INDRAPRASTHA
JOURNAL OF MANAGEMENT

Diffusion of Smartphones in India

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Abstract

This paper aims to forecast the growth of smartphones in India. The country has been experiencing very high smartphone adoption rate in the last few years. The tendency to adopt an innovation, low cost technology, and higher economic power are a few of the primary reasons responsible for such high rate. This is expected to continue till it reaches the saturation level. This paper uses analytical models to predict the smartphone adoption in the growing Indian market. Logistic and Gompertz models form the basis of this analysis. The Gompertz model fits better for the available dataset due to its higher R^2 value and lowest mean square error (MSE). The paper forecasts that the density of smartphone (number of device per 100 people) in India would reach to 53.6 by 2020 from its 2013 level (6.1). Due to such high adoption rate, the total number of smartphone users in India is projected to reach 716.74 million in 2020. This is equivalent to an average addition of 90.99 million new users per year to the total base. However, the addition would be slow, as the curve would start reaching the saturation level. The average annual addition of new users would be 47.23 million between 2025 and 2035. Since smartphone brings convenience in terms of internet accessibility, the mobile internet base in India has grown tremendously. This mobile - internet combination has triggered a very high growth in the m-commerce segment. Therefore, it is of paramount importance for mobile manufacturers, policy makers, e-commerce companies and retailers to adapt to this diffusion so that activities for better infrastructure, channels and products could be carried out well in advance in order to realize maximum market value.

Keywords: Smartphone diffusion; Technology diffusion; Logistic model; Gompertz model; Forecasting

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1. INTRODUCTION

India is one of the biggest markets for the mobile industry. As per the July 2014 report of Telecom Regulatory Authority of India (TRAI), the total number of wireless subscribers in India has increased to 914.92 million (TRAI, 2014). With such numbers, India now has the second largest number of mobile phone users in the world. However, there has been a slow but very promising shift in the preference of mobile users. More and more users are now using or planning to use 'smartphone'. Though, there is no standard definition of a smartphone; a cellular phone with an operating system which can perform complex applications (internet, entertainment, shopping, games etc.) like a computer could be called a smartphone. Communication was the sole purpose of cellular phones. However, smartphone have completely changed this view. Ability to perform many functions has made smartphone the preferable alternative. As per International Data Corporation, there has been a significant migration of mobile users from non-smartphone to the smartphone category. Low cost phones, cheaper 3G tariffs, increased purchasing power, better infrastructure, easy access to internet, urge to get connected 24/7 and growing number of generation C are other prominent factors which are responsible for high adoption rate.

In the first quarter of 2013, 10% of mobile users in India belonged to smartphone category, however, within one year, this share increased to 29% in first quarter of 2014 (IDC, 2014). It shows the ongoing change in the behavior of Indian consumers to buy technologically advanced phones (Please refer to Figure 4, Annexure 1 for details). This is expected to continue at similar rates in future. Though, Indian consumers were slow in adapting to this new phenomenon, the growth has been fuelled in recent times. In India, smartphone manufacturers (Samsung, Micromax, HTC, etc.) are continuously launching new products, with features customized for domestic consumers. As per International Data Corporation (IDC), the smartphone market in India grew by staggering 186% in first quarter of 2014. This growth is much higher than growth in other developing markets such as China where the market experienced only 31% growth for the same period. In 2013, 44 million smartphones were shipped to India which is almost 171% higher than 16.2 million shipments in 2012. The following figure clearly indicates the increasing adoption of smartphone in India (IDC, 2012).

Figure 1: Smartphone shipment in India (million units per year)

Asia Pacific overall has experienced very high smartphone penetration. Highest penetration in Hong Kong and Singapore with 87%, followed by other countries, Malaysia, Australia and China (Nielsen, 2014). Though, India still ranks lower than other countries in terms of cumulative penetration, the corresponding rate has been explosive. From 2009 to 2013, smartphone subscriber market in India grew with a compound annual growth rate (CAGR) of 137.7%. Such high sales have resulted in an increase in smartphone density (number of smartphones per 100 people) in India. In 2013 and 2012, there has been 120% and 81% average growth in smartphone density compared to the respective previous year's values.

Figure 2: Smartphone cumulative density in India

Recently, the Indian market has been flooded with low cost smartphones (BBC, 2013). Many companies have been founded only over the last few years due to the huge market potential. Companies such as

Nokia used to be the biggest market shareholder in India. However, the crop of new companies such as Micromax and Karbonn has changed the entire picture. Now, Chinese vendors and Mozilla have also entered the race (BBC, 2014). Continuously new products are being introduced by Korean giant Samsung which currently holds the number one position in the Indian smartphone market. Micromax, Karbonn, LAVA and Nokia are other vendors in top 5. These top 5 companies represent almost 66% of the total existing market (Please refer to Figure 5, Annexure 1).

Wave of affordable smartphones has resulted in a larger mobile internet user base in India and vice versa. This has been observed globally. As per the latest estimates of the Telecommunication Development Sector (ITU-D), mobile-broadband penetration on a global scale would touch 32% by the end of 2014. This is five times of 2009 level (ICT, 2014). Though the penetration level of mobile broadband in developing countries is still at 21%, it is growing at a faster rate (26%) which is twice as high as growth rate in developed countries (11.5%). The same trend has been observed in India, where the number of mobile internet users has increased substantially.

According to Internet And Mobile Association of India (IAMAI), mobile internet users in India increased from 68 million (2012) to 130 million (2013), a growth of about 91 percent. This number is expected to reach 185 million in 2014 (IAMAI, 2014). The report also states that over 50% of internet users are accessing the internet on their mobile. This in turn has provided a platform for mobile commerce (m-commerce). Easy accessibility to the internet and online shopping activities has made smartphone a new medium for online sellers and retailers. The contribution of m-commerce site traffic to the online shopping category has increased from 8 percent to 20 percent in 2013. About 61 percent of smartphone users in the country has purchased via their mobile phones (Business Standard, 2014). High consumer movability which comes due to smartphone usage has forced retailers to change their advertisement and promotion strategy. With a significant focus on digital marketing, data using digital footprint of consumers is being used by manufacturers and retailers to target consumers with more customized products. Retailers are developing new smartphone apps which can perform various functions such as advertisements, shopping, bill payments, sending gifts etc.

Market potential, rate of adoption, consumer behavior are a few of the very important parameters which really describe how a smartphone market would pan out in future. Technology products generally tend to have a short life span due to continuous advancements. Therefore, it is extremely important for technology companies to be agile and adapt to the changing environment quickly. Particularly, stakeholders related to the mobile industry need to understand and envisage the developments which could take place due to quick adoption of smartphones. Various studies have been conducted to understand the diffusion of mobile phones for different countries (Chaddha et al., 1971; Gruber and Verboven, 2001; Botelho and Pinto, 2004). Similarly, few studies have also been conducted to estimate the market size for mobiles in India (Singh, 2008). However, no study has conducted for smartphone yet. Attributes of consumers and reasons for purchasing normal mobile phones are different from smartphones therefore a fresh look at the diffusion process of smartphone is required. This study would enable companies to see things from an analytical model's perspective and help them plan appropriate strategies for various fronts (investments, R&D, advertisement, pricing, distribution etc.).

This paper presents an overview of different literature available in the field of diffusion. The findings could not only be relevant for policy makers of the telecom industry, but also for company executives who use such policies and execute marketing activities based on sales forecast. The paper starts with a brief discussion of general trends in the smartphone industry. Next it looks at the basic bass model and the description provided by Rogers in Diffusion of Innovations. The paper also discusses relevant information from other papers which talk about diffusion of mobile in India. Then the paper directs us to the two prominent models frequently used for mobile diffusion, Logistic and Gompertz. Relevance of these two models is presented and then quantitative analysis using data for smartphone is carried out. Then paper outlines the conclusion, limitation and direction for further research.

2. LITERATURE REVIEW

Multiple studies have been carried out and several models have been defined in order to understand the diffusion process of innovation. Sales of a new product could be considered either in terms of the diffusion process or adoption process (Mahajan and Wind, 1986). Rogers defines diffusion as a process by which an innovation is communicated among the members of a social system through channels over time. It is a special type of communication in that the messages are concerned with new ideas. On the other hand, adoption could refer to a process in which consumer goes through a sequence of stages. This sequence starts with a consumer being made aware of the innovation and ends with the final acceptance and adoption of the innovation. The rate of adoption is the relative speed at which innovation is adopted by members of the system. It can be represented as the numerical indicator of the steepness of the adoption curve for an innovation (Rogers, 1983).

Rogers showed that perceived attributes of any innovation plays a major role in explaining the rate of adoption. The five attributes (Relative advantage, compatibility, complexity, trialability and observability) explain almost 49 to 87 percent variance in the rate of adoption (Rogers, 1983). In addition, other four variables (a) type of innovation-decision (b) nature of communication channels diffusing the innovation (c) nature of social system in which innovation is diffusing and (d) extend of change agent's promotional efforts in diffusing the innovation directly, affect the innovation rate of adoption (Rogers, 1983). There might be many reasons why certain people tend to adopt certain innovations. For example, the desire to seek specific social status by adopting a new innovation could be one of the indirect but main reasons for imitating the innovation (Tarde, 1903). More or less, all the reasons could be defined with the above attributes. However, irrespective of whether the product has been purchased once or frequently, it has been observed that it follows a common first purchase sales volume curve (Mahajan and Wind, 1986). Diffusion models are mathematical models which predict the diffusion of innovative technology. Many models have their origin from biology and ecology (Lotka, 1956; Pielou, 1969). One of the first new product growth models in marketing was proposed by Fourt and Woodlock (1960). Then, Frank M. Bass proposed Bass model which described how certain population adopts new products (Bass, 1969). Bass model enjoyed acceptance among modelers since it generalized the framework of Fourt and Woodwork work. Since then, Bass model has been successfully applied to explain diffusion processes for various industries such as retail, consumer durables and telecommunications (Bass, 1969; Nevers, 1972; Dodds, 1973; Ismail and Abu, 2013). A behavioral rationale for the model is presented in terms of innovative and imitative behavior. Influentials are the first adopters of innovation and they influence other (called 'imitators') to adopt the innovation (Bulte and Joshi, 2007).

Mahajan stated that diffusion models generally focus on the generation of product life cycle to forecast the first-purchase sales volume (Mahajan and Wind, 1986). Rogers observed that the number of adoptions over time shows a bell curve, however, when the number of individuals adopting a new idea is plotted on a cumulative frequency basis over time, the distribution is a S - shaped curve (Rogers, 1983). Bass suggests a rationale of how individuals can be defined as a set of (i) Innovators (ii) Early adopters (iii) Early majority (iv) Late majority and (v) Laggards. The shape of the curve is a result of such process. Classification depends on the timing of adoption. First, only few (called 'innovators') adopt the innovation and then they influence others to adopt the same. Interaction between adopters and imitators generate a rapid growth in the diffusion process. Rate of adoption is high till the market starts getting saturated. As the time goes by, the number of potential adopters becomes less; therefore the adoption rate goes down. Using this concept, many literatures have followed these models and S curve to explain the diffusion of mobile phones (Singh, 2008), Botelho and Pinto, 2004, Gambo and Otero, 2009). Therefore, we also hypothesize that the growth of smartphone density would follow the S - curve.

3. MODELS FOR DIFFUSION

Many models could be used to explain the S shaped curve, however, two mathematical functions, which have been used frequently to explain the new product diffusion process, are Logistic and Gompertz. Wang and Kettinger used the logistic model to survey the diffusion of number of cell sites and numbers of subscribers in US (Wang and Kettinger, 1995). Rai used these models to forecast the future development of Internet (Rai and Samaddar, 1988). Gurbaxani found the S shaped pattern of BITNET consistent with the logistic curve (Gurbaxani, 1990). Authors of the study additionally used exponential function to explain growth from January 1981 to Jan 1994. However, the authors also admitted that exponential function could only be used in the early stages of the diffusion, since this function has no saturation level. Logistic and Gompertz models allow growth rate to increase in a certain way and eventually slow down to a finite saturation level. Both describe the S shaped phenomenon for diffusion. However the rate of the function is defined differently.

As per the Logistic function, the rate of diffusion would be directly proportional to the product of existing smartphone subscribers and the remaining untapped market. Therefore, the function can be described by the following equation:

$$N = \frac{s}{(1 + xe^{-yt})} \tag{1}$$

The Gompertz function defines that the rate of smartphone subscribers is proportional to the existing level of the smartphone subscribers and the logarithm of the smartphone subscriber density level. Therefore, the following equation describes the model:

$$N = Se^{-xe^{-yt}} \tag{2}$$

Where, N is smartphone density (number of smartphones per 100 people); S is saturation level density (point of highest density when the growth rate of diffusion would tend to become 0); x and y are positive constants. Please refer to the Annexure 2 for further explanation on model equations.

One of the main parameters, which are used in the analysis, is the saturation level density of smartphone. A smartphone is a recent innovation and since its adoption is still in the process at a high rate, therefore it is logical to assume that the saturation level of smartphone in India is yet to be achieved. In order to arrive at a number for smartphone saturation level which could be used for analysis, we would refer to saturation level of mobile phone in India (let's assume this value is 'A') from available literature and then assume that smartphone would reach the same level in India in few years. Since smartphone is an advanced version of mobile phone, we consider this assumption to be valid. However, to make sure that the most appropriate saturation value is being analyzed, we would consider a range of saturation level values around 'A' and carry out the model estimation. Saturation level, which provides the best R^2 value and lowest MSE would be accepted as the suitable value. Furthermore, the scenario analysis would provide the scenarios for different possibilities.

Various studies have estimated different saturation levels for different markets. Saturation level in Portugal was estimated to be at 67.4% (Botelho and Pinto, 2004). In Finland, Frank expected the penetration level to be 91.7% in 2009 (Frank, 2000). For India, Singh estimated the saturation level of mobile phones to be 120 phones per 100 people (Singh, 2008). Singh also described that the saturation level of mobile-density would most likely depend on country's adoption timing and tendency. Therefore, it would be important to identify whether the specific country is an early adopter or late adopter. Since developed countries (in this case early adopters) already have the infrastructure for landlines, they would incur high costs of switching (from landline to mobile). Therefore, they would tend to have a lower saturation point. However, developing countries (in this case later adopters) already lack infrastructure and therefore would tend to have a high saturation point due to lower switching costs. Current penetration of smartphone in other developed countries (such as Hong Kong and Singapore) has already reached a high level. Considering this, we would first assume that saturation level in India would easily cross the 90 level and reach the point of 100 smartphones per 100 people (India has high migration from feature phones to smartphones). Therefore, 100 is our 'A' value. Now, we would conduct the analysis with a range of saturation values starting from 70 to 120 (70, 80, 90, 100, 110 and 120). The value, which provides the lowest Mean Square Error (MSE), would be considered as the right saturation level.

Furthermore, it is very important to understand the start date of the diffusion. Apple's iPhone was one of the first innovative products which revolutionized the entire domain of smartphone. Soon, many other companies followed the same path with their own products. Considering such development, one could easily credit iPhone introduction for the beginning of smartphone era. In India, iPhone was introduced on August 22, 2008 (Reuters, 2008); therefore, we can assume 'Year 2008' as the start date for the beginning of this diffusion process in India.

4. METHODOLOGY

The paper follows the secondary data research methodology. Diverse set of literature has been reviewed in this regard. Such review enables us to understand the existing work which has been done in the space of diffusion and modelling for technology products, particularly mobile phones. It helps us understand whether estimating the diffusion of smartphone would be possible using available models. Post this analysis, suitable models (Logistic and Gompertz) have been selected for further study.

Data for the smartphone shipment in India was referred from International Data Corporation (IDC). The data was converted into density (no. of smartphones per 100 people) using overall tele density and population data referred from the Telecom Regulatory Authority of India (TRAI). Model equations were rewritten into linear forms and then ordinary least squares (OLS) method was used for these equations to find out the better fitting curve. OLS provides the value of equation parameters (x and y) for available density values. A range of saturation values was used for estimation process. The specific saturation value, which provides the least mean square error, has been used for writing the final model equation. Final equation forecasts the smartphone density values India is estimated to experience in coming years. These forecasted density values coupled with the projected population data provides the total number of smartphone subscribers in India at different times. In addition, two different scenarios with lower and higher saturation values were also estimated.

5. ANALYSIS AND RESULTS

Model equations (1) and (2) could be rearranged and rewritten in the following logarithmic forms respectively:

$$\ln\left(\frac{S}{N}-1\right) = \ln x - yt \quad (3)$$

$$\ln\left(\ln\left(\frac{S}{N}\right)\right) = \ln x - yt \quad (4)$$

Using equations 3 and 4, data were plotted on linear graphs and then Ordinary Least Squares (OLS) method was used in Microsoft Excel to estimate the values of constant x and y. For the given density values, above stated linear log equations for Gompertz model provides better R^2 value than the logistic model (Please refer to the Annexure 3 for respective graphs). Therefore, it has been concluded that the Gompertz model fits better than the logistic model and is more appropriate to explain the S shaped phenomenon and forecast the diffusion process of smartphones in India. Going one step further, a range of different saturation values was used in the Gompertz model which yields different mean square error (MSE) values.

Table 1: Gompertz model parameters for different saturation levels

$N = Se^{-xe^{-yt}}$				
Saturation level (S)	lnx	y	R^2	Mean Square Error (MSE)
70	1.9694	0.2145	0.9936	0.07234
80	1.983	0.2069	0.9939	0.06694
90	1.9952	0.2006	0.9942	0.06293
100	2.0063	0.1954	0.9944	0.05908
110	2.0163	0.1909	0.9946	0.05597
120	2.0256	0.1869	0.9947	0.05384

Out of all the values, least MSE corresponds to the saturation value 120. Therefore, this is being used as the most suitable value for S. It estimates that in saturated state, the penetration rate would be 120 smartphones per 100 people in India. The OLS method also gives the following values for equation parameters: x = 7.5807 (where lnx = 2.0256) and y = 0.1869. Hence, the final Gompertz equation for smartphones could be written as:

$$N=120\ e^{-7.5807e^{-0.1869t}} \qquad (5)$$

Following figure presents the above equation in a graphical manner (where Y axis presents the smartphone density (per 100 people) and X axis presents the time (years).

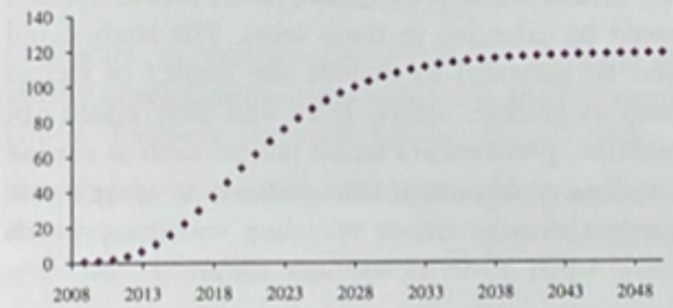

Figure 3: Estimation of smartphone penetration in India

At t = 0, the model provides the starting density value as $N_0 = 120/\ e^{7.5807} = 0.061$. However, when t becomes very large then N tends to reach the saturation value. The inflection point of the curve occurs at or t = 10.84 years. The function reaches the maximum penetration rate at this point. Rate of growth of density would increase till 2018 and then would start decreasing. The density value would be approximately 44 mobiles per 100 people (N = S/e) at this point.

Using different t values, smartphone density values in India at different times can be forecasted. In order to calculate the total number of smartphone users, we would refer to the population estimates by a United Nations report *"World Population prospects: The 2012 Revision"*. This report projects the population of India to reach 1418.75 million in 2025. This is equivalent to an average population growth rate of 1.11% per annum (from 2013 to 2025). The report also projects an average annual population growth rate of 0.57% from 2026 to 2050. Using estimated values of the population and smartphone density, it can be estimated that India would touch 716.74 million smartphone users in 2020. Therefore, one could say that on an average 90.99 million new users would be added per year (from 2013 to 2020)[1]. Furthermore, the total number is projected to reach 1234.61 million in 2025, with an average 103.58 million additions per year (from 2020 to 2025).

Table 2: Gompertz equation and estimation with saturation value 120

$N=120\ e^{-7.5807e^{-0.1869t}}$		
Year	Smartphone density (per 100 people)	Smartphone subscribers (million)
2016	21.93	280.27
2018	37.26	486.82
2020	53.66	716.74
2022	68.97	941.77

5.1 Scenario analysis

We also project two different scenarios for the smartphone market in India. We understand that the market is always volatile and subject to many internal and external factors (such as policies, natural events, innovations, social trend etc.) which could easily impact the growth of any product. Therefore, this analysis presents two more scenarios with saturation values 80 and 100. If the market gets saturated at density value 80 smartphones per 100 people, Gompertz equation estimates the smartphone user base in India to be 582.52 million by the end of 2020 (an average addition of 71.82 million smartphones per annum). However, at the saturation value 100, India would have 654.79 million smartphone users in 2020. Following tables present the scenario analysis with an estimated density and cumulative subscribers.

1. Actual value for 2013 has been considered for this calculation

ANNEXURE 1

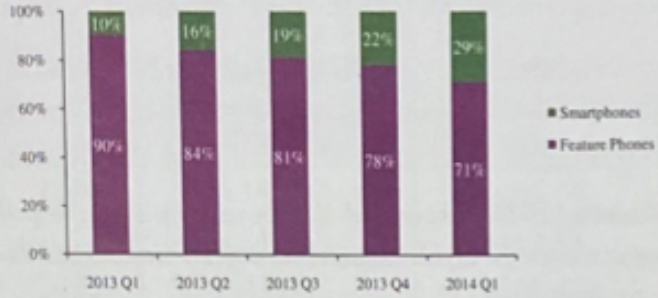

Figure 4: Migration from feature phones to smartphones

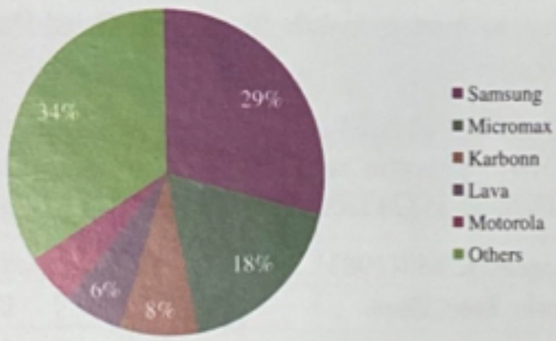

Figure 5: Smartphone vendor share in 2014 (Second quarter)

ANNEXURE 2

Let's take 'N' as the smartphone density, which is the dependent variable in the equation and 'S' represents the saturation density, which the curve would reach in the long term. As per the Logistic function, the rate of change in density of smartphone subscribers is directly proportional to the product of exiting smartphone subscribers and the remaining untapped market. Therefore,

Integration of the equation over t gives the following equation:

S = Saturation level (point of highest density when the growth of diffusion would tend to become 0); x is a positive constant. Values of x and y describe the shape and slope of the curve. At t = 0, N = S/(1+x). The rate would reach its maximum value at the inflection point. At that point and .

Similarly, the Gompertz function defines the rate of smartphone subscribers. The rate of subscribers is proportional to the existing level of the smartphone subscribers and the logarithmic of the smartphone subscriber density level. Therefore;

Integration of the equation over t gives the following equation:

At t = 0, . At , the rate would be maximum with value.

ANNEXURE 3

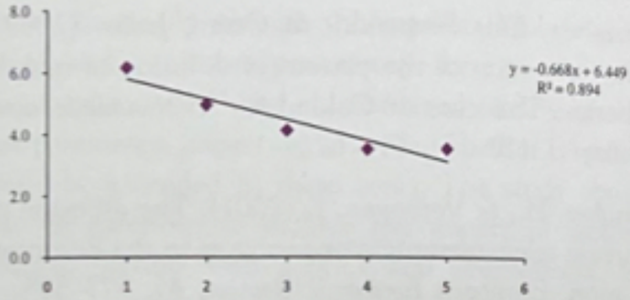

Figure 6: Linear logarithmic (Logistic) for saturation value -100

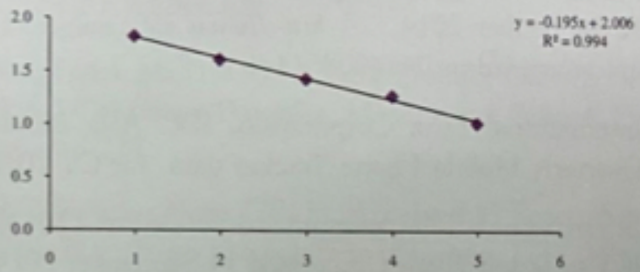

Figure 7: Linear logarithmic (Gompertz) for saturation value -100

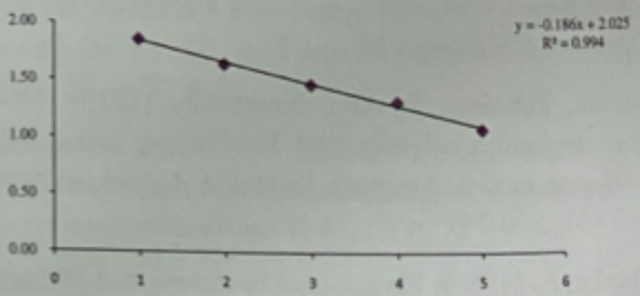

Figure 8: Linear logarithmic (Gompertz) for saturation value -120