

A Strategic Framework for Technology Valuation in Agriculture and Allied Sectors in India – Case Study of Chitosan

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Standardized tools for valuation of agricultural technologies developed in National Agricultural Research System of India are featured in this study with a generalised framework. A valuation pyramid with several levels of qualitative and quantitative approaches was designed. The new framework was articulated by a case study on production of Chitin & Chitosan from crustacean waste, a technology of Central Institute of Fisheries Technology, Kochi. The value of the novel technology was calculated using various methods, customized for the specific domain. With few suppositions at every level of the process flow, the value worth of the technology was calculated using different methods. This system attempts to deliver a valuation practice which is suitable for most of the technologies coming up in the public agricultural research system.

Keywords: Indian Council of Agricultural Research, Agricultural Research System, Reproduction Cost Method, Replacement Cost Method, Competitive Advantage Valuation, IP valuation methods, Valuation pyramid, Chitosan technology, net present values, discounted cash flow, Surrogate measures, Monte Carlo method, OPT Black Scholes, Technology Life Cycle, IP Management

Intellectual property (IP) in the form of patentable technology, legally protectable trademarks and designs, copyrights and others have increasingly emerged as most important assets, not only for large, medium and small companies, but also for research, educational and extension institutions covered under the National Agricultural Research System (NARS) in India. The efforts of Indian Council of Agricultural Research (ICAR) towards creation of an institutional mechanism for commercialization of products/technologies generated from its Research & Development (R&D) investments have led to building awareness on IP portfolio and their valuation.¹ The business propositions as spinoffs catalyze building an innovation ecosystem in NARS. Issues centering the valuation of IP are emerging as major challenges for technology transfer units across NARS which initiates transactions of license or sale, mergers and acquisitions for the technologies being developed or acquired. As the pace of developing IP assets enhances, it is also expected that negotiations, strategic planning, financing and litigation processes may acquire greater significance. The monetization of these tangible and intangible assets generated within

the system by R&D processes, assume much importance in decision making process in public system within the dynamic market environment. Currently there are no standardized tools for valuation of agricultural technologies in India, especially within NARS. With an objective to initiate a set of such tools, a generalized framework to value intellectual assets and technology developed in public research systems including NARS is proposed.

Approaches for Valuation

As intangible assets are often composite assets involving a patent, trade mark, logo, copyright, etc., its value is realized in combination with other assets. Generally, there are two kinds of approaches for IP valuation-qualitative and quantitative, segregated according to their characteristics.² Qualitative analysis is usually opted for internal assessment of technology through different indicators and attributes such as type and stage of IP protection, technology class and its incumbent growth in the field, market demand, patent life, stage of development, financial aspects, legal issues and other managerial factors that can influence the value of IP. The preferential order for the indicators varies, case by case, customised based on the technology. Claim analysis and citation analysis

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received from patents originated from original work are important factors in qualitative analysis in assessing the worth of the invention. The results of the analysis may be either numerical or descriptive, but it doesn't give any information on financial terms. Hence qualitative analysis specifically enlightens only about characteristics of the technology to the IP management system³.

Quantitative analysis is exercised by professionals in the field, which is a constituent of three approaches, namely, cost method, market method and income-based approach or discounted cash flow (DCF) method.⁴ These methods are applied internationally both in public and private sectors for IP valuation. Results in Quantitative approaches often culminate in monetary expressions and assist to determine the value of the IP for a particular time frame.³ The significant practises in predominance for IP valuation are discussed in the following:

Cost Approach

The strategy in implementing cost approach is to assess the value of an IP by calculating the cost for an alternative contemporary technology that is available. The fundamental hypothesis of this approach is that the cost of new asset equals the value of its possession.⁵ The two different methods under cost approach are 'Reproduction Cost Method' and 'Replacement Cost Method' which are based on the cost of an exact replica and the cost of a technology with an equivalent benefit, respectively. As the exact replica for IP may not be possible, replacement cost method is fitting and widely accepted.⁶ In simple terms, all the costs involved in the R&D of the technology is added here along with adjustments for inclusion of profitability factor and opportunity cost. The obsolescence cost, taxes and amortized cost, if any, are deducted from the total value depending on the case, to arrive at the determinative cost of a technology.

Market Approach

The market approach focuses on market transactions of IP in order to determine its realistic value in the market by comparing with a close existing technology. Though this is an ideal approach, it is not reliable as most of the IP transactions in the market are done with tangible assets of a company and the price of the transaction may not be disclosed all the time, especially pertaining to IP component as such. Information on the market transactions for a

particular IP can be collected from dedicated databases and professionals in the field.⁷ But, most of the times this is an incomplete data, as transaction facts are always not available. If market data of the immediate competitor is available, the price of the newly developed technology/product can be fixed close to that of the competing one based on the pricing strategy, whether it is skimming or penetrating in nature. The sales volume of the new technology/product may also be assumed by analysis of the market forces and current sales of the competitor. The annual revenue and profit margin can be subsequently calculated. Further the percentage of profit available to the licensor may be worked out for first four or five years. The value of the technology can be arrived by summing up the net present values (NPV) of the profit figures.

Income Approach

Another prevalent method is the income approach derived from discounted cash flow (DCF) theory where the value of the IP is estimated by the current value of the revenue generated in future.⁵ As per this method, the value of an IP is a factor of the income it can generate. There are three diverse processes in income approach, namely relief from royalty method, profit-split method and incremental profit method.^{5,7} The most widely accepted method is the relief from royalty method and it is based on finding out the value of the IP by summing up the discounted cash flow or NPV of the estimated royalty in first four or five years. Commonly all the three categories of income approach can be used to get the average value for valuation of IP or the approach may be restricted to a specific method based on the type of IP, legal and other managerial issues.

Other approaches for IP Valuation

There are numerous other methods in existence, which are hybrids of the above mentioned basic approaches. They include Industry Standards – Comparables method, Ranking method, Rules of Thumb (including the '25% Rule'), Surrogate measures, Disaggregation methods, and Competitive Advantage Valuation (CAV), Monte Carlo method, OPT Black Scholes method, Pay off method, etc.^{8,9}

Monte Carlo method is based on DCF method and helpful to assess an IP without any commercialization track record in the market. It considers capital investment, time required for the product to enter the market, potential market and such others as the

variables, and highlights the key uncertainties.¹⁰ OPT Black Scholes method is extensively used in Biotech and Pharma related technologies. This method is based on option, pricing and time. It is useful to the technologies, which are only in early stages. Fundamental for Pay off method is from value scenarios. It compliments all the three traditional approaches-cost, market and DCF methods. Internal databases, published survey and announcements and litigation documents constitute the source of comparable transactions. The Ranking/Rating method helps in preparing for license negotiations by comparing technologies. It requires expert reviewers to review technology from various perspectives.¹¹ Surrogate measures are usually used to evaluate patents. This takes into account the three measures namely, number of patents issued to a company, payment of patent maintenance fees and prior art citations.¹² CAV method was developed to address current issues in IP valuation which uniquely balances the cost and precision. It mainly consists of five steps. The First step involves the patents association with a product, the product association with a set of competition parameters and the patent's association with individual competition parameters. In the second step the associated product is compared to an average substitute product to analyse base competitive advantage contributions of the patents and the patents incorporated in the associated product are compared to one another to estimate the relative competitive advantage contributions of the patents. The calculation of net present value of the associated product and attribution of fraction of the net present value to technical intellectual property assets formulates the third step. The fourth step is composed of attribution of a portion of the associated product's technical intellectual property asset value to each patent, based upon its relative competitive advantage contribution to the product's net present value. Finally, in the fifth step, the values of the patents are adjusted for intellectual property risks.¹³ The appropriate approach for IP valuation is decided based on all the influencing factors. But, always more than one method is considered to determine the value of an IP and verify the results, as no single method can estimate the exact value of an IP, as there is always a wide scope for discretion.¹⁴

Designing a Standard Valuation Framework

The IP valuation of technologies in any public sector Research and Development (R&D) organization can be done through a modified strategic valuation

framework. A comprehensive valuation framework with support of data base management and management information systems can provide some solutions to the complex task of valuation of IP, assets and technologies.

Strategic Framework

Any IP valuation exercise can be viewed as a four level pyramid¹³, where each level supports the analysis generated on the level above (Fig. 1). The four levels are structured as:

- (i) Foundation level - the underlying rationale for and the key assumptions of the IP valuation;
- (ii) IP profile level - the business, legal and economic attributes of the IP asset are defined;
- (iii) Methodology level - the specific quantification and financial analysis are performed to generate a realistic value of the IP in financial terms; and
- (iv) Solution or Deliverable level - addresses the important issue of how the valuation exercise solves a business question or generates a recommendation to a specific commercialization problem.¹⁴

With the new framework, the pyramid is further customized for IP valuation cases in Indian NARS. The technologies developed in Indian agricultural research systems generally do not attract much value as the targeted customers are poor and marginal farmers. The agri-business firms which use agricultural and allied tools and technologies looks for production volume rather than high priced products. In spite of its high usability, a high value technology in agricultural domain may not attract many firms for licensing deals unless otherwise it fetches higher profit through wider usage and marketing. In case of agricultural sector, the government policies and regulations are also playing a big role, and which in turn affect the projected value of the technology. Furthermore, the agricultural technology domain

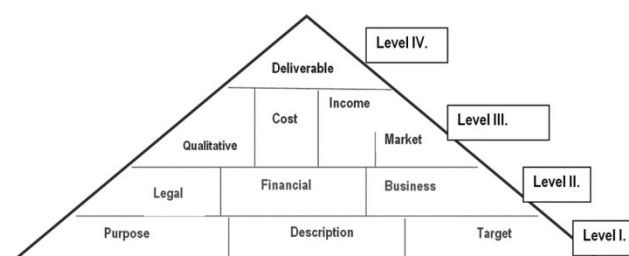


Fig. 1 — Valuation Pyramid (adapted from Flignor & Orozco, 2006)

consists of a mix bag of technologies, from cheaper seeds/ fertilizers to high value precision farming sensors. All these factors are to be taken into consideration while customizing the valuation pyramid for agricultural technologies.

Foundation Level

The first level of the pyramid also called foundation level consists of basic queries to collect all the relevant information with the IP/technology under consideration¹³. It consists of three building blocks namely, purpose, description, and target. 'Purpose' refers to the basic need for evaluating the IP, whether it is for having negotiations for licensing, sale, and/or financing. It assists in finalizing a transaction strategy, fixing a process, reporting, taxing and litigation. 'Description' about the IP helps to categorize it into exact form of IP, copyright, trade mark etc. "Target" includes possible markets with market intelligence data and it gives an idea on the commercialization strategy and the targeted customers. This foundation level analysis helps to define the need, focus, depth, completeness, aim and general working parameters of IP valuation process.

IP Profile Level

The second level looks into the legal, financial and business angles. It articulates the business and legal issues that dictate the opportunities and limitations of the asset and ultimately its ability to generate income and create value.¹⁴ At this stage the developed IP should be assessed within the existing legal and regulatory frameworks. Legal issues include counter claims, stage of prosecution (pre-grant, grant stage etc.) and the jurisdiction. Apart from these, other factors including the barriers to exploitation, market lifecycle, any bundling of more services or other assets, competitor products and services, customer and supplier dynamics, government regulation and new technologies also need to be considered.¹⁵ The financial profile of the technology quantifies the prospective use and influence of the IP on the value chain of the product or service and business profile gives an estimate of potential markets, estimated sales volume and future cash flows.

Methodology Level

This forms the most important level in the pyramid. As discussed in earlier section, there are two well accepted approaches for valuating an intellectual asset.¹⁶ One is qualitative approach, which includes patent indicators, due diligence and patent rating/

ranking. The other is quantitative approach. The three predominant methods in this category are:^{3,4} Cost approach, Market approach, and Income approach as depicted in Fig. 2. The major approaches for real time valuation of IP are quantitative in nature and they compute the value of the IP in monetary terms.

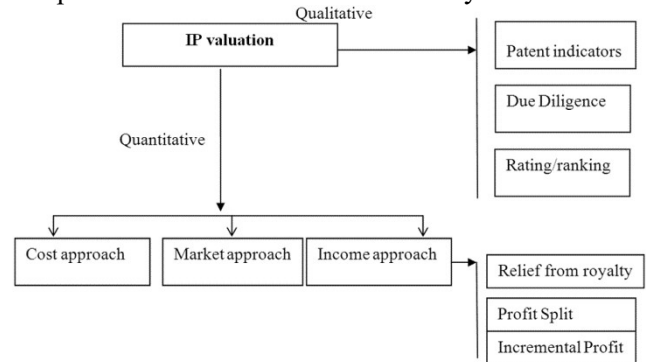


Fig. 2 — IP Valuation methods

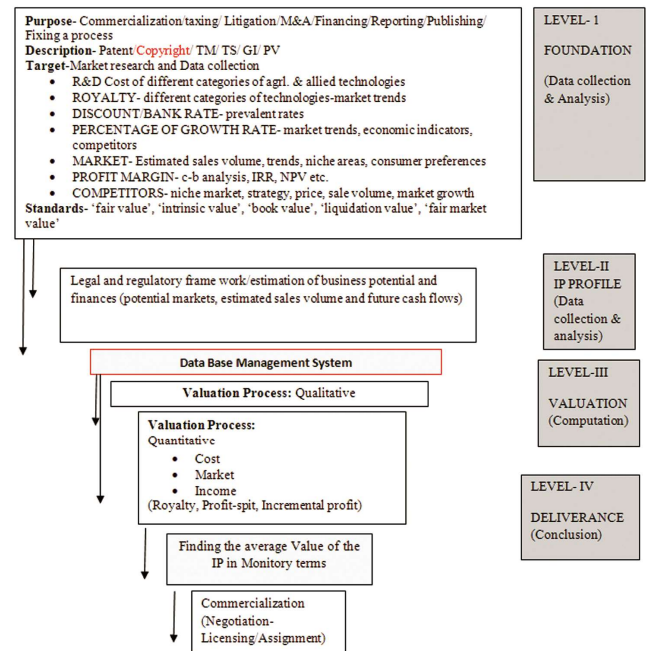


Fig. 3 — Methodology flow chart of IP valuation process

Deliverables Level

This level is the final output level of the valuation pyramid. The deliverable solutions, which are derived from the valuation exercise, aid in planning, commercialization, recommendation, compliance, or dispute resolution.

Process Flow

The general flow chart of the activities to be taken up while implementing any IP Valuation project at a research institute level is given in Fig. 3. Selection of

the most appropriate IP valuation method depends on a number of factors developed in the valuation pyramid. Critically, proper analysis and execution of the 'foundation' and 'profile' levels will identify the availability, reliability, and suitability of data to employ the methods. Given that each method requires extensive knowledge of data, this is typically the determining point for finalizing the valuation methodology. 'Methodology level', the most vital part in a valuation pyramid consists of an array of methods for IP valuation. Though the methods include both qualitative and quantitative methods, the latter may be employed to get a definite monetary value of the IP using any or average of the cost, market or income method(s). If the IP is not commercialized, then one of the alternative methods may be most appropriate. As a general rule, the reliability of a valuation method decreases as the number of adjustments and assumptions increases; therefore, the best method is usually the simplest and most straightforward one within scope of the given facts and circumstances.

No valuation method is definitive in nature. However, the income method is found to be more realistic and good for technologies in the growth phase of technology life cycle, where the focus is on the expected returns from new market creation and existing market penetration.¹⁷ If the technology is totally new and no data on market forces and competing products available, cost method is employed, while market method is suitable for a business environment with multiple close competitors. If applied properly, all valuation methods should converge near a similar valuation estimate. Therefore, employing multiple valuation methods for a given IP asset to demonstrate robustness and completeness of the analysis is recommended. Sometimes a combination of methods is also employed in practice. Based on the negotiations with the technology seeker, a particular valuation method can be employed or average of values obtained by more than valuation methods may be considered.

Case Study of Chitosan Technology

To illustrate the above mentioned protocol of IP valuation of any technology/product from the ICAR system, a case study on '*Production of Chitin & Chitosan from Crustacean Waste* (sourced from ICAR-Central Institute of Fisheries Technology, Kochi)' was attempted with a few assumptions and some imaginary data.

Chitosan is a linear polysaccharide composed of randomly distributed β -(1-4)-linked D-glucosamine

(deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit). It is made by treating shrimp and other crustacean shells with an alkali-sodium hydroxide. This has value tagged to it and is used in various sectors like biomedical technologies including preparing of bandages to reduce bleeding and as an antibacterial drug for skin applications. It has applications in agriculture for seed treatment and as bio-pesticide. In winemaking, chitosan is used as a fining agent and for preventing spoilage. It acts as a self-healing polyurethane paint coating in consumer industry. The recent uses identified for this polysaccharide also include limiting fat absorption, with potential role in diet-control supplements and as a soluble dietary fibre. The process for commercial production of chitosan is through deacetylation of chitin, which is the structural element in the exoskeleton of crustaceans (such as crabs and shrimp) and cell walls of fungi.

Market Research for this technology indicates that there are various players, in this technological field having patent application filed for both process and products. Some of major players in the domain are:

- Agratech International Inc., Goose Creek, South Carolina, USA - Leaders in Chitosan manufacturing process. Original Assignee for US Pat No. 8318913 B2 dated 27 November 2012 for chitogen manufacturing process.
- The United Chitotechnologies, Delaware, USA - Founded in 1989 to research, develop, manufacture and market products and services derived from natural chitin. In January 2013, they approached Agratech Inc., for assignment/sole licensing of the patented technology.
- Pfyton Remedies, Hyderabad, India - A leading chitosan manufacturer in India. Selling it in bottles as soft gel @ Rs. 2000/bottle with a sales volume of 1500 bottles/month.
- ICAR-CIFT - Undertakes research on the process of production of chitosan. The institute filed a process patent for 'Process for the production of high density bulk chitosan' against Indian Pat No. 2582/DEL/2004 (IPIndiaonline, 2014).

The cost of the 3 year ICAR project on '*Development of an enzymatic process for the production of high density bulk chitosan*' carried out during the years 2004 to 2007 was Rs.13,00,000 excluding the salaries of the Principal Investigator and 3 Co-Principal Investigators. The average salary of all investigators was approximately Rs.50,000/- per month during the period 2004-2007. All the

investigators had spent 50% of their time in the particular project. The indirect cost including depreciation of R&D expenditure is Rs.1,00,000 per year. Application and maintenance fees for patent was Rs.1,00,000. ICAR weighs the option to license its patent to Pfyton Remedies and they offered 8% royalty to the ICAR. The expected cash flow to Pfyton in the first four years from the licensed product is Rs.30 million, Rs. 45 million, Rs. 60 million and Rs. 70 million. The administrative costs are 10% and IT is 30%. Bank interest rate is 9%. Pfyton spends 60% of the total revenue as operating (variable) costs and 5% for adding incremental fixed assets. The profit split ratio is 1:3 (ICAR:Pfyton). If Pfyton could have gone for Chitosan production without ICAR patent it would have earned 10% profit out of the total revenue, whereas it is 25 % with the new technology. The Profit split factor in this case is 50:50.*

By analysing the case study and by making use of the process of flowchart suggested earlier, the information required at different levels of valuation pyramid are summarised as below:

Level –I: Foundation

- (i) Purpose: Commercialization
- (ii) Description: Patent
- (iii) Target: Pharmaceutical market- Pfyton remedies

Level-II: IP Profile

- (i) Legal: Indian jurisdiction
- (ii) Business: Licensing out strategy
- (iii) Financial: Cash flow as Royalty

Level-III: Valuation Methodology

Cost Method

Cost approach is based on the sum of all costs involved in developing the particular IP. It includes salary component, R & D expenses, overheads and depreciation. After finding out the total costs spent on developing the IP, the opportunity cost, profitability factor and amortization may be added to it and amount towards taxes and obsolescence may be deducted, if any. The final amount is considered as the value of the IP. In other words, it is the value based on reproduction or replacement costs of an asset, considering market acceptance and timing needs. The drawback of this method is that it always looks into historical data and future cash flows from the market by commercializing the developed IP/technology is not taken care of. Therefore, it often yields lowest value for an IP. It is also possible that

R&D costs can be wrong indicators, as prototype building is always expensive and may give exaggerated value of the IP, even if this approach is used at an intermediate stage of IP Protection and IP Management. Generally, it is assumed that cost-based approach provides a benchmark for further negotiations and not a fair value of the IP. However, this is the only reliable method in the case of a completely novel IP/technology, which is in the introductory stage of the Technology Life Cycle (TLC). The valuation of IP in the given case using cost approach is depicted in Tables 1 and 2.

Market Method

The market approach is based on the premise that market transactions of intellectual property indicate the value. Market information can be very useful in analyzing and valuing intellectual property, but it seldom is comprehensive enough to provide the basis for a satisfactory conclusion of value on its own. In this method, the value is calculated based upon guidelines of companies or transactions of similar assets or close competitors. It is done by comparing the IP to comparable assets recently exchanged under similar circumstances. However, it is often difficult to find comparable companies or relevant transactions adequately matching the technology, product and industry application of an IP. Furthermore, comparing two different IPs, even the ones in the same domain can be difficult. This method can be employed if the IP/technology reaches the maturity stage in the TLC.

For the current case, a few assumptions are made considering the available information on the competitors. As per details given, the price / bottle of

Table 1 — Calculation of salary component

Salary Components	
Salary/month/person	Rs. 50,000
Total no. of persons involved in R&D	4
Total time duration of the project	3 years
Total salary	Rs.72,00,000
Time spent on project in %	50
Cost of salary for project	Rs.36,00,000

Table 2 — Calculation of value of IP using Cost method

	Value of IP
R&D expenses	Rs.13,00,000
Cost on salary for project	Rs.36,00,000
Indirect cost	Rs.3,00,000
Patent cost	Rs.100000
Total cost	Rs.53,00,000

Hence, the value of IP as per Cost method is INR 5.3 million

chitosan soft gel produced by Pfyton is Rs.2000. In case a new chitosan based product on similar lines is introduced into the market, its price can be fixed similar to that of the competitors. In most cases a penetrating pricing strategy is adopted, in which the new product is introduced with a comparatively lower price to capture more market. Similarly, the sales volume is also calculated by considering the competing technology/products along with analyzed data of market research studies.

As discussed above, the price and sales volume for the first four years was arrived at based on assumptions and accordingly, the corresponding annual revenues were calculated. The profit percentage is taken as 20 % and accordingly the yearly profit figures were computed. As the arrived figures represent future cash flows, it has to be discounted to present amount using standard procedure for calculating net present value (NPV). The general formula for calculating NPV (Eqn.1) is used for arriving at the present value of future cash flow as royalty.

$$NPV = CF_n / (1+k)^n \quad \dots (1)$$

where, CF_n = Cash flow for the year 'n'

k = Bank rate

The sum of NPVs for the useful life of the patent (generally taken as 4-5 years) is considered to be the value of the IP in monetary terms. The step by step procedure is depicted in Table 3 and 4.

Table 3 — Assumptions made on the price and sales volume

	Year 1	Year 2	Year 3	Year 4
Number of bottles sold/ month	250	500	750	1000
Price per bottle (Rs.)	1500	2000	2000	2000
Profit margin = 20%				

Income Method

The income approach is based on discounted cash flow (DCF) theory and defines the value of the subject property as the present value of the anticipated net economic benefits, to be achieved over the duration of the property's useful life. The net income of property over its lifetime is used in this approach. This is the most common method for valuing an IP and this method is useful in identifying its intrinsic value. This method can be best employed, if the IP is in the growth stage of TLC. The process of valuation of IP using income method includes various levels such as calculating proportion of the revenue (royalty) attributable to the subject IP, estimating size and growth rate of relevant industry. Subsequently estimation of revenue, risk and growth associated with the IP proportion of the revenue attributable to the subject IP and finally application of Discounted Cash Flow (DCF) technique follows. The three types of income approach include (a) Relief from royalty method, (b) Profit split method and (c) Excess/incremental profit method. These are attempted in this case study.

Relief from Royalty Method

This method values an IP by calculating the licensor's relief from payment to a third party for accessing rights to the IP. The present value of future royalty payments (cash flows) using appropriate risk factors (both technology and industry related) are calculated using this method. Information on projected market conditions for the economy, industry, and market segment such as potential size of the market, growth opportunities, and competitive threats, expectations of market acceptance and market share, and assumptions of price are required for fixing the royalty rate. The royalty rate was finalised based on the negotiations with the technology seeking firm

Table 4 — Procedure of IP valuation using Market method

Particulars	Year 1	Year 2	Year 3	Year 4
Number of bottles/month	250	500	750	1000
Price (Rs.)	1,500	2,000	2,000	2,000
Revenue/month (Rs.)	3,75,000	10,00,000	15,00,000	20,00,000
Revenue/year (Rs.)	45,00,000	1,20,00,000	1,80,00,000	2,40,00,000
Profit (20%) (Rs.)	9,00,000	24,00,000	36,00,000	48,00,000
Admn. Cost @ 10% (Rs.)	90,000	2,40,000	3,60,000	4,80,000
Actual Profit (Rs.)	8,10,000	21,60,000	32,40,000	43,20,000
Income Tax @30% (Rs.)	2,43,000	6,48,000	9,72,000	12,96,000
Profit after IT (Rs.)	5,67,000	15,12,000	22,68,000	30,24,000
Cash flow @ 9% DR (Rs.)	5,20,183.4862	12,72,620.15	17,51,312.13	21,42,277.84
Value of IP (Rs.)	56,86,393.607			

Hence, the value of IP as per market method is INR 5.686 million

and by referring the information available in reports of accounting firms, existing in-house licenses, infringement lawsuit awards and other related websites. The value of IP using relief from royalty method is calculated in Table 5. After finding the royalty amount, the subsequent steps are same as in the market method.

Profit Split Method

In this method the actual profit expected by the use of an IP is split between the licensee and licensor in a mutually agreed ratio. The generally adopted ratio between the licensee and the licensor is 3:1. For this, the anticipated variable costs (direct material, direct labor, variable overhead (e.g. indirect labor,

perishable tools, etc.), sales commissions, product warranty expenses and profit sharing/executive bonuses, and incremental fixed costs for producing and selling the IP enabled product/technology have to be found out, and it should be deducted from the total revenue to obtain the gross profit. The net profit can be computed by deducting the amount towards taxes and administrative overheads. The NPV of the percentage of net profit (generally 25 %) has to be found out for the useful life of the patent (4-5 years) similar to the previous method (Table 6).

Excess/Incremental Profit Method

In this method, the first step is to identify the excess profit generated by the entities utilizing the IP over similar entities without the IP or products encompassing the IP over similar products without the IP. The extra percentage of profit obtained solely by the use of IP may be split among the licensee and the licensor generally in 1:1 ratio. The NPV analysis of the share of future cash flow to the licensor is further done as similar to the previous methods for the useful life time of the IP. The valuation is worked out in Table 7.

The average value of IP calculated by finding the mean of all three methods of income approach is 8.2151858. In the present case of Chitosan, the

Table 5 — Procedure of IP valuation using Income method- Relief from royalty

(In million INR)	Year 1	Year 2	Year 3	Year 4
Revenue	30	45	60	70
Royalty @ 8%	2.4	3.6	4.8	5.6
Admn cost @ 10%	0.24	0.36	0.48	0.56
Actual profit	2.16	3.24	4.32	5.04
Income Tax @ 30%	0.648	0.972	1.296	1.512
Profit after IT	1.512	2.268	3.024	3.528
Cash Flow @ 9% DR	1.38715596	1.90893022	2.3350828	2.4993176

Value of IP (in million INR) is 8.130493176

Table 6 — Procedure of IP valuation using Income method- Profit-split

(In million INR)	Year 1	Year 2	Year 3	Year 4
Revenue	30	45	60	70
Operating cost @ 60%	18	27	36	42
Incremental fixed cost @ 5%	1.5	2.25	3	3.5
Profit	10.5	15.75	21	24.5
Profit split 1:3	2.625	3.9375	5.25	6.125
Admn cost @ 10%	0.2625	0.39375	0.525	0.6125
Actual profit	2.3625	3.54375	4.725	5.5125
IT @30%	0.70875	1.063125	1.4175	1.65375
Profit after IT	1.65375	2.480625	3.3075	3.85875
Cashflow @ 9% DR	1.51720183	2.08789243	2.5539968	2.73363578

Value of IP (in million INR) is 8.89272691

Table 7— Procedure of IP valuation using Income method- Incremental Profit

(In million INR)	Year 1	Year 2	Year 3	Year 4
Revenue	30	45	60	70
Incremental Profit @ 15%	4.5	6.75	9	10.5
Profit at 50:50 Sharing basis	2.25	3.375	4.5	5.25
Admn Cost @ 10%	0.225	0.3375	0.45	0.525
Actual profit	2.025	3.0375	4.05	4.725
IT @ 30%	0.6075	0.91125	1.215	1.4175
Profit after IT	1.4175	2.12625	2.835	3.3075
Cashflow @ 9% DR	1.300458716	1.789622086	2.18914017	2.343116386

The value of IP in million INR is 7.622337353.

income method provided a better value for the IP in monetary terms.

Level -IV: Deliverance

At this level the product is ready for commercialization. The developer can negotiate with technology seeking firms based on arrived IP values and fix a suitable value/royalty for transferring/licensing out the technology/IP.

Conclusion

Developing comprehensive IP valuation framework within NARS with support of database management and management information systems can provide some solutions in the complex task of valuation of IP, assets and technologies. In this context of the NARS, following issues are important while designing and developing a valuation mechanism for IP and technologies developed by public agricultural research system.

- Need for identifying the resources and building tested data bases or information base for real time IP valuation.
- Research budgeting *vis-a-vis* the value of the technology/IP to be developed.
- Current practices for analysis of the exact value of the technology from research before its commercialization.
- Need for sensitization of commercialization and technology transfer units on importance of IP valuation and provide with the framework and tools for execution of the same.
- Need for repository or database, which has relevant information on crop/animal technologies.
- Developing user friendly software based on Decision Support System which can support the IP valuation process.
- Freedom to experiment with innovations including new products or services.
- Encouragement for risk taking and tolerance for mistakes.

In this context, a 10 step protocol for valuation of an IP/Technology developed by NARS institutions in India is:

- (i) Invention disclosure
- (ii) Assessment of technology developed- collection of data on cost of developing the technology- patentability and novelty of the technology
- (iii) IP filing (optional); Tech Transfer Office or Institute Technology Management Unit(ITMU)

or Agri-Business Incubation (ABI) units to monitor processing

- (iv) Collection of data about competitive technologies/products in the domain- Benefits of the technology over the competing technologies-IP landscape in the domain
- (v) Market studies, target market, efficacy of the product, market acceptance, preferable cost of the product, marketing strategy, regulatory requirements
- (vi) Developing a database system- Excel computation charts (optional)
- (vii) Calculating future sales volume and cash flows (with or without scenario analysis)
- (viii) Find the valuation of the technology/IP using cost, market and/or income approach
- (ix) Negotiation with technology seeker-fixing royalty rate
- (x) Commercialization- Assignment/License compliance

Undervaluation or overvaluation of IP/technology often leads to economic loss to either developer or licensing firm and may lead to conflicts and under-utilization. A strategic valuation framework as suggested would help to arrive at a more realistic value for the IP or novel technologies. It would also aid in strategically placing the IP/technology in appropriate domain or market niche and provide the technology developer a bench mark for negotiation with the technology seeker. An interactive software was also developed in Visual C++ and MS Excel platform based on the suggested methodology and it would aid the researchers, business firms and students for valuation of their technology or intellectual property in real time cases.

* [Most of the information given is not real time facts or values and they are generated entirely based on the assumptions for academic purposes]

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