital significantly influences the determination of capital productivity After analysing the villages-wise comparison of Capital productivity in surveyed villages, the district-wise comparison of Capital productivity is depicted in the Chart. 2

Chart: 2
Capital productivity for Surveyed districts
(In Rupees)



Source: Computed from field survey 2019-20.

A district-wise comparison of capital productivity revealed the highest returns in the Siang district, generating ₹4.74 of output per unit of capital. This figure represented 27.30 per cent of the total observed productivity among the four districts. The West Siang and Shi-Yomi districts followed, achieving ₹4.48 and ₹4.19 per unit of capital, respectively (25.81 per cent and 24.12 per cent of total productivity). Upper Siang recorded the lowest capital productivity among the four districts, at ₹3.95 per unit (22.76 per cent).

4. Result and discussion.

This study attempts to identify the determinants of output per unit of labour and capital equipment utilized. Given that previous analysis demonstrated variation in output per unit of labour and capital across the surveyed villages, a regression analysis was performed to determine the key factors influencing output per unit of capital and labour used in shifting cultivation.

4.1 The determinant of output per unit of labour used

The model for the analysis of output per unit of labour used can be written as,

$LP = \alpha + \beta iXi$

Or, $\alpha + \beta_1 X_1 + B_2 X_2 + \ldots\ldots\ldots\ldots.. + \beta nXn$

Where, LP= Labour Productivity

α = Constant value of model

i= 1, 2…….n

X= variable

β = Coefficient value of the variables

1	Dependent variable		Output per unit of labour used in shifting cultivation (LP)
2	Explanatory variables	X_1	Average person day engaged in shifting cultivation in a year
		X_2	Area under shifting cultivation
		X_3	Percentage of labour engaged in shifting cultivation
		X_4	Average household size of the village
		X_5	Average age of household head in the village
		X_6	Average of highest education attainment of family members
		X_7	Distance from village to main market
		X_8	Percentage of workers engaged in Self-Cultivation
		X_9	Output per unit of capital used

The result for the regression analysis of output per unit of labour used found that;

Source	SS	df	MS	Number of obs = 20
Model	47573151.1	9	5285905.68	F(9, 10) = 18.26
Residual	2894593.85	10	289459.385	Prob > F = 0.0000
Total	50467744.95	19	2656197.1	R-squared = 0.9426
				Adj R-squared = 0.8910
LP	Coef.	t	P>|t|	Remarks
X_1	-36.71	-4.45	0.001	***
X_2	82.12	3.24	0.009	***
X_3	-171.95	-7.27	0	***
X_4	-1705.18	-6.16	0	***
X_5	-29.73	-0.54	0.6	
X_6	-22.98	-0.21	0.84	
X_7	-12.65	-0.81	0.44	
X_8	52.61	1.95	0.08	**
X_9	49.97	1.84	0.095	**
cons	23165.6	7.36	0	

Source: Table computed from field survey 2019-20.
Note: * = 99 % level of Significances**
****= 95 % level of Significance**
*** =90 % level of Significance**

The findings of the regression model for output per unit of labour used exhibited strong explanatory power, accounting for 94.3 percent of the variance. This confirms the model is robust. The model stipulates that output per unit of labour is positively related to the explanatory variables: X_2 (Area under shifting cultivation), X_8 (Percentage of workers engaged in Self-Cultivation), and X_9 (Output per unit of capital used).
Specifically, the model found the coefficient for X_2 (Area under shifting cultivation) is positively related to the dependent variable at a 99 percent level of significance. This indicates that a larger area under shifting cultivation corresponds to greater output per unit of labour used.
The explanatory variables X_8 (Percentage of workers engaged in Self-Cultivation) and X_9 (Output per unit of capital used) were also found to be statistically significant, each at a 95 percent level of significance. This signifies a positive relationship between X_8, X_9, and output per unit of labour. The rationale is that a larger number of plots necessitates a larger amount of capital used, which in turn influences the amount of labour employed. Consequently, greater capital utilization leads to higher labour productivity. These findings indicate that under shifting cultivation, labour and capital are complementary resources.
Conversely, the study observed that output per unit of labour is negatively related to X_1 (Average person-days engaged in shifting cultivation in a year), X_3 (Percentage of labour engaged in shifting cultivation), and X_4 (Average Household Size of the village), with a 99 percent level of significance for each. This suggests that increasing household size, person-days, and labour engagement on a limited number of plots during a crop year minimizes labour productivity. When the plot size remains constant, increased engagement (days worked or number of labourers) does not proportionally increase the output per acre, thereby reducing labour productivity.
4.2 The determinants of output per unit of Capital used.
The model for the analysis can be written as,
$CP = \alpha + \beta iXi$
Or, $\alpha + \beta_1 X_1 + B_2 X_2 + \ldots\ldots\ldots\ldots + \beta nXn$
Where, CP= Capital Productivity
α = Constant value of model
i= 1, 2…….n
X= variable
β = Coefficient value of the variables

1	Dependent variable		Output per unit of capital used in shifting cultivation
2	Explanatory variables	X_1	Average person day engaged in shifting cultivation in a year
		X_2	Area under shifting cultivation
		X_3	Percentage of labour engaged in shifting cultivation
		X_4	Average household size of the village
		X_5	Average age of household head in the village
		X_6	Average of highest education attainment of family members

		X_7	Distance from village to main market
		X_8	Percentage of workers engaged in Self-Cultivation
		X_9	Output per unit of labour used

The result of the regression analysis for Output per unit of capital used shows that

Source	SS	df	MS	Number of obs = 20
Model	5465.48	9	607.28	F(9, 10) = 20.59
Residual	294.99	10	29.5	Prob > F = 0.0001
Total	5760.47	19	303.18	R-squared = 0.9488
				Adj R-squared = 0.9027
CP	Coef.	t	P>|t|	Remarks
X_1	0.38	4.96	0.001	***
X_2	0.05	0.15	0.886	
X_3	0.86	1.62	0.137	
X_4	12.99	2.9	0.016	***
X_5	1.49	4.81	0.001	***
X_6	-0.25	-0.23	0.823	
X_7	0.14	0.92	0.379	
X_8	-0.87	-5.37	0.001	***
X_9	0.005	1.83	0.097	**
cons	-152	-2.38	0.039	

Source: Table computed from field survey 2019-20.

Note: * = 99 % level of Significances**

****= 95 % level of Significance**

*** =90 % level of Significance**

N = 20

The explanatory power of the model is 94.9 percent, establishing it as a robust model. The coefficient of X_1 (Average person-days engaged in shifting cultivation in a year) is positively related to the dependent variable at a 99 percent level of significance. As the number of person-days (labour days) engaged in a crop year increases, the output per unit of capital used also increases. This occurs because an increase in labour engagement typically involves a corresponding increase in the use of labour equipment (e.g., axes, machetes, weeders).

The explanatory variables X_4 (Average household size of the village) and X_5 (Average age of household head in the village) were also found to be positively related to output per unit of capital, statistically significant at the 99 percent level. The study observed that as the average household size and the age of the household head involved in shifting cultivation increase, the output per unit of capital also increases.

The analysis found that output per unit of capital is negatively related to X_8 (Percentage of workers engaged in Self-Cultivation) with a 99 percent level of significance. This result suggests that when workers engage in diversified occupations, such as gathering forest products, the output per unit of capital for those other activities may be higher in contrast to engagement solely in shifting cultivation.

Furthermore, a positive relationship was found between X_9 (Labour productivity) and output per unit of capital. The coefficient of the explanatory variable X_9 is statistically significant at a 95 percent level of significance. This implies that capital and labour used in shifting cultivation are complementary to each other, not substitutes.

5. Conclusion

The study on productivity under shifting cultivation observed that a majority of the state's population depends on agriculture for their livelihood. Agriculture has become the central strategy for planned socio-economic development, aiming for self-reliance and food security. Agriculture, particularly traditional shifting cultivation, is essential to the state's population due to challenging environmental conditions that limit conventional farming methods. While productivity is currently low, the organic nature of existing production offers potential for a full transition to organic farming. The study indicates that labour and capital are complementary inputs in this system, with productivity influenced by factors such as household size, working days, and capital costs, varying significantly across villages and districts. The study established that labour and capital are complementary inputs in shifting cultivation, not substitutable.

A study on labour productivity under shifting cultivation found that it is an important factor in the overall return per unit of labour in agriculture, defined as the ratio of output to the total hours worked by all persons. Key findings included that household size influences total workdays and labour exchange, and that labour productivity is highest in Lipu Bagra village (4.27 quintals) and West Siang district (2.24 quintals).

A study on shifting cultivation in four districts found that capital productivity was highest in Siang district (4.74 rupees per unit of capital), followed by West Siang and Shi-Yomi districts, and lowest in Upper Siang (3.95 rupees). High capital productivity correlated with the availability of fixed and working capital, influenced by household size and plot size. Regression analysis indicated that labour productivity increases with the area under shifting cultivation and output per unit of capital, but decreases with increased person-days, labour engagement, and household size. Capital productivity positively correlated with person-days engaged, household size, and the age of the household head, but negatively with the percentage of workers solely in self-cultivation. The study concluded that labour and capital are complementary in shifting cultivation but not substitutable.

Capital productivity is associated with the availability of fixed and working capital, with the latter increasing with plot size. The regression model for output per unit of labour confirmed a positive relationship with cultivated area and output per unit of capital, while noting a negative relationship with household size and increased person-days on a given plot, indicating that additional labour input does not yield proportional output increases. The robust model for output per unit of capital found positive relationships with person-days engaged, average household size, and the age of the household head, but a negative association with engagement in self-cultivation outside of the primary agricultural tasks, suggesting higher returns in other activities.

References:

1. https://www.Census2011.co.in
2. Department of Agriculture, Government of Arunachal Pradesh. https://agri.arunachal.gov.in/aboutus.php
3. Kalita, et al (2017), “Jhum Improvement for Sustaining Farm Livelihood and Natural Resource Conservation in North Eastern Hill Region: Vistas and Frontiers,”Director ICAR Research Complex

for NEH Region Umroi Road, Umiam, Meghalaya, Pp-Pp, 1-12.
4. Shanmugan, K and Baria, B, P, (2019), "Agricultural Labour Productivity and Its Determinants in India," The Indian Journal of Labour Economics, volume 62, Pp. 431–449 (2019).
5. Freeman, R (2008), "Labour Productivity Indicators Comparison of Two OECD Databases Productivity Differentials & the Balassa-Samuelson Effect," OECD Statistics Directorate Division of Structural Economic Statistics, Organisation for Economic Co-orporation and Development.
6. https://cleartax.in/g/terms/NSVA-deflator
7. https://www.investopedia.com/terms/g/NSVApricedeflator.asp
8. https://www.investopedia.com/terms/g/grossincome.asp