CHAPTER-III

Production Process and Factor Intensity of Bell Metal Industry of Sarthebari – A Cobb Douglas Production Function Analysis

3.1 Introduction:

In economic theory, production is defined as the transformation of factor inputs into output by adding additional value. Production function may be referred to as the functional relationship between the factor inputs and the output. The production function is the formalisation of the production framework where the entrepreneurs mix various factors of production in an efficient way to maximise production and profits. Stigler (1966 P.127) defined production function as "The production function is the name given to the relationship between the rates of input of productive services and the rate of output of product. It is the economist's summary of technological knowledge". The most important factors affecting a production function are time and level of technology. Time is important because production process is a flow not a stock. On the other hand, changes in technology may alter the production function of the firm.

In economic theory, the two most widely used production function are Cobb Douglas(C-D) production function and the CES production function. Cobb Douglas Production function is the most widely used empirical production function which can be used to analyse the production process of both individual firm and industry. The two variable Cobb Douglas production function is defined as (Nicholson and Cnyder, 2008),

$Q = f(K, L) = AK^{\alpha}L^{\beta}$

Where, A is a Positive Constant

α is a positive fraction which denotes Output Elasticity of Capital.

β is a positive fraction which denotes Output Elasticity of Labour.

C-D production function is also the most widely used production function to analyse the technical efficiency of a firm or an Industry. This function can be analysed using a log linear stochastic model which have been used in this analysis. This function is used because of its important role in the analysis of production and related policies. The C-D production function also plays a very important role in the analysis of growth models as its Elasticity of Substitution is equal to one.

The objective of this chapter is to study the reasons why this industry has localized in Sarthebari town and its surrounding villages while the bell metal production units of other places of Assam had to be shut down. The production process as well as the factor intensity of the bell metal industry is also analysed on the basis of Cobb Douglas production functions. Objective of this chapter is also to find out whether the industry is operating under increasing, decreasing or constant returns to scale.

3.2 Review of Literature :

The bell metal industry is localised in and around Sarthebari resulting in various internal and external economies of scale. It is very important to study the causes and effects of the localisation of an industry in a particular place. Friedrich (1929) in the translation of Webber's book *'Uber Den Standert der Industrien'* analysed the different theories of location put forwarded by Webber. Saikia (2011) studied the location concentration of Indian industries during the post liberalisation period. This paper studies the location of Indian industries from two aspects – first looking at the trends of regional concentration of Indian industries and second, by studying the regional industrial diversification. This study concludes that post liberalisation the concentration of Indian industries has increased in specified area increasing the regional disparities. Thi Bui and Preechametta (2019) examined the effects of regional cooperation in the concentration of manufacturing firm in the border areas of Thailand and Cambodia. The study concluded that there is a positive correlation between the agglomeration level and the choice of the areas by the firms and there is a strong tendency of the firms enjoying increasing returns to scale to stay in the hub. Lepori (2022) in the literature review of different theories of location competitiveness gave a condensed view of different theories in this regard.

There have been many studies regarding the production techniques of industries. Small and Medium Enterprises (SMEs) in Sri Lanka play a very important role in the economic development. Santha (2013) investigates the economic and technical efficiency of the medium and small handicraft industries of Sri Lanka using the stochastic translog production frontier. Shahroudi (2011) studied the small scale industry of Iran and fit a Cobb Douglas production function by taking non linear regression. It is important to find out the constraints and potential of an industry. Redzuan and Arif (2011) studied the potential and constraints of the handicraft industry in the backward region of Kotha Bharu and Trumpat districts of Kelantan state of Malaysia. This paper tried to suggest measures to put silverware handicraft industries of the region in the development of rural areas. Griliches (1967) estimated Cobb Douglas Production Functions to study the productivity growth of the manufacturing industries of the US after World War II. It did a cross sectional data analysis of the *Census of Manufactures* of 1958 and 1960. Peguy *et al.* (ND) analysed the impact of Information and Communication Technology (ICT) on the small and medium scale industries using the extended Generalised Method of Moment in Cameroon and found that the impact of ICT is negative and significant. Batool and Zulfiqar (2013) analysed the input output relationship of the SME sector in Pakistan. The extended Cobb Douglas production function is used to study 48 Pakistani industries for the year 2005-06 and concluded that government intervention is required to increase productivity in the sector.

Meller (1975) used single equation models of Cobb Douglas and CES production Functions of 21 industrial establishments of Chile and concluded that structural heterogeneity existed within the industry. Vezzani (2013) performed a Cobb Douglas Production function of more than 1000 industries of Europe during the period 2000-02. The study concluded that intellectual capital is the most important factor of production hence there is need for R&D policy focus. Yunus (2015) studied the manufacturing industries in Malaysia in terms of production functions. It estimated Dobb Douglas production Function of 17 Malaysian industries and concluded that the Malaysian manufacturing industry .experience constant returns of scale. Ikram (2016) did an empirical analysis of the surgical instruments industries of Pakistan. To study the technical efficiency, it considered the Cobb Douglas production function and the Stochastic Frontier Model. This study found that by reducing technical inefficiency the productivity can be enhanced and suggested the use of Triple Helix +1 model where the traditional Triple Helix forces should be integrated with local community.

In a production analysis, study of inefficiency is very important. Stochastic Frontier Analysis is the most widely used model of estimating the inefficiency in a production process. Coelli *et al.* (2005) formulated the Cobb Douglas Stochastic Frontier BC (Battese and Coelli) model based on the Aigner and Chu Model (Aigner & Chu, 1968). In the paper "On Estimating the Industry Production Function" Wagner and Chu, applied the techniques of mathematical programming on cross sectional data to formulate the production function by controlling the disturbance term. Rather than the average function this study estimated the frontier function which estimates the probability of the level of output being higher than the average level. This model was reinforced by Aigner *et al.* (1977) in the paper "Formulation and Estimation of Stochastic Frontier Production Function Models". In this paper use of two error terms rather than one was suggested. In this paper the error component was bifurcated into symmetric normal distribution disturbance and inefficiency coefficient which is truncated normal variable. Jondrow *et al*. (1982) suggested a solution of separating the error terms *u* and *v* in Stochastic Frontier Model by considering the expected value of *u*. This paper deals with both half normal and exponential case and concluded that estimation of level of technical inefficiency for each observation in the sample is possible. Baccouche and Kouki (2003) has done a sensitivity analysis of panel data of Tunisian manufacturing firms for the period 1983-1993 bases on the Stochastic Frontier Model. The study used truncated normal, half normal and exponential cases and estimated firm specific technical inefficiency coefficients for each model. Kumbhalkar and Wang (2010) in their paper in discussed in detail the methods of fitting different Stochastic Frontier Models using STATA and their interpretation. This paper discusses specifications of various models and distributional assumptions of the inefficiency components. Meesters (2014) concluded that the frontier models- half normal, exponential and truncated normal models are special cases of the truncated normal distributions. Kumbhalkar *et al.* (2015) in their book have done a detail analysis of the Stochastic Frontier Analysis. This book explains various models of Stochastic Frontier Analysis and explains how these models can be fitted using STATA.

Pathania and Anwar (2012) analysed the manufacturing industries from 1998-99 to 2007-08 in India. They used Cobb Douglas production function to show that these industries are capital intensive and follow Constant Returns to Scale. Khan and Abdullah (2019) studied the Technical Efficiency of the Micro Small and Medium enterprise sugar mills in

Maharashtra and Uttar Pradesh. In the study, they have taken Cobb Douglas Stochastic model and derived that the industry is working under the Constant Returns to Scale and the years of operation has an inverse effect on the technical efficiency. Roy (2014) in the paper "Entrepreneurship Evolution of Cluster Industry in Assam- with special emphasis to Bell metal Industry of Sarthebari" studies the bell metal industry of Sarthebari as a cluster and studied the evolution of entrepreneurship in the industry. It studied the production trend of bell metal industry under The Assam Cooperative Bell metal Utensils Manufacturing Society Ltd from 1994-95 to 2011-12. This study also examines the trend of the price of raw materials from 2006 to 2013. The study found that the bell metal industry of Sarthebari is facing the problem of lack of raw materials, proper training and help from financial institutions. This study states that the handmade bell metal products of Sarthebari are costly in comparison to the products of Moradabad, but ignores the fact that the artisans of Moradabad produce brass metal products, not bell metal products.

Sahay (2015) in the paper "Turnaround Strategy for Brass and Bell Metal Industry in Assam, India" compared Moradabad of Uttar Pradesh and Assam based brass and bell metal industries and concluded that those in Assam lack certain facilities like power driven lathe machine for turning, welding, electroplating, machine polishing and buffing, rolling mill etc as compared to the industries of Moradabad. This paper fails to mention that there are two rolling mills in Sarthebari. Again it states that the engraving work in the products of Moradabad is excellent, whereas those of Sarthebari are negligible. But this study fails to mention that *Maihangs*, *Kahis* and *Batas* are very intricately hand engraved with beautiful designs. For development of the industry in Assam, the study recommends a holistic approach from the government including training of the artisans, establishments of Common Facility Service Centres (CFSCs) etc.

In view of the above studies we can state that the production analysis of handicraft and traditional industries is rare. By trying to fit the Cobb Douglas production function in bell metal industry, the research gap in this research area can be filled up.

3.3 Methodology:

One of the major causes of localisation is that, due to the internal and external economies of scale the average cost of the firms comes down. To test whether there is any effect of average cost of production in the localisation of the bell metal producing firms, the average cost of production of *Garhshalls* producing different bell metal products in each cluster is estimated from the data collected from field survey. First, the total cost of production of the *Garhshall* is calculated by the enumerating the daily cost of production of each *Garhshall* viz. cost of charcoal, rolling mill charges, food and refreshments and other costs. Then this total cost is divided by the average daily amount of production per kilogram to derive the average cost of production per kilogram per day.

To fit the production function of the bell metal industry, the following variables are defined. Labour in the bell metal industry is heterogeneous. The *Kohar* gets the highest share of the *Gorhoni* among all the artisans in a bell metal production unit. He always gets 150% of the *Gorhoni* received by the *Aidha,* or supporting artisan, because of this reason, the labour cost is considered rather than the physical units of labour. The variable labour cost of production is determined by taking the product of amount of average product produced by each *Garhshall* in the past fortnight in terms of Kilograms per day and the making charge they receive at the end of the day. Thus the labour cost of production per day is determined in Rupees.

For determining the variable capital, the variable costs of production which includes non labour expenditure, is considered. Daily data were collected about cost of raw materials, primarily scrap metal and *Bogorir Angar*. Along with that rolling mill charges, cost of transportation and food and refreshment costs are also considered. Some costs were expressed on monthly basis by the *Garhshall*. Average monthly expenditure of each *Garhshall* on maintenance, electricity duty, telephone bill, medical expenses and other expenses were collected from the field survey. They were converted to daily basis by dividing these costs by 30 because production and *Gorhoni* are always calculated on daily basis in the industry.

As the Labour and Capital are taken in terms of money (Cost of Labour and Capital), total production are also expressed in terms of market price of the products in Sarthebari. For that, average price of the product in the last fortnight at Sarthebari were considered.

For analysis of the production pattern of the industry the Cobb Douglas production function is considered. The function t is considered as-

$Q= f(K,L)= AK^{\alpha}L^{\beta}$ ……………………………(3.1)

Where,

Q is Total production of the *Garhshall* in terms of market value, L is labour cost of production, K is capital costs on variable factors and A is a constant.

The above function is then converted into linear form by taking natural logarithm, which takes the form

$\ln(Q) = \ln(A) + \alpha \ln(K) + \beta \ln(L)$ ………………(3.2)

Adding the error term U we obtain the following Linear Regression Model

$\ln(Q) = \ln(A) + \alpha \ln(K) + \beta \ln(L) + U$ ……………. (3.3)

Data collected from the field are tested on the above regression model.

To study the level of technical efficiency of the bell metal industry, the Stochastic Frontier Model, which estimates efficiency scores of a production function, is used.

The Stochastic Frontier Model is specified as (Coelli *et al.,* 1998; Pp 242-245)

$\ln Qi = X'_i\beta + v_i - u_i$ ………………………………… (3.4)

Where Qi = the output of the *i*th firm

X'_I = Vector containing the logarithms of inputs

β = vectors of unknown parameters

u_i = non negative variable representing technical inefficiency

v_i = random error term

The Cobb Douglas Stochastic Frontier Model is given as-

$\ln Q_i = \beta_0 + \Sigma \beta_n \ln x_i + (v_i - u_i)$ ……………………………….(3.5)

Q_i - observed output quantities of the *i*-th unit

x_i - observed inputs quantities of the *i*-th unit

u_i- non negative time-invariant random variables capturing time-invariant technical inefficiency,

v_i- random variables of *i*-th unit in year *t* reflecting effect of statistical noise

From equation 3.5 we have-

$$Q_i = \exp(\beta_0 + \Sigma\beta_n \ln x_i + v_i - u_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

or, $$Q_i = \exp(\beta_0 + \Sigma\beta_n \ln x_i) \text{ X } \exp(v_i) \text{ X } \exp(-u_i) \ldots\ldots\ldots (3.7)$$

Where,

$\exp(\beta_0 + \Sigma\beta_n \ln x_i)$ is the deterministic component or frontier

$\exp(v_i)$ is the statistical disturbance

and, $\exp(-u_i)$ is the inefficiency component of the model.

As we have considered the Capital and Labour Cost of as the two factor inputs in our analysis, equation 3.7 can be rewritten to give our analytical model.

$$Q_i = \exp(\beta_0 + \beta_1 \ln L + \beta_2 \ln K) X \exp(v_i) X \exp(-u_i) \ldots\ldots\ldots\ldots\ldots (3.8)$$

The most important objective of Stochastic Frontier Analysis is to estimate the technical efficiency of the industry. The ratio of observed output to the corresponding Stochastic Frontier output is the most common measure of technical efficiency. Thus we have the Technical Efficiency Coefficient –

$$TE_i = \frac{Q_i}{\exp(x_i\beta + v_i)}$$

$$= \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)}$$

$= \quad \exp(-u_i)$

This measure of technical efficiency lies between 0 and 1 and measures the ratio of the output of a firm into a fully efficient firm. By estimating the parameters of the Stochastic Frontier Model in equation 3.7, we can predict the technical efficiency coefficient TE_i of the bell metal industry of Sarthebari.

3.4 Hypothesis of the Study:

The hypothesis of the study is proposed as:

H_0 : There is no significant difference between the variations of Capital and Labour on production

H_1 : There is significant difference between the variations of Capital and Labour on production

The Hypotheses is tested through ANOVA using *F* and *t* test statistics.

3.5 **Localisation of Bell Metal Industry in Sarthebari** :

The Webbers location theory lays down that three factors can be responsible for influencing the location of an industry in a particular area- labour cost, transport cost and agglomeration economics. Sarthebari is the only place in Assam where the bell metal art being continued for centuries, enjoying Webber's location factors. This art, which once flourished in other places of Assam, died out. As a cluster bell metal craft was there in places like Raha in Nagaon district and Titabar of Jorhat district. Again one or two production units of bell metal could be found in places like Bilasipara and Sapatgram in Dhubri district. But they failed to survive and ultimately had to be shut down. The question arises why this art survived and flourished in Sarthebari while the artisans of other areas of Assam could not continue the bell metal craft.

The bell metal industry of Sarthebari survived as a cluster because it enjoys various economies of scale, both internal and external. There are some non economic factors also, which are responsible for its localisation. We have analysed the causes of the localisation of bell metal industry from three aspects- internal economies of scale, external economies of scale and non economic factors.

3.5.1 Internal Economies of Scale of Bell Metal Industry of Sarthebari:

It was observed that the bell metal industry of Sarthebari enjoys seven types of internal economies of scale. The different economies of scale enjoyed by the industry are enumerated below.

3.5.1.1 Purchasing Economies of Scale:

An industry achieves purchasing economy when it is able to purchase factor inputs in bulk. There are two main raw materials which are sourced from outside in the bell metal industry- scrap metal and *Bogorir Angar* or charcoal from Indian Jujube tree. There are a number of sources of these two raw materials. While *Bogorir Angar* is sourced from the state of Meghalaya, scrap metal is sourced from different parts of the country. There is no fixed supply chain of these raw materials. Traders from different places supply these to the bell metal industry of Sarthebari. While the *Kohars* purchase *Bogorir Angar* directly from these traders, scrap metal is purchased either by the cooperative or by the *Mohajons*. Thus the bell metal industry enjoys a relatively easy source of raw materials as the suppliers of these supply them in Sarthebari itself. But as the numbers of bell metal production units were very small in other places, the traders would never supply these in the location of the industry. Therefore, it was a big problem for those artisans to acquire the raw materials. Because of the shortage of raw materials, the bell metal industry of other places in Assam died out whereas it flourished in Sarthebari.

3.5.1.2 Financial Economies of Scale:

Bell metal production is a micro level activity which does not require much capital for establishment. The artisans of this type of industry primarily depend upon private borrowing from money lenders. Because of lack of knowledge and education, they fail to reap the benefit of institutional credit. In this regard, the artisans of bell metal industry of Sarthebari are also not different from those of other similar industries elsewhere in this regard. They very rarely get institutional finance and depend on private borrowing from the

Mohajons. Familiarity of the borrower is the basis of private borrowing as there is little paperwork involved. But the *Kohars* of Sarthebari does not have to face the problem of lack finance as the *Mohajons* are ever ready to supply them with finance. Moreover, they can take advance amount from the *Mohajons* which are settled once they deliver the products as per order. Thus the *Kohars* of Sarthebari enjoys financial economies of scale which the bell metal artisans of other places of Assam seldom enjoyed.

3.5.1.3 Marketing Economies of Scale:

Marketing is one of the most important factors for the success of an industry. If the producers are not able to sell their goods, they will not be able to survive in the market. The bell metal artisans of Sarthebari enjoy a very favourable marketing environment. The bell metal products of Sarthebari have a very high demand across the state of Assam. In almost all the towns of Assam we can see at least one shop selling bell metal utensils from Sarthebari. There are 43 business establishments including two sell points of the cooperative in Sarthebari. Apart from that there are 30 *Arabdaris* who sell bell metal products all over Assam. Again there are traders from Bhutan and Arunachal Pradesh who collects bell metal products from Sarthebari and exports them to other places. Apart from these there are many suppliers of bell metal products who supply those to different places of Assam. People from areas like Barpeta Town, Barpeta Road, Nalbari, Pathsala, and Guwahati etc. regularly visit Sarthebari for bell metal products, particularly for gifts of marriages. Thus we can say that there is a readymade market of the products of a *Garhshall* of Sarthebari, and the industry as a whole enjoys a very robust marketing economy of scale. This facility could not be enjoyed by any other solitary bell metal production units in other places of Assam.

3.5.1.4 Technical Economies of Scale:

The bell metal artisans of Sarthebari also enjoy technical economy of scale. It refers to benefits enjoyed by the producer via technology. The most important technical economy comes to the bell metal industry of Sarthebari via the two rolling mills. With the help of rolling mills, the *Kohars* can convert the *Golas* to flat sheets with minimum effort. This has helped the *Kohars* to increase their productivity. There are no rolling mills elsewhere in

Assam. If a producer wants to set up a bell metal production unit elsewhere in Assam he will not be able to enjoy the benefits of this technology.

3.5.1.5 Managerial Economies of Scale:

The bell metal industry enjoys the managerial economies of scale through the cooperative. The cooperative and its office bearers are there always to help the *Kohars* in need. The *Kohars* also get help from many *Mohajons* in the management of production and marketing of products. The *Kohars* also get managerial help from different quarters of the society because the industry is in the heart of Sarthebari, and all the local people are very proud of it. Even if a person is not directly linked to the industry, he or she is always there to help the *Kohars*. This type of help can never be found in any other places.

3.5.1.6 Specialisation Economies of Scale:

Another internal economy of scale enjoyed by the bell metal industry of Sarthebari is specialisation through division of labour. It has been observed that there is a tendency of concentration of the production of a particular product in one or two clusters. For example, production of *Taal* is concentrated in Sarthebari and production of *Bati* is concentrated in Gomurah. Definitely the artisans of Sarthebari have attained specialisation in production of *Taal* and those of Gomurah have attained specialisation in the production of *Bati*. Again one *Garhshall* produces only one type product. It is not possible for a *Garhshall* to produce all types of products. As there are a number of *Garhshalls* producing different types of products, collectively they are able to produce all the types of bell metal products demanded by the consumers. Thus it will not be possible for a solitary bell metal production unit anywhere else because it will not be able to enjoy the economies of specialisation in that area.

3.5.1.7 Risk Bearing Economies of Scale:

Collectively the *Garhshalls* of Sarthebari also enjoy the risk bearing economies of scale. Though individually all of them are micro units producing ten to twenty kilograms of bell metal products per day, collectively they produce 4065.5 Kilograms [1] each day. This has enabled the bell metal artisans of Sarthebari to bear risks of different kinds like introduction

[1] Directorate of Economics and Statistics, Govt. of Assam

of new design and production of different sizes and shapes. If one *Garhshall* fails to sustain the risks, they can always go back to their previous products as they enjoy other internal economies of scale.

3.5.2 External Economies of Scale:

Collectively the bell metal industry of Sarthebari enjoys various external economies of scale. Though there are a number of production units producing different types of products, they operate under the same basic principles. Again due to the presence of a very strong cooperative they operate in a unified manner. Hence, the bell metal industry as a whole works as a single entity. Because of this reason, it enjoys various external economies of scale. Following are the different external economies of scale enjoyed by the industry.

3.5.2.1 Transportation Economy:

Transportation of raw materials and finished products is a major problem faced by the producer of any given industry. But due to the concentration of more than 300 *Garhshalls* in the same area, all the production units enjoy transportation economy of scale. No *Kohar* has to go out of Sarthebari for procuring raw materials or for sale of their products. All the raw materials required for production of bell metal products are locally available. The responsibility of supplying scrap metal lies with the cooperative and the *Mohajons*. The *Kohars* does not have to bother about that. Again traders supply charcoal to the doorsteps of the *Kohars*. Regarding sale of their products also, the traders collect the finished products from the *Garhshalls* itself. Therefore, there is little or no transportation costs involved for the *Kohars*. If an entrepreneur wants to set up a bell metal production unit elsewhere, he will never be able to enjoy this economy.

3.5.2.2 Skilled Labour:

The backbone of a successful handicraft industry is quality of labour. The bell metal artisans of Sarthebari are engaged in this trade for generations. They get hands on training for the production of these products from their elders and family members. This has helped in the development high level skill. All the artisans are highly skilled. Nowhere else in Assam there will be such concentration of highly skilled bell metal artisans. Thus it will be impossible to replicate the bell metal industry of Sarthebari elsewhere in Assam or any other places.

3.5.2.3 Helping Industry:

When localisation of an industry takes place in an area, the firms help each other and all of them develop collectively. The same is also true in case of the bell metal industry of Sarthebari. Although many *Garhshalls* are producing the same products, there is no competition amongst them. Each *Kohar* has their own space in the market; therefore no one has to oust the others for their expansion. One of the major problems faced by the industry is that they are unable to meet the market demand. Again most of the *Kohars* are neighbours or relatives. This social bonding also helps them to work collusively. So when need arises, all the *Kohars* help each other. This helping attitude has helped in the localisation of the industry in Sarthebari in a big way.

3.5.2.4 Brand Value:

Anywhere in Assam two of the most famous local brands are bell metal products from Sarthebari and *Pat*[2] *Muga* silk of Sualkuchi. The bell metal products of Sarthebari have a very high brand value not only in Assam but in other parts of India also. The bell metal products are easily recognisable due to their unique style and design. This brand value has helped in concentration of the industry in Sarthebari.

3.5.2.5 Research and Government Initiative:

Government of Assam has given high priority for development of this indigenous handicraft industry of Assam. In 2018 the then Chief Minister of Assam, Sarbananda Sonowal has directed the government officials to take necessary steps for development of this industry[3]. In July 2020, Govt. of Assam has presented a cheque of Rs. One Crore to the Cooperative. Thus the bell metal industry of Sarthebari receives great help from the state government and from various research institutes including Indian Institute of Technology, Guwahati for research and development. This visibility of the industry is possible only because of localisation.

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[2] Mulberry silk

[3] https://nenow.in/north-east-news/assam-chief-minister-directs-steps-for-reviving-bell-metal-industry.html

3.5.3 Non Economic Factors of Localisation of Bell Metal Industry in Sarthebari:

There are a number of economic factors for the localisation of the bell metal industry in Sarthebari. But there are some non economic factors also which are responsible for its localisation. Historically, the people of Sarthebari were engaged in the trade. During the pre Ahom rule (1228 to 1826 C.E), the people of Sarthebari started producing bell metal products. Slowly these became popular and the bell metal products became an integral part of Assamese culture and society. Bell metal products became an integral part of the socio religious life of the Assamese people. Thus there was always a demand for the bell metal products. Due to tradition and historical importance of the industry, this industry survived and localised in Sarthebari. Trust is also another factor in this regard. The whole industry runs on trust without much paperwork. There is a relation of trust among different stakeholders of the industry including the traders supplying raw materials, the *Kohars*, traders from other places, *Arabdaris* and the *Mohajons*.

3.6 Location of the Bell Metal Industry:

It is observed that *Garhshalls* producing one type of bell metal product has the tendency to concentrate in one or two revenue villages of the study area. From Table 3.1 we can see that all the *Garhshalls* producing *Taal* are concentrated in Sarthebari whereas 78.38% of the 37 producers of *Bati* are concentrated in Gomurah. Thus there is also micro level localisation of products in the industry.

3.6.1 Localisation of Different Bell Metal Products in Different Clusters:

The bell metal industry of Sarthebari enjoys a number of internal economies of scale due to its concentration in the area. When an industry enjoys internal economies of scale, its average cost of production comes down. Table 3.1 shows average cost of different products cluster wise.

Table-3.1: Average Cost of Production of Different Products per Kilogram per Day (In Rs.)

Product	Cluster						Average Cost of Production
	Sarthebari	Namshala	Gomurah	Karakuchi	Lachima	Amrikhawa	
Kahi	86.31 (24)	74.3 (22)	122 (1)	63.29 (13)	73.46 (6)	76.43 (8)	76.54 (74)
Bhortaal	105.18 (28)	-	-	-	-	-	105.17 (28)
Bata	125.17 (13)	-	106.88 (5)	-	64.00 (1)	70.00 (1)	115.47 (20)
Bati	55.81 (2)	94.87 (3)	62.91 (29)	-	-	52.5 (3)	63.34 (37)
Baan Bati	156.06 (7)	114.00 (1)	-	-	-	-	150.52 (8)
Lota	-	157.5 (2)	-	-	-	-	157.5 (2)
Maihang	88.00 (1)	-	-	-	-	-	88 (1)
Bell/ Others	93.33(2)	-	-	-	-	-	93.33 (2)

Source: Field Survey
Notes : i) Figures in Parentheses indicate the number of *Garhshalls producing* the product.
ii) '-' indicates nil`

It can be seen from Table 3.1 that the production of *Kahi* is concentrated primarily in three clusters viz. Sarthebari, Namshala and Karakuchi, where 79.73 % of the *Garhshalls* producing *Kahi* are concentrated. Out of them, *Garhshalls* of Karakuchi enjoys least average cost at Rs.63.29 per kilogram of output. It is interesting to point out that that *Garhshalls* producing *Kahi* of Sarthebari has the highest average cost of Rs.86.31 per kilogram of output even as most number of *Garhshalls* producing *Kahi* are situated here. Again 65% of the *Garhshalls* producing *Bata* are concentrated in Sarthebari, but they have the highest average cost of Rs.125.17 per kilogram of output.78.38% of the *Garhshalls* producing *Bati* are concentrated in Gomurah. But the *Garhshalls* producing *Bati* of Sarthebari and Amrikhawa have a lower average cost than those of Gomurah at Rs.55.81 and Rs.52.5 per kilogram of output. If we consider *Baanbati*, we can see that 87.5% of the *Garhshalls* are concentrated in Sarthebari, but the solitary *Garhshall* producing *Baanbati* of Namshala has a lower average cost than those of Sarthebari at Rs.114.00 as against Rs.156.06 per kilogram of output.

Thus we can say the micro level localisation of different bell metal products in different clusters takes place not because of economic reasons but because of non economic factors. The causes of localisation of various bell metal products in different clusters of the study area are analysed below.

3.6.1.1 Tradition:

Bell metal production is an industry deeply rooted in the tradition. Due to the traditional nature of the industry *Kohars* and *Aidhas* select their product hereditarily without much consideration of the economic factors. If a *Kohar* is producing *Kahi*, very rarely his son will want to produce *Maihang*. Naturally, he will choose the product which his father produces.

3.6.1.2 Availability of Artisans :

In a Garhshall, the *Aidhas* are usually relatives or members of the extended family of the *Kohar*. The *Kohar* is always comfortable to work with an *Aidha* whom he knows very well and belongs to the same *Chupa*[4]. This brings in the element of confidence of the *Kohar* on his *Aidhas*. If a *Kohar* does not have belief in a person, he will never recruit him as an *Aidha*.

3.6.1.3 Specialisation:

Table 3.1 reveals that *Bata*, *Baanbati* and *Maihang* are concentrated mostly in Sarthebari. Though they are different products they have a basic similarity in their design. They are products mounted on a stand. This shows that due to working for generations, the bell metal artisans of Sarthebari have attained specialisation in producing products which has a stand. Similar conclusion can also be drawn from the example of concentration of *Garhshalls* producing *Bati* in Gomurah.

3.7 Production of Bell Metal:

The production of bell metal involves high degree of manual labour. It still involves the age old technology. No modern technology is used for the purpose of producing bell metal products. However, the only partial use of modern technology can be seen in the case of *Kahi, Bata* and *Maihang*. There are two roller mills in Sarthebari, one is owned by the

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[4] Small locality within a cluster, similar to a street.

Assam Cooperative Bell Metal Utensils Manufacturing Society Ltd. and the other is owned by a private entrepreneur. The mill is used to make flat metal sheets out of *Gola* at the nominal fees of Rs. Six (Rs. 6.00) per kilogram. The *Kohars* take the *Golas* to the roller mill and makes metal sheets. He then returns to *Garhshall* and makes *Kahi* and the top part of *Bata* and *Maihang* by the same process as mentioned in Chapter–I. This has made the job of the *Kohars* a little bit easier. But apart from that, all other jobs are done by manual labour. Again, it should be noted that *Kohars* producing other products cannot take help of the roller mills.

The total number of sampling units stands at 172. If we look at cluster wise distribution Sarthebari has the highest number at 74. Out of these 24 are producing *Kahi*, 28 are producing *Bhor/Pachang Taal*, 13 are producing *Bata*, 2 units produce *Bati*, one unit is producing *Maihang* and the two remaining units produce school bells and other smaller items. It is clear from Table-3.1 that a particular area specialises in producing one product. This is evident that except six units all the other 29 units of Gomurah produce *Bati*. Again *Kahi* is mainly produced mainly in Sarthebari, Namshala and Karakuchi. Again *Taal* is produced only in Sarthebari.

The bell Metal production units mainly produce eight (8) types of products. Each has their own varieties. Each product commands different making charges, based on the expertise needed to produce the product, market demand and availability of craftsmen. Now a days the *Kohars* have stopped production of many bell metal products particularly *Kalah* (Pitcher) and *Xorai*[5]. Now these are replaced by brass metal products. This is because brass metal is comparatively much cheaper and it is easier to make these products out of brass metal as it is a softer metal than bell metal. But a *Kohar* will never make any brass metal objects as they find it undignified to make brass metal products. He will only deal with bell metal, nothing else.

The *Gorhoni* is fixed in the triennial general meeting of the Assam Cooperative Bell Metal Utensils Manufacturing Society Ltd. The rates are fixed through the process of collective bargaining of The Cooperative and *Kaanh Silpi Sangha*, the umbrella organisation of the bell metal artisans. All the *Mohajons* and artisans follow the making charges until it is

[5] Traditional Assamese offering tray mounted on a stand, used for decoration and gifts to show respect.

reviewed. The market price of the products is fixed on the basis of the making charge and the price of scrap metal.

Table 2.3 gives the average *Gorhoni* or making charge and market price per Kilograms in Sarthebari Market in the first week of May 2017.

Each production unit on an average works 8-12 hours per day. They do not stop production till they use up all the scrap metal which they have brought for production. From the table- 3.2 it can be seen that *Kahi* plays the leading role in terms of production per day. On an average also, the average production of a unit is the highest for *Kahi*. Because of the roller mill, the productivity of the *Kohars* producing *Kahi* has increased very much. On the other hand, *Lota* is produced in least amount. The two units producing *Lota* makes only 4 Kilograms per unit per day. This is because the retail cost of bell metal *Lota* is very high and therefore its demand is not as high as other products. Again production of bell metal *Lota* requires a very high degree of expertise. Now a days, most of the *Lotas* that are found in the market are of brass metal, not of bell metal.

Table 3.2 gives the total and average productivity of each bell metal product. It can be seen from the table that all the *Garhshalls* in the sample dealing with *Kahi* produce a total of 1269 Kilograms with an average of 17.5 Kilogram per *Garhshall*. The productivity of *Garhshalls* producing *Taal* is also very high at 16.57 Kilograms per day. The average productivity of *Kahi* (17.5 Kilograms) and *Taal* (16.57 Kilograms) are comparatively higher because the *Golas*[6] of these products are already pressed in the form of round sheets in the roller mill. This has increased the productivity of these products. Again the average productivity of *Maihang* (10 kilograms) and *Bata* (9.1 kilograms) are almost same. This is because both are similar products. The upper part of *Bata* and *Maihang* are pressed in the roller mill, but the stand has to be done by hand in the *Garhshall*. Because of this, the average productivity of *Bata* and *Maihang* are significantly lower than *Kahi* and *Taal*. The average productivity of *Bati* is 11.43 Kilograms per *Garhshall*. This is because the average weights of *Bati* are far less than *Kahi* or *Taal*. The usual weight of a *Kahi* is from 1 Kilograms to 1.5 Kilograms whereas that of *Taal* is from 1.5 to 3 Kilograms. On the other hand, the average weight of a *Bati* is 400 to 600 grams. Thus even if the number of *Batis*

[6] Raw bell metal Balls created from the scrap metal.

produced is higher, its productivity in terms of weight is much less. In other words, we can say that on an average a *Garhshall* producing *Kahi* produces 10 or 11 *Kahis* per day, whereas a *Garhshall* producing *Bati* produces 15 to 20 *Batis* each day.

It can also be seen from Table 3.2 that the market value of total products of all the *Garhshalls* producing *Kahi* stands at Rs. 14,59,350.00 with a value of average productivity at Rs. 20,125.00 per *Garhshall*. But the value of average productivity of *Taal* is the highest at Rs.23,198.00 per *Garhshall*. On the other hand, the value of average productivity of *Baanbati* is lowest at Rs.9025.00. The Standard Deviation of the value of average productivity of *Garhshalls* producing different bell metal products are calculated as-

$\sigma = 4818.27$

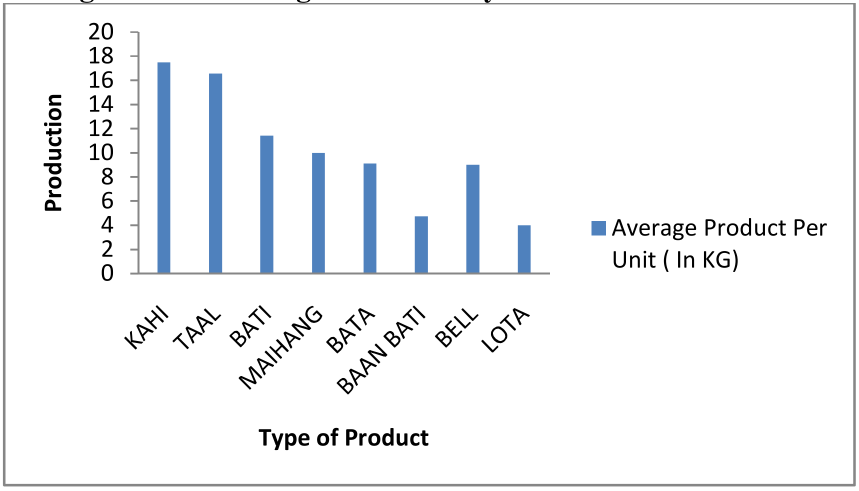
This shows that the deviations in the value of average productivity of *Garhshalls* producing different bell metal products are very high. This is because of the difference in the average productivity, and difference in the market price of the products. The figure 3.1 shows the average productivity of *Garhshalls* producing different bell metal products.

Table-3.2: Total and Average Productivity of Bell Metal Products

SL. No.	Product	Total Product Per Day (In KG)	Average Product Per Unit (In KG)	Average Work Hour Per day	Total Product Per Day (In Rs)	Average Product Per Unit Per Day (In Rs)
1	*KAHI*	1269	17.5	10.34	1459350.00	20125.00
2	*TAAL*	464	16.57	9.04	649600.00	23198.00
3	*BATI*	423	11.43	10.95	486450.00	13145.00
4	*MAIHANG*	10	10	12	16000.00	16000.00
5	*BATA*	182	9.1	11.15	291200.00	14560.00
6	*BAAN BATI*	38	4.75	11.13	72200.00	9025.00
7	BELL/ OTHERS	18	9	12	26100.00	13050.00
8	*LOTA*	8	4	8	20000.00	10000.00
Total Production		2412	14.02	10.58	3020900.00	17563.00

Source: Field Survey.

Figure- 3.1: Average Productivity of Bell Metal Products



Source: Field Survey

Table-3.3 gives a breakup of the productivity of bell metal units from each cluster. It can be seen that the production units of *Kahi* of Namshala are most efficient with a daily average of 20.73 Kilogram followed by Amrikhawa at 19.88 Kilogram, whereas those of Sarthebari are least efficient at 15 Kilogram per unit. On the other hand, the two production units of *Bati* at Sarthebari are most efficient at 15.5 Kilogram per day. Out of all the products, productivity of *Lota* is the lowest at 4 Kilogram per day.

Table-3.3: Cluster Wise Distribution of Productivity of Bell Metal Units

Product	Cluster						Total
	Sarthebari	Namshala	Gomurah	Karakuchi	Lachima	Amrikhawa	
Kahi	360 (15.00)	456 (20.73)	10 (10)	202 (15.4)	82 (13.6)	159 (19.88)	1269
Taal	464 (16.57)	0	0	0	0	0	464
Bata	119 (9.5)	0	48 (9.6)	0	10 (10.0)	5 (5.0)	182
Bati	31 (15.5)	23 (7.6)	337 (11.62)	0	0	32 (10.67)	423
Baan Bati	33 (4.71)	5 (5.0)	0	0	0	0	38
Lota	0	8(4.0)	0	0	0	0	8
Maihang	10 (10.0)	0	0	0	0	0	10
Bell/ Others	18 (9.0)	0	0	0	0	0	18

Source: Field Survey
Note: Figures in parentheses indicate average productivity of each *Garhshall.*

3.8 Production Function of the Whole Bell Metal Industry:

Based on the data collected from the field, the Linear Regression Model is estimated as-

$\ln(Q) = \ln(2.849) + 0.083 \ln(K) + 0.740 \ln(L)$

From the Model we have

$\alpha = 0.083$

$\beta = 0.740$

As $\alpha < \beta$, we can conclude that the Bell Metal Industry is a labour intensive one.

Again we have $\alpha + \beta = 0.823 < 1$, which shows the industry is subject to decreasing returns to scale. If a firm increases Capital and Labour by 1% each, the production will increase by 0.083 and 0.740% respectively. Thus it will be beneficial for the firm to increase the amount of Labour.

The coefficient of determination r^2 for the model is calculated at

$r^2 = 0.952$

This explains that the model is able to explain 95.2% variations on the dependent variable (Production) on the basis of independent variables (Labour and Capital).

The F test values of the model is calculated as

F = 1677.814 at 2*df*. At sig F= .0000

The *t* value of the model is also calculated as

t= 17.578 at sig t= .0000

This shows that the t value is highly significant and only Labour is significant at 95% confidence interval and Capital is not significant. Thus we can accept the null hypothesis and conclude that bell metal industry is a labour intensive one.

3.8.1 Marginal Products and Elasticities of the Production Function of Bell Metal Industry:

The production function of the bell metal industry as a whole can be represented in the form of traditional Cobb- Douglas Production Function as-

$$Q = 2.849\, L^{0.740}\, K^{0.083}$$

For this Production Function we have

$$MP_L = \frac{\partial Q}{\partial L} = 2.10826\, L^{-0.26} K^{0.083}$$

$$MP_K = \frac{\partial Q}{\partial L} = 0.236467\, L^{0.740} K^{-0.917}$$

The Output Elasticity Functions for Labour and Capital are given as

$$E_L = \frac{\partial Q}{\partial L} \cdot \frac{L}{Q}$$

$$= \frac{\partial Q}{\partial L} \cdot \frac{L}{2.849\, L^{0.740}\, K^{0.083}}$$

$$= \frac{(2.10826\, L^{-0.26} K^{0.083})L}{2.849\, L^{0.740}\, K^{0.083}}$$

$$= 0.74$$

$$E_K = \frac{\partial Q}{\partial K} \cdot \frac{K}{Q}$$

$$= \frac{\partial Q}{\partial L} \cdot \frac{K}{2.849\, L^{0.740}\, K^{0.083}}$$

$$= \frac{(0.236467\, L^{0.740} K^{-0.917})K}{2.849\, L^{0.740}\, K^{0.083}}$$

$$= 0.083$$

Thus we have

$E_K = \alpha = 0.083$

$E_L = \beta = 0.74$

Thus we can say that the derived Cobb Douglas production function satisfies the restrictive property of non variation of output elasticities with variations in input levels. This function also satisfies the non negativity assumptions of Cobb Douglas production functions.

3.9 Production Functions of Different Bell Metal Products:

The different products of the bell metal industry require different level of skill. One *Garhshall* is specialised in producing only one type of product. Although all the *Kohars* and their *Garhshalls* use the same technique of beating the hot bell metal into different shapes, each type of product is unique in design. Hence one *Garhshall* can produce only one product. Because of this reason also, there is difference in productivity of *Garhshalls* producing different type of products. This study analyses the production functions of different bell metal products. As *Baanbati*, *Lota*, *Maihang* and Bells are produced in only Eight (8), Two (2), One (1) and Two (2) *Garhshalls* respectively, there is not enough cross sectional data to calculate individual production functions. As this study is based on cross sectional data, the individual production functions of these four products could not be analysed. To study the production functions of these products, the investigator has to use time series data. But the production functions of *Kahi, Bati*, *Taal*, and *Bata* are analysed and discussed below.

3.9.1 Production Function of *Kahi:*

Kahi is the most popular bell metal product of Sarthebari. 74 production units out of 172 produce *Kahi*. In Assamese Culture also, *Kahi* plays a very important role. In *Annaprasanna*[7] of a child bell metal *Kahi* is used. Again invitees to the ceremony gift and bless the child with *Kahi* made from bell metal. In Assamese marriages also, the bride and bridegroom are presented with bell metal utensils, primarily *Kahi*.

Based on the data collected from the field, the Linear Regression Model for production of *Kahi* is estimated as-

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[7] Solid food feeding ceremony of a child which takes place usually 7^{th} or 9^{th} month of age.

$\ln(Q) = \ln(1.444) -0.008 \ln (K) + 1.002 \ln(L)$

From the model we have

$\alpha = -0.008$

$\beta = 1.002$

As $\alpha < \beta$, we can conclude that the production of *Kahi* is also labour intensive one.

Again we have $(\alpha+\beta = 0.994) <1$, which shows the industry is subject to decreasing returns to scale. If a firm increases capital by 1% each, the production will increase by only 0.008%. As 0.008~ 0; we can conclude that increase in capital only has little effect on the production of *Kahi*. If a firm increases labour by 1%, the production will increase by 1.002%.

Again as $(\alpha+ \beta = 0.994) \sim 1$, we can say that the production of *Kahi* shows almost constant return to scale.

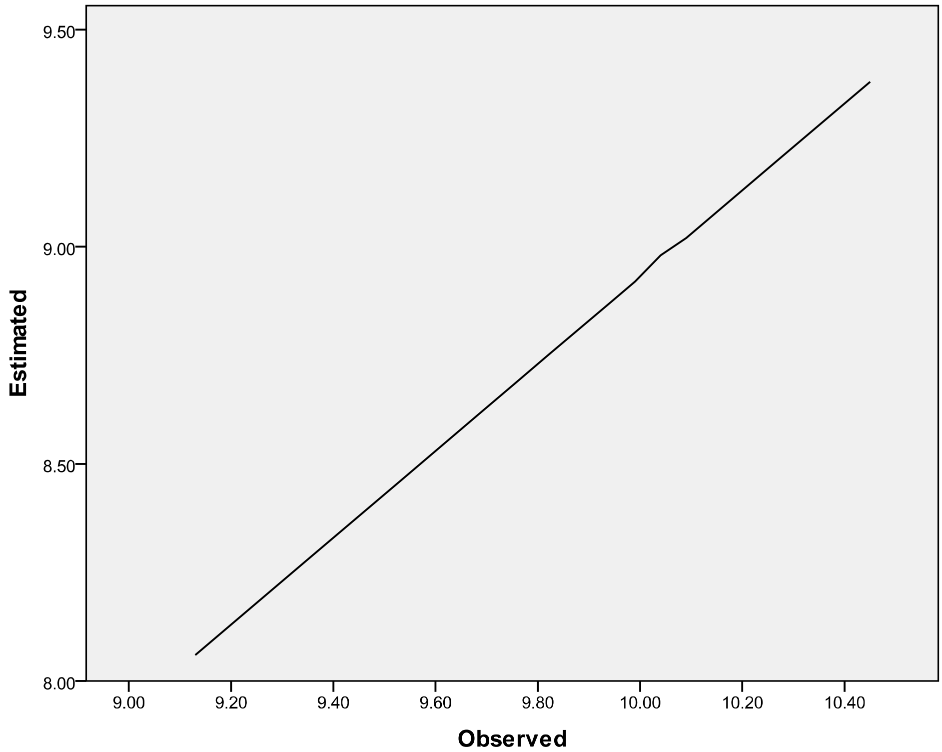
The coefficient of determination r^2 for the model is calculated at

$r^2 = 1.00$

This means that the independent variable can perfectly predict the dependent variable. In other words, there is no variation in the dependent variable that is not explained by the independent variable. This explains that the model is able to explain 100% variation on the dependent variable (Production) on the basis of independent variables (Labour and Capital). As this model is able to explain 100% of the variations, it is a perfect model.

As it is very rare occurrence and can sometimes indicate over fitting, we have rechecked the result by visualising the fit. For that we have plotted the Observed Values against the estimated values. In Figure 3.2, the Observed values of production are taken along the X axis and the Estimated values of production are taken along the Y axis. As the regression line is a straight line at 45^0 with no deviation we can conclude that the model is able to explain 100% variations hence it is a perfect fit.

Figure 3.2: Regression line of Observed on Estimated Value for *Kahi*



Source: Field Survey

The F test values of the model is calculated as

F = 184150.11 at 2*df*. At sig F= .0000

The *t* value of the Model is also calculated as

t= 49.575. At sig *t*= .0000

This shows that the t value is highly significant and only Labour is significant at 95% confidence interval and Capital is not significant in the production of *Kahi*. Thus we can accept the null hypothesis and conclude that production of *Kahi* is a labour intensive one.

3.9.2 Production Function of *Bati*:

Bati is a small bowl used to serve curry. These are also used to eat porridge and other similar breakfast items. One of the most popular traditional snack item *Doi Sira* (Puffed rice with curd) is traditionally eaten in bell metal *Batis* in Assam. In Assamese households *Bati* is the other most important utensil along with *Kahi* for serving food. *Bati* is the second most demanded bell metal product from Sarthebari. 37 Units out of 172 sampling units of the study produce *Bati*.

Based on the data collected from the field, the Linear Regression Model for production of *Bati* is estimated as-

$\ln(Q) = \ln(1.407) + 0.084 \ln(K) + 0.608 \ln(L)$

From the Model we have

$\alpha = 0.087$

$\beta = 0.920$

As $\alpha < \beta$, we can conclude that the production of *Bati* is also labour intensive one.

Again we have $(\alpha + \beta = 1.007) > 1$, which shows the industry is subject to increasing returns to scale. If a firm increases capital by 1% each the production of *Bati* will increase by 0.087%. As 0.087~ 0; we can conclude that increase in capital only has little effect on the production of *Bati*. If a firm increases labour by 1% the production will increase by 0.920% respectively. Thus it will be beneficial for the firm to increase the amount of Labour rather than Capital.

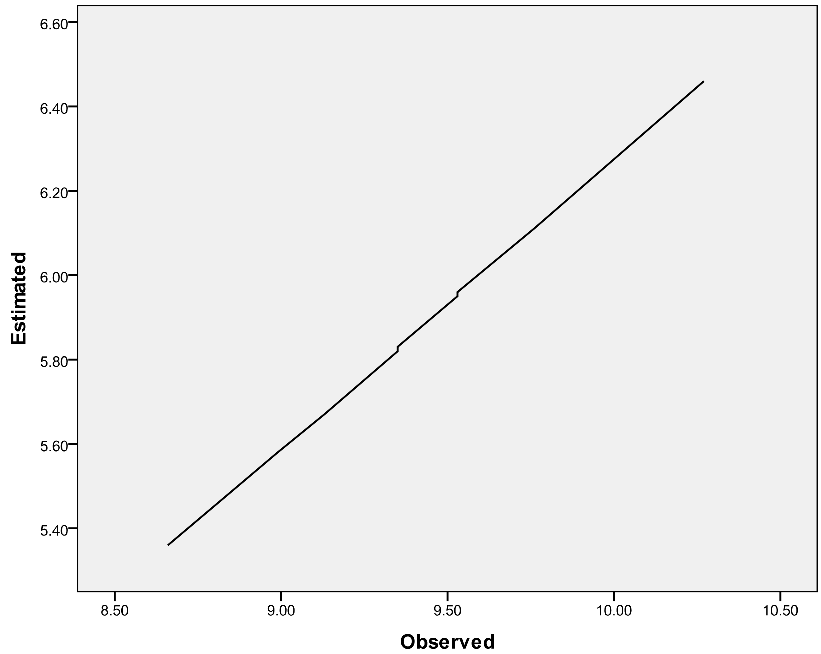
The coefficient of determination r^2 for the model is calculated at

$r^2 = 1.00$

This explains that the model is able to explain 100% variation on the dependent variable (Production) on the basis of independent variables (Labour and Capital). As this model is able to explain 100% of the variations, it is also a perfect model like that of *Kahi*.

As it is very rare occurrence and can sometimes indicate over fitting, we have rechecked the result by visualising the fit. For that we have plotted the Observed Values against the estimated values. In Figure 3.2, the Observed values of production are taken along the X axis and the Estimated values of production are taken along the Y axis. As the regression line is a straight line at 45^0 with no deviation we can conclude that the model is able to explain 100% variations hence it is a perfect fit.

Figure 3.3: Regression line of Observed on Estimated Value for *Bati*



Source: Field Survey

The F test values of the model is calculated as

F = 85054037 at 2*df*. At sig F= .0000

The *t* value of the Model is also calculated as

t= 240309. At sig *t*= .0000

This shows that the t value is highly significant and only labour is significant at 95% confidence interval and capital is not significant in the production of *Bati*. Thus we can accept the null hypothesis and conclude that production of *Bati* is a labour intensive one.

3.9.3 Production Function of *Taal*:

Taal is one of the most unique and popular product of Sarthebari. *Bhortaal* is the most widely produced variety of *Taal,* produced in Sarthebari. *Taal* is used in religious programmes of the *Satras* of Assam. It is also an integral part of *Naam Prasanga*[8] in Assamese *Vaishnavite* culture. Making of *Bhortaals* require special skills as not many *Kohars* have the ability to produce the vibrating and sonorous sound required in a good quality cymbals. *Kohars* of Sarthebari also produce *Pachang Taal*[9]. Traders from Bhutan procure *Pachang Taal* from Sarthebari and sell them in Buddhist monasteries all over the world including those in Bhutan, South Korea, Japan, China etc.

Based on the data collected from the field, the Linear Regression Model for production of *Taal* is estimated as-

$\ln(Q) = \ln(1.400) -0.00002 \ln (K) + 1.00 \ln(L)$

From the Model, we have

$\alpha = -0.00002$

$\beta = 1.00$

As $\alpha < \beta$, we can conclude that the production process of *Taal* is also labour intensive one.

Again we have ($\alpha + \beta = 0.99998$) ~1, which shows the industry is subject to constant returns to scale. If a firm increases Capital by 1% each the production will increase by 0.00008% which is almost constant. In other words, production will not change even if the producer increases capital without changing labour. If a firm increases labour by 1%, the production will increase by the same proportion.

The coefficient of determination r^2 for the model is calculated at

$r^2 = 1.00$

This explains that the model is able to explain 100% variation on the dependent variable (production) on the basis of independent variables (labour and capital). As this

[8] Group Prayer with musical Instruments like *Nagara* (Drum) and Taal (Cymbals).
[9] Cymbals used in Buddhist Culture.

model is able to explain 100% of the variations, it is a perfect model like the earlier ones of *Kahi* and *Bati*.

The F test values of the model is calculated as

F = 0 at 2*df*. At sig F= .0000

This shows that as the F=0, the explained variance of production is exactly 0. Another meaning of this is that the means of every group is perfectly identical and the model is a perfect fit. It shows that *Taal* is very highly skilled product. Human labour determines the production of *Taal*. Thus it will be beneficial for the firm to increase the amount of labour rather than capital.

The *t* value of the Model is also calculated as

t= 3.083E^8. at sig t= .0000

This shows that the t value is highly significant and only Labour is significant at 95% confidence interval and capital is not significant in the production of *Taal*. Thus we can accept the null hypothesis and conclude that production of *Taal* is a labour intensive one.

3.9.4 Production Function of *Bata*:

Bata is another unique product of Sarthebari. It is a decorated plate mounted on a stand. *Bata* is not used for consumption of any food item. In any religious programme of Assamese culture, the *Prasad*[10] to the Almighty is offered on a *Bata*. Whenever a guest visits an Assamese family, he/ she is offered *Tamul Paan*[11]on a *Bata*.

Based on the data collected from the field, the Linear Regression Model for production of *Bata* is estimated as-

$\ln(Q) = \ln(1.687) +0.004 \ln (K) + 0.994 \ln(L)$

From the model, we have

[10] *Prasad* in Assam is mainly soaked lentils (*Moong*, *Chana* and Peas) with finely chopped Coconut and Ginger.
[11] Areca Nuts and Beetle Leaves

$\alpha = 0.004$

$\beta = 0.994$

As $\alpha < \beta$, we can conclude that the production of *Bata* is also a labour intensive one.

Again we have $(\alpha + \beta = 0.998) < 1$, which shows the industry is subject to decreasing returns to scale. If a firm increases Capital by 1% each, the production will increase by 0.004%. As 0.004~ 0; we can conclude that increase in capital only has little effect on the production of *Bata*. If a firm increases labour by 1% the production will increase by 0.994% respectively, this is almost the same proportion. Thus it will be beneficial for the firm to increase the amount of labour rather than capital in the production of *Bata*.

The coefficient of determination r^2 for the model is calculated at

$r^2 = 1.00$

This explains that the model is able to explain 100% variation on the dependent variable (Production) on the basis of independent variables (labour and capital). As this model is able to explain 100% of the variations, it is a perfect model.

The F test values of the model is calculated as

F = 42999.670 at 2*df*. At sig F= .0000

The *t* value of the model is also calculated as

t= 34.349. at sig *t*= .0000

This shows that the t value is highly significant and only labour is significant at 95% confidence interval and capital is not significant in the production of *Bata*. Thus we can accept the null hypothesis and conclude that production of *Bata* is a labour intensive one.

3.10 Degree of Efficiency of Different Bell Metal Products:

It has been noted that different bell metal products have different degrees of efficiency. Table 3.4 shows the different degrees of production efficiencies of *Garhshalls* producing different products.

Table- 3.4: Degree of Efficiency of Various Bell Metal products

Product	Output Elasticity of Capital (α)	Output Elasticity of Labour (β)	Degree of Efficiency (α+ β)	'F' Value	't' Value
Kahi	-0.008	1.002	0.994	184150.11	49.575
Taal	-0.00002	1.00	0.99998	0	$3.083E^{8}$
Bata	0.004	0.994	0.998	42999.670	34.349
Bati	0.087	0.920	1.007	85054037	240309

Source: Field Survey

In Table-3.4 we can observe that the output elasticity of capital of *Kahi* and *Taal* are negative. But while rounding up to the second decimal points these becomes zero. This shows that the production efficiency of *Kahi* and *Taal* primarily depends on labour. Again regarding the degree of efficiency of *Kahi,* it shows decreasing returns to scale. Again that of *Taal* also shows decreasing returns to scale but if we round up to the third decimal point then we can conclude that *Taal* shows constant returns to scale. Again among all the models, that of the *Taal,* the 'F' value is zero which means the model is a perfect fit. If we analyze the production function of *Bati* we can see that it is the only product which shows increasing returns to scale. Among all the products, the output elasticity of capital of *Bati* is the highest at 0.87. This shows that if this industry has to be developed to a more profitable one, it has to be made capital intensive rather than labour intensive. For that new technologies have to be introduced. As a handicraft trade bell metal product making is primarily dependent upon the quality and efficiency of the *Kohar* and the *Aidhas*, but introduction of new technologies will definitely help the industry to grow further.

3.11 The Stochastic Frontier analysis of the Bell Metal Industry of Sarthebari: `

Stochastic Frontier Model as calculated from the data collected from the field is given below.

```
Stoc. frontier normal/half-normal model               Number of obs =     172
                                                      Wald chi2(2)  = 3399.63
Log likelihood = 174.51018                            Prob > chi2   =  0.0000
```

log_production	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
log_labour	.7355164	.0556216	13.22	0.000	.6265	.8445327
log_capital	.0899955	.0600981	1.50	0.134	-.0277947	.2077856
_cons	2.822421	.1696143	16.64	0.000	2.489983	3.154859
/lnsig2v	-4.867157	.1081155	-45.02	0.000	-5.079059	-4.655254
/lnsig2u	-13.40768	109.6618	-0.12	0.903	-228.3409	201.5255
sigma_v	.0877224	.0047421			.0789035	.0975269
sigma_u	.0012262	.0672334			2.61e-50	5.76e+43
sigma2	.0076967	.0008365			.0060572	.0093363
lambda	.0139781	.0677375			-.1187849	.1467412

```
LR test of sigma_u=0: chibar2(01) = 0.00              Prob >= chibar2 = 1.000
```

From the model we can draw the following conclusions. The model is estimated as-

$$\ln(Q) = \ln(2.822) + 0.09 \ln(K) + 0.736 \ln(L)$$

The Standard Deviations of the two error components are estimated as

$\sigma_u = 0.877$

$\sigma_v = 0.00123$

The log likelihood values of the technical inefficiency terms are estimated as-

$\ln\sigma^2_u = -4.867$

$\ln\sigma^2_v = -13.408$

The estimate of the total variance is calculated as

$\sigma^2_s = \sigma^2_u + \sigma^2_v = 0.0076967$

The ratio of the Standard Deviation of the inefficiency and the individual component is estimated as-

$\lambda = \frac{\sigma_u}{\sigma_v} = 0.0139781$

In the SFA model the Wald Chi Square statistics is estimated as 3399.63 showing that the explanatory variables are significant.

The Log Likelihood model value is calculated as 174.5108 which show the model is a good fit of the data.

The Stochastic Frontier Model is based on the Null and Alternative Hypothesis that

$H_0 : \sigma^2_u = 0$

$H_1 : \sigma^2_u > 0$

The Likelihood Ratio Test value is estimated at 0.00 with *p* value 1.00

Thus the Null Hypothesis is rejected and concluded that there is technical inefficiency in the Stochastic Frontier Model.

The Technical inefficiency coefficient is given by

$\ln\sigma^2_u = -4.867$ with SE $(\sigma^2_u) = 0.10811$

The Standard Normal Variate (Z) value is estimated at -45.02 with

$p > |Z| = 0.00$

Thus we can conclude that the technical inefficiency coefficient is statistically significant and the production of bell metal is technically inefficient. By increasing the proportion of Capital in relation to Labour, this inefficiency can be reduced.

To test the causes of inefficiency in Bell Metal production, two factors were identified – experience (age) of the *Kohar* and average work hour in the *Garhshall* per day. As the *Kohars* start as a *Jogali* in his late teens, their age explains the amount of experience they have on the craft. The more experienced the *Kohar*, more will be his expertise. The average work hour of a *Garhshall* may indicate two things- they produce more products than others or they take more time than other *Garhshalls* to produce the products. Thus the work hour may be a cause of inefficiency. The Stochastic Frontier Half Normal model considering the inefficiency factors of experience and work hour is given below.

Stoc. frontier normal/half-normal model

logproduction	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
loglabour	.756	.058	13.00	0	.642	.87	***
logcapital	.074	.062	1.20	.231	-.047	.194	
logage	.053	.028	1.90	.058	-.002	.107	*
logworkhour	.033	.047	0.71	.48	-.059	.126	
Constant	2.536	.229	11.05	0	2.086	2.985	***
Constant	-4.891	.108	-45.23	0	-5.103	-4.679	***
Constant	-13.28	96.138	-0.14	.89	-201.708	175.147	

Mean dependent var	9.695	SD dependent var	0.401
Number of obs	172	Chi-square	3485.249
Prob > chi2	0.000	Akaike crit. (AIC)	-339.099

*** *p*<.01, ** *p*<.05, * *p*<.1

From the model we can draw the following conclusions. The model is estimated as-

$$\ln(Q) = \ln(2.536) + 0.074 \ln(K) + 0.756 \ln(L) + 0.053 \ln(A) + 0.33 \ln(W)$$

The variables A and W denote Age of the *Kohar* and Average work hour of a *Garhshall* per day, respectively.

It is observed from the model that the technical inefficiency coeffecients are significant and lack of experience can be a cause of inefficiency in productivity of a *Garhshall*.

3.12 Conclusion:

The bell metal industry of Sarthebari is a labour intensive Industry which is subject to decreasing returns to scale. The output elasticity of Capital is very low at 0.083, and that of labour is 0.74. It implies that if this industry has to be developed, importance should be given in developing the productivity of labour. Again it has been observed that setting up the roller mill has helped the *Kohars*, particularly those involved in the production of *Kahi, Taal, Bati, Bata* and *Maihang*. If some new technologies like Power Hammer, Propane Forges, Grinders etc are introduced then the importance of Capital in this industry can be increased as it is done in other parts of India. This will lead to increased productivity. This point is validated by the Stochastic Frontier Analysis of the industry. The production is inefficient because of its dependence on labour. The industry can be turned into an efficient one by changing the techniques of production and increasing the factor intensity of Capital.

If the production technique of the bell metal industry remains more or less static and maintain the traditional form of handicraft industry, then it can be developed further by creating more *Garhshalls*. This will create enough employment opportunities in the area. For that proper planning and training of the prospective *Kohars* should be given. The government can play a bigger role here.

As we have already discussed the production technique and factor intensity of the industry, the next step is to study the profitability of it. This is done in the next chapter.