Pre-Feasibility Study

LIVESTOCK SEMEN PRODUCTION UNIT
(Cattle and Buffalo)

Small and Medium Enterprises Development Authority

Ministry of Industries & Production
Government of Pakistan
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2 EXECUTIVE SUMMARY

Reproductive efficiency is the most economically important trait in farm animals. The profit obtained from milk and meat is directly related to the fertility of the respective farm animal. Artificial insemination (AI) technique has gained much acceptance and popularity among livestock breeders and farmers in recent years. Thus the demand for such Semen Production Units are increasing.

The proposed project is for establishing a semen production unit (SPU), where the adult bulls of good genetic background are maintained. Semen from the bulls is collected twice a week. Semen from the bulls is collected twice a week. After laboratory evaluation, semen will be diluted and packed. A mix of six buffalo bulls, two Friesian and two Sahiwal bull depending upon the location of the Semen Production Unit (SPU) are suggested in this Pre-feasibility Study.

An estimated investment of Rs 12.78 million is required, out of which capital investment is Rs. 11.98 million and working capital is Rs. 0.80 million. The Internal Rate of Return (IRR), Net Present Value (NPV) & Payback Period of the project are 43%, Rs. 17.01 million and 2.63 years respectively. The project is proposed to operate as a sole-proprietorship.

3 INTRODUCTION TO SMEDA

The Small and Medium Enterprises Development Authority (SMEDA) was established in October 1998 with an objective to provide fresh impetus to the economy through development of Small and Medium Enterprises (SMEs).

With a mission "to assist in employment generation and value addition to the national income, through development of the SME sector, by helping increase the number, scale and competitiveness of SMEs", SMEDA has carried out ‘sectoral research’ to identify policy, access to finance, business development services, strategic initiatives and institutional collaboration and networking initiatives.

Preparation and dissemination of prefeasibility studies in key areas of investment has been a successful hallmark of SME facilitation by SMEDA.

Concurrent to the prefeasibility studies, a broad spectrum of business development services is also offered to the SMEs by SMEDA. These services include identification of experts and consultants and delivery of need based capacity building programs of different types in addition to business guidance through help desk services.

4 PURPOSE OF THE DOCUMENT

The objective of the pre-feasibility study is primarily to facilitate potential entrepreneurs in project identification for investment. The project pre-feasibility may form the basis of an important investment decision and in order to serve this objective, the document / study covers various aspects of project concept development, start-up, and production, marketing, finance and business management.

The purpose of this document is to facilitate potential investors in **Livestock Semen Production Unit** by providing them with a general understanding of the business with the intention of supporting potential investors in crucial investment decisions.

The need to come up with pre-feasibility reports for undocumented or minimally documented sectors attains greater imminence as the research that precedes such reports reveal certain thumb rules; best practices developed by existing enterprises by trial and error, and certain industrial norms that become a guiding source regarding various aspects of business set-up and it's successful management.

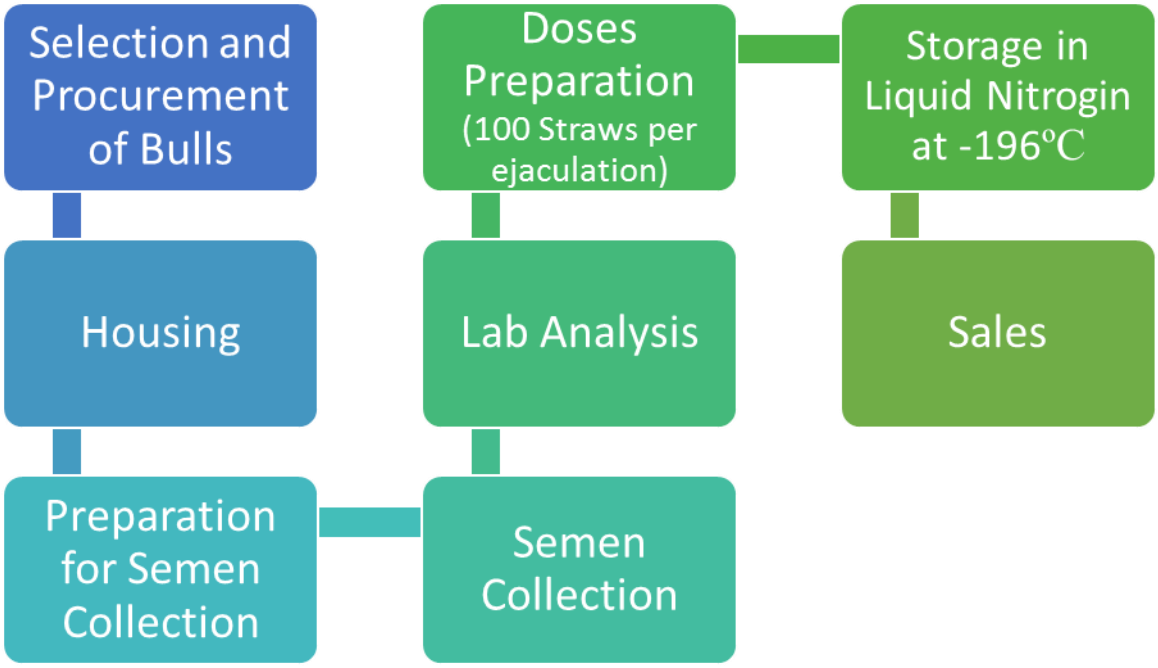
Apart from carefully studying the whole document one must consider critical aspects provided later on, which form basis of any Investment Decision.

5 BRIEF DESCRIPTION OF PROJECT & PRODUCT

The profitability of dairy & livestock farms critically depends on the fertility and genetic breed of farm animals. There are two ways of breeding of farm animals, naturally and by artificial insemination. Presently, there are very few large farmers, who raise the breeding bulls specifically for their own herds. Most of them do not have access to any breeding bull. Artificial insemination (AI) technique started during 1972-73 in the country has now gained much acceptance and popularity among livestock breeders and farmers with increasing demand for more AI services.

The proposed project is for establishing a semen production unit (SPU), where the adult bulls of good genetic background are maintained. Semen from the bulls is collected twice a week. After laboratory evaluation, semen will be diluted and packed. The deep-freezing of the semen in liquid nitrogen is carried out for the preservation of spermatozoa for longer periods. This semen is then utilized for artificially inseminating the female animals for improving the breed of the offspring, ultimately leading to better milk and meat yields. The proposed legal structure of the business entity is sole proprietorship.

5.1 Production Process Flow



Detail of Production Process and its Technical Aspects are given in chapter 14.

5.2 Installed and Operational Capacities

Initially, 10 bulls have been suggested for establishing SPU. Cow bulls have also been proposed in the SPU beside buffalo bulls. A mix of six buffalo bulls, two Friesian and two Sahiwal bull depending upon the location of the SPU are recommended.

Table 1: Installed and Operational Capacity

Description	Details
Semen Ejaculates per week per bull	4*
Semen Ejaculates per year per bull	208
Semen Dozes Produced Per Ejaculate per bull	100
Semen Dozes Produced Per Year per bull	20,800
Doze Losses per bull (5%)	1,040
Net Total Dozes per bull	**19,760**
Total Bulls	10
Total No. of Dosses Produced in a Year	197,600
No. of Dosses Produced in Year 1 (70%)	**138,320**

***** Twice a day.

6 MANAGEMENT OF BULLS

Following points should be address in managing bulls for quality semen production.

- ⇒ Maintenance of bulls in good condition suitable for semen collection is highly essential for the success of Semen Production Unit.
- ⇒ The best condition for breeding is one in which the animal is healthy, receiving sufficient nutrients but at the same time devoid of fattening.
- ⇒ The bulls, which receive plenty of exercise, will usually produce larger ejaculates containing more sperm of higher activity.
- ⇒ A properly balanced ration should be fed containing the right mix of proteins, minerals and vitamins. Green fodder must be available. In fact, feeding and exercise may be judiciously controlled to obtain a condition of thrift in which the animal is neither fat nor thin and weak.
- ⇒ There is no hard and fast rule for the number of services. It varies between individuals and breeds. It is of great importance that males should be used regularly and not too much at one time, and too little at another. Ejaculation every other day is within the capacity of an adult bull.
- ⇒ Bulls should be docile, well trained to be led and free from vices. The use of a shield over eyes often assists the control of a bad tempered bull and prolongs its breeding life. Most bulls will serve best in familiar surroundings. A regular routine should be followed and bulls should be handled in the same manner each time. It is sound practice to provide cool quarters to the males with adequate shade and cool drinking water. High environmental temperature is harmful to the reproductive performance of males.
- ⇒ The animals should be vaccinated against foot and mouth and hemorrhagic septicemia as per schedule and de-wormed against internal parasites on regular basis.
- ⇒ The breeding bulls should be free from venereal disease, if they acquire these diseases it will affect the semen production performance of the animals. Moreover, the semen of these bulls will not be fit for use.
- ⇒ If the animals are not protected properly against the viral disease there is every threat of loss of animal.

7 CRITICAL FACTORS

Following are the factors critical for the success of this business venture:

⇒ Background knowledge and related experience of the entrepreneur in Semen Production Process.
⇒ Application of good husbandry practices such as timely feeding, watering and vaccination to ensure animal's health and disease-free environment.
⇒ Selection of appropriate farm tools and equipment.
⇒ Sanitation and disinfection program should be strictly followed and regularly monitored.
⇒ Bulls should be given enough space according to their age as less space could arise different complexities.
⇒ Feed should not be stored for a long time as it would lose its nutrition and there is a chance that feed would get fungal and can prove to be poisonous.

8 GEOGRAPHICAL POTENTIAL FOR INVESTMENT

Metropolitan cities like Karachi, Lahore, Peshawar, Quetta, Multan, Bahawalpur, Faisalabad, Rawalpindi, Hyderabad, Ziarat, D.I. Khan etc. are major markets of Livestock Semen Production Units as there are many livestock farms are in these areas. The rural and peri-urban areas around these and other major cities across the country with abundant water and availability of fodder make a better choice for such units.

9 POTENTIAL TARGET CUSTOMERS / MARKETS

Apart from Sialkot, Jhang, Rahim Yar Khan, Bahawalnagar, Bahawalpur, Sahiwal in the Punjab, livestock farms in peri-urban locations of all cities of other provinces such as Karachi, Hyderabad, Nawabshah, Larkana, Dadu, Qila saifullah, Panjgur, Pishin, Quetta, Bannu, Laki Marwat, Kohat, Peshawar are primary markets.. Following are some of the target clients for this unit;

- Large Livestock Farms.
- Artificial Insemination Technicians.
- Public Sector Breed Improvement Department.
- Importers

Besides meeting the domestic market demands of frozen semen, there is a potential for exports as well. The proposed SPU will cater to the needs of breed-able population of cattle and buffaloes. There is an acute shortage of good quality frozen semen, both for buffalo and cattle breeds.

10 PROJECT COST SUMMARY

A detailed financial model has been developed to analyze the commercial viability of Livestock Semen Production Unit. Various costs and revenue related assumptions along with results of the analysis are outlined in this section.

The projected Income Statement, Cash Flow Statement and Balance Sheet are also attached as annexure.

10.1 Project Economics

All the figures in this financial model have been calculated for estimated revenues of Rs. 10.37 Million in the year one.

The following table shows internal rate of return, payback period and net present value of the proposed venture.

Table 2: Project Economics

Description	Details
Internal Rate of Return (IRR)	43%
Payback Period (Yrs.)	2.63
Net Present Value (Rs.)	17,010,170

10.2 Project Financing

Following table provides details of the equity required and variables related to bank loan:

Table 3: Project Financing

Description	Details
Total Equity (50%)	Rs. 6,389,956
Bank Loan (50%)	Rs. 6,389,956
Markup to the Borrower (%age / annum)	12%
Tenure of the Loan (Years)	5 Years

10.3 Project Cost

Following fixed and working capital requirements have been identified for operations of the proposed business.

Table 4: Project Cost

Project Cost	Amount (Rs.)
Capital Cost	
Land	1,750,000
Building/Infrastructure	4,082,500
Machinery & equipment	5,664,500
Furniture & fixtures	135,000
Office vehicles	135,200
Office equipment	77,000
Pre-operating costs	136,690
Total Capital Costs	**11,980,891**
Working Capital	
Raw material inventory	463,007
Cash	336,013
Total Working Capital	**799,021**
Total Investment	**12,779,911**

10.4 Space Requirement

Approximately, 4 kanal of land would be required for setting up the proposed Unit. As this business is land intensive, therefore, it is suggested to purchase the required land instead of rental or leased land. However, in order to avoid the initial high capital costs, the long-term lease contract for land acquisition may be considered. But entrepreneur can be more risk free on purchased land because of making heavy investment on shed and boundary wall as well as future business expansion.

The total cost for acquiring land is assumed at Rs. 1.75 million.

The infrastructural requirements of the project mainly comprise of the construction of Sheds, open space, labor room, laboratory, feed store and other facilities. Details of space requirement and cost of construction of building and infrastructure for the proposed unit is provided in the table below:

Table 5: Space Requirement

Description	Area (Sq.ft.)	Cost / Sq.ft	Amount (Rs.)
Management building	400	2,000	800,000
Laboratory	300	2,000	600,000
Bull Shed	1,000	1,000	1,000,000

Feed Store	500	750	375,000
Labor Residence	450	1,200	540,000
Grounds	15,350	50	767,500
Total Infrastructure	**18,000**		**4,082,500**

The entrepreneur should make sure that the following things are available at the site before setting up the unit:

i. Electricity Connection

ii. Clean Water Supply

10.5 Animals and Machinery & Equipment

The proposed number and details of the animals required for the project are given in the table:

Table 6: Procurement of Animals

Description	Detail
Buffalo Bulls (Nos.)	6
Friesian (Nos.)	2
Pure Sahiwal (Nos.)	2
Total	**10**
Average Purchase Price Per Bull (Rs.)	175,000
Total Cost of Animals (Rs.)	**1,750,000**

The bulls would be used for reproduction activity for 10 years, and after that, they would be replaced with younger bulls. Young adult breeding bulls of known pedigree will be purchased from livestock experiment stations of the respective breeds or from livestock breeders listed in the progeny-testing program of Livestock and Dairy Development Department.

A breeding soundness examination (BSE) of dairy bulls, to be selected and raised at SPU, will be required just before their purchase. For dairy bulls to be raised at SPU, it is an absolute requirement that bull is born to “elite” cow inseminated with the semen of progeny tested bull.

Detail of Machinery & Equipment required for the unit is given below in table;

Table 7: Machinery & Equipment Requirement

Description	Quantity	Cost	Amount (Rs.)
Bull for Cart	1	100,000	100,000
Cart	1	25,000	25,000
Refrigerator	1	40,000	40,000

Microscope	1	350,000	350,000
Incubator (50 Liter)	1	75,000	75,000
Water Distiller (4L / hr)	1	65,000	65,000
Artificial Vigina	10	25,000	250,000
Sterilizer	1	100,000	100,000
Weighing Balance	1	75,000	75,000
Magnetic Stirrer	1	35,000	35,000
Semen Filling Pump with Accessories	1	600,000	600,000
Cold Cabinet	1	1,500,000	1,500,000
Cattle Crush with Installation	1	25,000	25,000
Fodder Chopper	1	30,000	30,000
Water Pump	1	50,000	50,000
Liquid Nitrogen Container (50 Liter)	3	120,000	360,000
Liquid Nitrogen Container (10 Liter)	1	52,000	52,000
Liquid Nitrogen Container (2Liter)	1	32,500	32,500
Generator	1	150,000	150,000
Total Machinery & Equipment for SPU			**3,914,500**

10.6 Furniture & Fixture

Detail of Furniture & Fixture required for the unit is given below in table;

Table 8: Furniture & Fixture

Description	Quantity	Cost	Amount (Rs.)
Furniture (Lump sum)			75,000
Air conditioner	1	60,000	60,000
Total Furniture & Fixtures			**135,000**

10.7 Vehicle

Two bikes will be used for procurement of different supplies and other business operations. The cost of bikes are estimated at Rs. 135,200.

10.8 Office Equipment

Detail of Office Equipment required for the unit is given below in table;

Table 9: Office Equipment

Description	Quantity	Cost	Amount (Rs.)
Computers	1	35,000	35,000
Computer printer (s)	1	15,000	15,000

UPS	1	25,000	25,000
Telephones	1	2,000	2,000
Total Office Equipment			**77,000**

10.9 Raw Material Requirement

Following table shows raw material requirement to raise 10 bulls for production.

Table 10: Raw Material Requirement (Year 1)

Description	Nos.*	Cost per Bull per Year	Cost in 1st Year (Rs.)
Feed Cost for Bull for Production and Cart	11	76,650**	843,150
Vaccination & Medication	11	1,000	11,000
Total Feed and Vaccination Cost			**854,150**

* 10 Bulls for Semen Production and 1 for the Cart for bringing fodder and other inputs.

** Feed required for a Bull is 35 Kg a day (10% of its Body Weight). The Feed Cost is taken as Rs. 6 / Kg. Hence the total feed cost per bull becomes Rs. 76,650 (35 Kgs X Rs. 6 / Kg X 365 Days / Year).

10.10 Human Resource Requirement

In order to run operations of Livestock Semen Production Unit smoothly, details of human resources required in first year of operation along with monthly salary are recommended as under:

Table 11: Human Resource Requirment (Year 1)

Description	No. of Employees	Monthly Salary per person (Rs.)
Manager SPU	1	50,000
Pay of Veterinarian	1	30,000
Pay of Technician	1	20,000
Bull Attendant	2	15,000
Accountant	1	25,000
Security Guard / Gate Keeper	1	15,000
Sweeper	2	15,000
Total	**9**	

10.11 Utilities and Other Costs

An essential cost to be borne by the project is the costs of Straw, Liquid Nitrogen Refilling, Misc. Supplies and Electricity Cost which are estimated to be Rs. 1.12

million in the first year of operations. The travelling expense being essential for purchase of quality animals and is estimated Rs. 134,464 in year one.

10.12 Revenue Generation

Revenue along with its assumption for the 1st year of operations is given in table below;

Table 12: Revenue Generation (Year 1)

Description	No. of Dosses Produced in Year 1 (70%)	Sale Price Per Dose	Amount (Rs.)
Revenue from Sale of Semen Dosses	138,320	75	10,374,000

11 CONTACT DETAILS

In order to facilitate potential investors, contact details of consultants and experts relevant to the proposed project are provided below:

Consultant / Supplier	Contact	Website
Department of Livestock Production University of Veterinary & Animal Sciences (UVAS), Lahore	+92-42-99211374, 99211449	http://www.uvas.edu.pk
Department of Livestock Management, Faculty of Animal Husbandry, University of Agriculture, Faisalabad, Pakistan	+92 41 9200161-70	http://www.uaf.edu.pk
Department of Livestock Production and Management PMAS-Arid Agriculture University, Rawalpindi.	+92-51-9292159	http://www.uaar.edu.pk

12 USEFUL WEB LINKS

Small & Medium Enterprises Development Authority (SMEDA)	www.smeda.org.pk
Government of Pakistan	www.pakistan.gov.pk
Ministry of Industries & Production	www.moip.gov.pk
Government of Punjab	www.punjab.gov.pk
Government of Sindh	www.sindh.gov.pk
Government of Khyber Pakhtunkhwa	www.khyberpakhtunkhwa.gov.pk
Government of Baluchistan	www.balochistan.gov.pk
Government of Gilgit Baltistan	www.gilgitbaltistan.gov.pk
Government of Azad Jammu Kashmir	www.ajk.gov.pk
Trade Development Authority of Pakistan (TDAP)	www.tdap.gov.pk
Security Commission of Pakistan (SECP)	www.secp.gov.pk
Federation of Pakistan Chambers of Commerce and Industry (FPCCI)	www.fpcci.com.pk
State Bank of Pakistan (SBP)	www.sbp.org.pk
Punjab Small Industries Corporation	www.psic.gop.pk
Sindh Small Industries Corporation	www.ssic.gos.pk
Punjab Vocational Training Council (PVTC)	www.pvtc.gop.pk
Livestock & Dairy Development Department, Government of Punjab.	www.livestockpunjab.gov.pk
Punjab Industrial Estates (PIE)	www.pie.com.pk
Faisalabad Industrial Estate Development and Management Company (FIEDMC)	www.fiedmc.com.pk
Punjab Agriculture and Meat Company.	http://www.pamco.bz/
Punjab Livestock & Dairy Development Board	http://www.plddb.pk/
University of Agriculture Faisalabad	www.uaf.edu.pk
University of Veterinary & Animal Sciences, Lahore	http://www.uvas.edu.pk/

13 ANNEXURE

13.1 Income Statement

Calculations **SMEDA**

Income Statement

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue		10,374,000	11,670,750	13,071,240	14,582,602	16,212,422	17,968,768	18,867,207	19,810,567	20,801,095	21,841,150
Cost of sales											
Feed cost		1,023,825	1,126,208	1,238,828	1,362,711	1,498,982	1,648,880	1,813,768	1,995,145	2,194,660	2,414,126
Vaccination & Medication		11,000	12,100	13,310	14,641	16,105	17,716	19,487	21,436	23,579	25,937
Chemical		126,000	148,500	174,240	203,643	237,184	275,397	302,937	333,231	366,554	403,209
Straw		436,800	514,800	604,032	705,962	822,239	954,710	1,050,181	1,155,199	1,270,719	1,397,791
Liquid Nitrogen Refilling		105,000	118,125	132,300	147,597	164,093	181,870	190,964	200,512	210,537	221,064
Miscellaneous Supplies		149,405	156,935	164,848	173,163	181,902	191,085	200,736	210,880	221,541	232,747
Bull mortality cost		92,500	101,750	111,925	123,118	135,429	148,972	163,869	180,256	198,282	218,110
Direct labor		960,000	1,056,000	1,161,600	1,277,760	1,405,536	1,546,090	1,700,699	1,870,768	2,057,845	2,263,630
Machinery maintenance		50,000	55,000	60,500	66,550	73,205	80,526	88,578	97,436	107,179	117,897
Electricity & Generator cost	1,117,205	300,000	330,000	363,000	399,300	439,230	483,153	531,468	584,615	643,077	707,384
Water cost		60,000	66,000	72,600	79,860	87,846	96,631	106,294	116,923	128,615	141,477
Total cost of sales		3,314,530	3,685,417	4,097,183	4,554,305	5,061,751	5,625,029	6,168,982	6,766,401	7,422,589	8,143,373
Gross Profit		7,059,471	7,985,333	8,974,057	10,028,297	11,150,671	12,343,739	12,698,225	13,044,165	13,378,506	13,697,777
General administration & selling expenses											
Administration expense		1,440,000	1,584,000	1,742,400	1,916,640	2,108,304	2,319,134	2,551,048	2,806,153	3,086,768	3,395,445
Administrative overheads		149,405	156,935	164,848	173,163	181,902	191,085	200,736	210,880	221,541	232,747
Electricity expense		36,000	39,600	43,560	47,916	52,708	57,978	63,776	70,154	77,169	84,886
Water expense		18,000	19,800	21,780	23,958	26,354	28,989	31,888	35,077	38,585	42,443
Gas expense		12,000	13,200	14,520	15,972	17,569	19,326	21,259	23,385	25,723	28,295
Travelling expense		134,464	141,241	148,363	155,847	163,711	171,976	180,662	189,792	199,387	209,472
Communications expense (phone, fax, mail, internet, etc.)		60,000	66,000	72,600	79,860	87,846	96,631	106,294	116,923	128,615	141,477
Office expenses (stationary, entertainment, janitorial services, etc		134,464	141,241	148,363	155,847	163,711	171,976	180,662	189,792	199,387	209,472
Promotional expense		224,107	235,402	247,272	259,745	272,852	286,627	301,104	316,319	332,311	349,120
Professional fees (legal, audit, consultants, etc.)		50,000	55,000	60,500	66,550	73,205	80,526	88,578	97,436	107,179	117,897
Depreciation expense		836,782	836,782	836,782	840,827	840,827	857,336	862,019	862,019	862,019	867,441
Amortization of pre-operating costs		27,338	27,338	27,338	27,338	27,338	-	-	-	-	-
Bad debt expense		311,220	350,123	392,137	437,478	486,373	539,063	566,016	594,317	624,033	655,234
Subtotal		3,433,779	3,666,663	3,920,463	4,201,141	4,502,700	4,820,647	5,154,043	5,512,245	5,902,717	6,333,931
Operating Income		3,625,691	4,318,670	5,053,594	5,827,155	6,647,971	7,523,091	7,544,182	7,531,921	7,475,789	7,363,846
Other income		120,450	132,495	145,745	160,319	176,351	193,986	213,385	234,723	258,195	284,015
Gain / (loss) on sale of office equipment		-	-	46,200	-	-	76,582	-	-	100,204	
Gain / (loss) on sale of office vehicles		-	-	-	-	54,080	-	-	-	-	
Earnings Before Interest & Taxes		3,746,141	4,451,165	5,245,538	5,987,474	6,878,402	7,793,660	7,757,567	7,766,644	7,834,188	7,647,861
Interest expense on long term debt (Project Loan)		668,792	550,812	417,869	268,066	99,264	-	-	-	-	-
Interest expense on long term debt (Working Capital Loan)		26,442	-	-	-	-	-	-	-	-	-
Subtotal		695,234	550,812	417,869	268,066	99,264	-	-	-	-	-
Earnings Before Tax		3,050,908	3,900,353	4,827,669	5,719,408	6,779,138	7,793,660	7,757,567	7,766,644	7,834,188	7,647,861
Tax		482,227	694,588	967,800	1,235,322	1,592,197	1,947,280	1,934,648	1,937,825	1,961,465	1,896,251
NET PROFIT/(LOSS) AFTER TAX		**2,568,681**	**3,205,765**	**3,859,869**	**4,484,086**	**5,186,940**	**5,846,379**	**5,822,919**	**5,828,819**	**5,872,723**	**5,751,610**

13.2 Balance Sheet

Calculations **SMEDA**

Balance Sheet

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Assets											
Current assets											
Cash & Bank	336,013	2,202,430	5,821,905	10,076,067	15,148,006	20,873,897	29,196,458	37,611,780	46,054,738	54,425,493	63,714,980
Accounts receivable		852,658	905,949	1,016,794	1,136,459	1,265,549	1,404,706	1,513,807	1,589,498	1,668,972	1,752,421
Finished goods inventory		144,110	153,987	171,162	190,229	211,396	234,891	257,041	281,933	309,275	339,307
Raw material inventory	463,007	298,806	345,121	398,614	460,400	531,761	614,184	709,383	819,337	946,335	-
Pre-paid insurance	-	-	-	-	-	-	-	-	-	-	-
Total Current Assets	799,021	3,498,003	7,226,961	11,662,637	16,935,094	22,882,604	31,450,240	40,092,011	48,745,507	57,350,075	65,806,708
Fixed assets											
Land	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000
Building/Infrastructure	4,082,500	3,878,375	3,674,250	3,470,125	3,266,000	3,061,875	2,857,750	2,653,625	2,449,500	2,245,375	2,041,250
Machinery & equipment	5,664,500	5,098,050	4,531,600	3,965,150	3,398,700	2,832,250	2,265,800	1,699,350	1,132,900	566,450	-
Furniture & fixtures	135,000	121,500	108,000	94,500	81,000	67,500	54,000	40,500	27,000	13,500	-
Office vehicles	135,200	108,160	81,120	54,080	27,040	217,741	174,193	130,645	87,096	43,548	-
Office equipment	77,000	51,333	25,667	89,137	59,425	29,712	103,187	68,792	34,396	119,452	79,635
Total Fixed Assets	11,844,200	11,007,418	10,170,637	9,422,992	8,582,165	7,959,078	7,204,930	6,342,911	5,480,892	4,738,326	3,870,885
Intangible assets											
Pre-operation costs	136,690	109,352	82,014	54,676	27,338	-	-	-	-	-	-
Total Intangible Assets	136,690	109,352	82,014	54,676	27,338	-	-	-	-	-	-
TOTAL ASSETS	**12,779,911**	**14,614,774**	**17,479,612**	**21,140,305**	**25,544,597**	**30,841,682**	**38,655,170**	**46,434,922**	**54,226,399**	**62,088,400**	**69,677,593**
Liabilities & Shareholders' Equity											
Current liabilities											
Accounts payable		113,723	126,446	140,651	156,518	174,251	194,080	216,264	241,098	268,911	210,243
Total Current Liabilities	-	113,723	126,446	140,651	156,518	174,251	194,080	216,264	241,098	268,911	210,243
Other liabilities											
Deferred tax		482,227	1,176,815	2,144,615	3,379,937	4,972,135	6,919,415	8,854,063	10,791,887	12,753,352	14,649,603
Long term debt (Project Loan)	5,990,445	5,060,188	4,011,950	2,830,769	1,499,786	-	-	-	-	-	-
Long term debt (Working Capital Loan)	399,510	-	-	-	-	-	-	-	-	-	-
Total Long Term Liabilities	6,389,956	5,542,414	5,188,765	4,975,384	4,879,723	4,972,135	6,919,415	8,854,063	10,791,887	12,753,352	14,649,603
Shareholders' equity											
Paid-up capital	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956	6,389,956
Retained earnings		2,568,681	5,774,446	9,634,314	14,118,400	19,305,341	25,151,720	30,974,639	36,803,458	42,676,181	48,427,791
Total Equity	6,389,956	8,958,637	12,164,401	16,024,270	20,508,356	25,695,296	31,541,676	37,364,595	43,193,414	49,066,137	54,817,747
TOTAL CAPITAL AND LIABILITIES	**12,779,911**	**14,614,774**	**17,479,612**	**21,140,305**	**25,544,597**	**30,841,682**	**38,655,170**	**46,434,922**	**54,226,399**	**62,088,400**	**69,677,593**

13.3 Cash Flow Statement

Calculations **SMEDA**

Cash Flow Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Operating activities											
Net profit		2,568,681	3,205,765	3,859,869	4,484,086	5,186,940	5,846,379	5,822,919	5,828,819	5,872,723	5,751,610
Add: depreciation expense		836,782	836,782	836,782	840,827	840,827	857,336	862,019	862,019	862,019	867,441
amortization of pre-operating costs		27,338	27,338	27,338	27,338	27,338	-	-	-	-	-
Deferred income tax		482,227	694,588	967,800	1,235,322	1,592,197	1,947,280	1,934,648	1,937,825	1,961,465	1,896,251
Accounts receivable		(852,658)	(53,291)	(110,845)	(119,665)	(129,090)	(139,158)	(109,101)	(75,690)	(79,475)	(83,449)
Finished goods inventory		(144,110)	(9,877)	(17,175)	(19,067)	(21,167)	(23,496)	(22,150)	(24,892)	(27,341)	(30,033)
Raw material inventory	(463,007)	164,202	(46,315)	(53,494)	(61,785)	(71,362)	(82,423)	(95,199)	(109,954)	(126,997)	946,335
Advance insurance premium	-	-	-	-	-	-	-	-	-	-	-
Accounts payable		113,723	12,723	14,205	15,867	17,733	19,829	22,184	24,833	27,814	(58,668)
Cash provided by operations	(463,007)	3,196,185	4,667,713	5,524,479	6,402,923	7,443,418	8,425,748	8,415,321	8,442,959	8,490,207	9,289,487
Financing activities											
Project Loan - principal repayment		(930,258)	(1,048,238)	(1,181,180)	(1,330,984)	(1,499,786)	-	-	-	-	-
Working Capital Loan - principal repayment		(399,510)	-	-	-	-	-	-	-	-	-
Additions to Project Loan	5,990,445	-	-	-	-	-	-	-	-	-	-
Additions to Working Capital Loan	399,510	-	-	-	-	-	-	-	-	-	-
Issuance of shares	6,389,956	-	-	-	-	-	-	-	-	-	-
Cash provided by / (used for) financing activities	12,779,911	(1,329,768)	(1,048,238)	(1,181,180)	(1,330,984)	(1,499,786)	-	-	-	-	-
Investing activities											
Capital expenditure	(11,980,891)	-	-	(89,137)	-	(217,741)	(103,187)	-	-	(119,452)	-
Cash (used for) / provided by investing activities	(11,980,891)	-	-	(89,137)	-	(217,741)	(103,187)	-	-	(119,452)	-
NET CASH	**336,013**	**1,866,417**	**3,619,475**	**4,254,162**	**5,071,939**	**5,725,891**	**8,322,561**	**8,415,321**	**8,442,959**	**8,370,755**	**9,289,487**

14 KEY ASSUMPTIONS

14.1 Operating Cost Assumptions

Table 13: Operating Cost Assumptions

Description	Detail
Operational days	365
Semen ejaculate per bull per Week	4
Semen ejaculate per bull per Year (52 week)	208
Dozes per ejaculate	100
Semen dozes per bull per Year	20,800
Number of bulls	10
Total semen dozes	208,000
Dozes loss	5%
Semen dozes available for sale	197,600
Wages growth rate	10%
Raw material growth rate	5%
Electricity growth rate	10%

14.2 Production Cost Assumptions

Table 14: Production Cost Assumptions

Description	Detail
Body Weight (bull)	350 kg
Fodder requirement per bull	10% of body weight of bull
Fodder Price	Rs 240 per 40 kg
Feed Requirement per bull	3 kg per bull
Feed Price	Rs 15 per kg
Liquid Nitrogen Refilling (Year 1)	Rs. 105,000
Vaccination & Medication	Rs 1,000 per bull
Chemical Expense	10,500 per month
Professional Fee	0.5% of Revenue

14.3 Revenue Assumptions

Table 15: Revenue Assumptions

Description	Detail
Semen dozes available for sale (Year 1)	138,320
Sale price per dose (Rs)	75
Sale price growth rate (Semen dose)	5%

Starting Production Capacity Utilization	70%
Production capacity utilization growth rate	5%
Maximum capacity utilization	95%

14.4 Financial Assumptions

Table 16: Financial Assumptions

Description	Details
Debt	50%
Equity	50%
Interest Rate on Debt	12%
Debt Tenure	5 Years

14.5 Cash Flow Assumptions

Table 17: Cash Flow Assumptions

Description	Details
Raw material inventory (in days)	90
Finished Goods inventory (in days)	15

15 TECHNICAL ASPECTS OF SEMEN PRODUCTION PROCESS

15.1 Examination of External Reproductive Organs

15.1.1 Scrotum

The scrotal shape of the bull controls testicular temperature. Optimum temperature is a few degrees below body temperature. This thermoregulatory function is essential for normal spermatogenesis. Normal bull scrotum should be pendulous, symmetrical and should have a distinct neck at point of attachment with the abdominal wall. Any deviation observed on inspection in size, shape or relative position should be reviewed with suspicion. All physiological (rounded, rotated, cleavage) and pathological (small hypoplastic, asymmetrical, straight sided, high pointed) variations must be observed.

15.1.2 Testes

On each clinical examination, testes should be carefully examined and palpated entirely for their size, consistency and free mobility within scrotum and through the inguinal canal. In general, both normal testes are symmetrical in size, uniform in consistency, and are freely moveable up and down. Biometry of each testicle (length, width and thickness) is determined by holding the other pushed dorsally. While doing this, the consistency of its texture is also checked with gentle pressure from thumb and fingers. Resonance and tonicity are the signs of normally developing tissues. Soft, firm and hard textures are indications of some kind of abnormality. Any defect observed (orchitis, asymmetry, excessive fat around testes, hernia, cryptorchidism, hypoplasia, etc.) need to be carefully diagnosed.

15.1.3 Epididymes

The epididymes on the side of each testis consists of three parts; caput (head), corpus (body) and cauda (tail). Like the testis, it needs to be palpated to its entire length to record its size, form and consistency. Though the defects of epididymes are rare, yet it must always be scrutinized for segmental aplasia (part of the duct missing), epididymitis, adhesions, tumors, abscesses and spermatic granulomas.

15.1.4 Reproductive Corpulatory Organs

This will include examination of sheath, prepuce and the penis. The young bulls should be examined for normal development of the penis and freedom from prepural adhesions and developmental anomalies such as persistent frenulum. The best time to examine the penis is at the time of semen collection. The

perpetual opening and sheath should be thoroughly palpated to record any abnormalities present. The veterinarian should always watch for the occurrence of persistent penile frenulum, hair ring around penis, fibropapilomas of penis, eversion of prepuce, penile hematomas, phimosis, paraphimosis and fibrotic preputial orifice.

15.1.5 Examination of Vision

Good sight is important to the breeding bulls. The eyes for common problems, like pink eye, scars and squamous cell carcinoma need to be checked. Scars resulting from accidents and infections like keratitis should be treated promptly and properly.

15.1.6 Examination of Teeth

The bull needs healthy, strong enough teeth to chew coarse fodder and concentrates. Overgrowth of molars and broken teeth must be diagnosed early through oral examination otherwise he shall loose weight rapidly and this may impair his reproductive performance.

15.2 Examination of Skeletal Development and Confirmation

15.2.1 Hind Legs Structure

Sound rear legs are vital to the breeding capacity of a bull. Pain or deformity in rear legs will not allow bull to readily mount the cow/teaser properly and give good thrust. The bulls therefore should be evaluated for mobility, interdigital fibroma (corn) and foot abscess should be checked.

Since the structural defects of the legs are heritable, and become more apparent and interfere more and more with the bull's breeding ability as the bull ages, such bulls should be culled right away. Special attention should be paid to hoof trimming in stall fed bulls. Similarly, the conformation of fore legs may also be checked. Some bulls show outward direction of feet, which on walking swiftly may stumble by striking with opposite foot.

15.3 Conformation of buffalo, Sahiwal and F1 cross-bred Bulls

The conformation of the bull is evaluated by checking the breed characteristics of the bull. Buffalo bulls should have Nili Ravi characteristics, black color with star at forehead white four feet and switch of tail, (Panj Kalian). Although such breed charms are not correlated with breeding soundness, yet buffalo breeders give a very high sentimental value to these phenotypic characteristics. Sahiwal bulls

should be of dark brown color with black extremities. F1 crossbred bulls of different colors are found. Generally, the farmers prefer black or black and white spotted bull with good height.

15.3.1 Secondary Sex Character

The developments of head and neck and hump muscles give a bull-like appearance to male animal. This masculine development takes place in bull as he approaches puberty and is said to be due to normal secretion of androgen hormone. A bull with well-developed body, heavy and deep at forequarters is generally liked.

15.3.2 Evaluation of Sexual Behavior

The sexual behavior of bull for convenience of understanding can be divided into; libido (sexual desire) and mating behavior (ability to complete the service).

a) Libido Index

Libido of a bull is defined as the willingness and eagerness to mount the teaser/cow and attempt service. The libido is graded from 0 to 3, depending upon its performance;

- 0-for being shy i.e. no desire to move towards cow/teaser.
- 1- for being Dull, very reluctant to reach the teaser.
- 2- for being Active, willingly moves towards the teaser.
- 3-being Aggressive, moves towards teaser in an uncontrolled manner.

b) Mating Behavior Index (MBI)

After the bull has reached the teaser/cow, it mounts and hold the teaser/cow to complete the act of copulation or semen ejaculation. During this period, the veterinarian gets an opportunity to record and examine the sequence of events, holding erection of penis, seeking movements (for vagina or artificial vagina) of penis, thrust, ejaculation and dismounting. Any painful condition in the feet, hind legs, back, penis, sheath, or in any part of the internal cavities (transmatic gastritis, peritonitis, nephritis, pleurisy, pneumonia, etc.) shall inhibit the desire of mating. In these situations, either bull will not mount the teaser at all or may step down after mounting without completing the act.

In bulls, it is easy to grade bulls for their mating behavior on the basis of number of attempts taken to mount the teaser for completion of a successful ejaculate. The bull is ranked from 0-3;

- 0-Poor when the bull ejaculate after more than 4 attempts
- 1-Fair, when he takes 3-4 attempts
- 2-Good, if it takes between 2-3 attempts
- 3-Excellent, when the bull ejaculates in less than 2 attempts.

The bulls falling in categories 0 and 1 for libido or mating behavior or both shall stand disqualified.

15.3.3 Evaluation of Semen Production Ability

It is now recognized fact that scrotal circumference of a bull is an accurate predictor of his sperm production ability (particularly in young bulls) and gives an accurate indication of future testicular function. In buffalo bulls, scrotal circumference has been found to be correlated with age, body weight, and sperm 0production. Similar correlation exists in cow bulls.

15.4 Management of bulls

15.4.1 Housing

Housing may be closed, semi-open or open. Bulls in tropical and subtropical conditions require protection from heat and adequate ventilation. Shade trees, shade cloth and thatch are effective. Fine water sprays with fans can be used to cool *Bos taurus* bulls under hot conditions. Bulls should be housed securely so there is no chance of escape and interaction with other bulls, staff and the general public.

15.4.2 Feeding

A balanced ration should be fed. This could be home grown or bought in or both. Care should be taken not to over-feed bulls as fat deposition in the inguinal canal negatively affects fertility. Condition score is an important guide to nutritional requirements. Breeding bulls should have a score of 3 on a scale of 1-5. Bulls should have access to mineral licks and clean water *ad libitum*.

15.4.3 Handling

The establishment of a firm relationship between the handler and the bull is essential and can not be overemphasized. The bull should be at ease when he is handled and the handler should not feel threatened. The proper application of a bull nose ring is required as soon as the bull arrives at the centre. The bull should be handled by both a halter and the bull ring. Care should be taken to use the ring only when the bull becomes unruly and difficult to handle by the halter alone. Bulls should be led by the halter and not by their nose (Fig. 1). Bulls should always be handled in such a manner that semen production is optimised. This includes taking note of all aspects of the physiology of male sexual behaviour. Negative stimuli should be avoided in the collection area. This includes pain delivered via the nose ring, which could lead to low libido (e.g. many of the difficult, slow, low libido *Bos indicus* bulls may have been made that way by poor training and handling techniques).

15.4.4 Health

Once the bulls have passed all the quarantine tests for disease control, normal routine preventive medicine should be practiced in the AI Centre. Care should be taken that bulls remain in excellent health for continuous semen production. The necessary vaccinations,

regular deworming and control of ectoparasites should be implemented to meet national and regional requirements. Adequate exercise and regular hoof care should be provided.

Continuous monitoring of diseases should be undertaken whether statutory or not. All quarantine requirements, including restrictions in the movement of animals and personnel, must be strictly observed. It is in the best interest of the AI Centre to be able to certify at all times that all animals are fit to produce semen for sale and distribution.

15.4.5 Records

A complete history of every animal should be kept from the time of arrival until the

day of departure from the centre. All incidents, ailments and medications should be recorded.

15.5 Semen Technology and Field Practices

15.5.1 Semen technology

a. Collection area and facilities

The semen collection area should be as close as possible to the semen evaluation laboratory (not more than 30 m). For teaser bull restraint a stanchion made from strong metal bars or smooth treated wooden poles and timber is recommended (Fig. 2). The floor of the collection site should not be slippery. It can be made of rough concrete or a dug-out filled with sand and sprinkled with water to avoid dust. Rubber mats can also be used.

Facilities for the restraint of bulls awaiting their turn for semen collection should be near enough to enable them to see clearly the mounting bull and serving area. The collection area should be ringed with strong metal bars or timber for the safety of people and the bulls themselves. The construction should be high enough to protect the full height of an average person (1.75 m). Spaces between rails should be small enough to prevent a bull getting his head through. Escape spaces in the surrounding fences should be placed at regular intervals. The collection area should be sheltered and must have adequate ventilation and light.

b. Preparation of bulls

The semen donor bulls must be housed under clean dry conditions and should be washed and cleaned before they arrive at the collection area. The washing area should not be more than 20 m from the serving area and should be made of rough concrete with a slanting floor to facilitate drainage of water, dung and urine. Adequate clean water with reasonable pressure should be provided through a hose pipe at this area. Prior to cleaning, the perpetual hair should be cut short, leaving a tuft of 2 cm length all round. Ordinary washing soap and a soft brush should be used to clean the bulls. During cleaning, emphasis should be put on the lower abdomen and the perpetual area. If necessary, washing of the perpetual sheath with normal saline solution can be done once every week or fortnight to reduce bacterial contamination of semen. Disinfectants should not be used. Clean, dry paper towels should be used after washing to remove excess water.

If the teaser bull or steer is dirty, its back should be cleaned with water and soap and dried thoroughly. An apron may be used if necessary. There is little risk of contamination of the penis or the semen if the teaser is clean and collection technique is good, allowing no or little contact of the penis with the teaser.

c. Preparation and sterilization of equipment and materials

All equipment used for the collection, evaluation and processing of semen must be clean and sterilized. The following procedures are recommended

i) Glassware

- Wash with detergent containing 2% Na2Co3. If glassware has become cloudy through repeated use, leave it submerged in potassium dichromate solution ($K_2Cr_2O_7$, 8 g; H_2SO_4, 12 ml; distilled water, 100 ml) for 24 hr.
- Wash with tap water
- Rinse with distilled water
- Dry and cover in clean paper or aluminum foil
- Place in hot air oven (160°C) for 30 minutes
- Transfer to a closed, dust free incubator (37°C)

ii) Rubber materials

- Wash in detergent
- Wash repeatedly in tap water
- Boil for 10-15 minutes
- Swab dry
- Store in a dust-free chamber fitted with ultraviolet radiation.

iii) Buffers

- After preparation, autoclave at 120°C and 15 lb pressure for 20 minutes
- Fresh eggs of Grade A should be collected from pathogen free flocks and the shell washed and swabbed with 70% alcohol

d. Artificial vaginas

An outer rubber barrel (usually 45cm long) with rough inner rubber liner that is non-spermiotoxic is recommended. The inner liner should periodically be checked for possible leakage. The rubber cones should be also non-spermiotoxic and a

correctly labeled collection tube should be attached. A jacket should be provided for the cone to prevent breakage and avoid direct exposure to sunlight. Rubber bands for holding on the cones and the two ends of the reflected inner lining onto the outer barrel should be strong.

A lubricant that is sterile, non-spermiotoxic, non irritant to the penis and easily washable (eg. KY jelly or white Vaseline that has been sterilized by boiling) should be applied sparingly and just before collection at the entrance of the artificial vagina (AV, Fig. 3). The lubricant can be replaced by a small amount of diluent to moisten the entrance to the artificial vagina.

Water for the outer jacket filling should be warmed to 60^{o}C. Enough of this should be poured into the inner chamber to provide the required pressure. This quantity may range from 500-750 ml. Inner temperature after lubrication should range between 40-45^{o}C. Assembled AVs should be kept in incubators at 55-60^{o}C. If there is a delay between preparation of the AV and collection, the temperature should be checked. Just before collection, excess water is poured off from the AV and enough air blown in to provide adequate internal pressure.

e . Electro Ejaculators

Electro ejaculators should only be used when absolutely necessary. Only lame or injured bulls should be subjected to the technique. Good training and good handling procedures allow most bulls to be collected with the artificial vagina. The prepuce should be washed and dried. The rectum should be emptied of faces and the probe inserted to lie over the seminal vesicles and ampullae. Stimuli should be applied with great care to achieve a very slow and gradual increase in intensity.

f. The collector

A collector should be selected on the basis of his/her ability, enthusiasm and experience to work with livestock. Protective gear should include gum boots with steel or wooden-toed caps, apron, head cap and thin half length plastic hand gloves.

g. Collection procedure

It is advised to collect the semen early in the morning. Bulls should be led, preferably using a halter, to the teaser in a gentle friendly manner by the handler, who should pay attention to the temperament of the particular bull. The bull should be allowed to watch other bulls mounting before collection. He is led around behind the teaser and may be allowed to mount other bulls. Two false mounts are usually given. These measures promote good sexual excitement, which improves

the quality of semen by cleansing the urethral passage and increasing the amount of semen collected. The bull is then allowed to mount for the first collection.

At this time the collector shall gently grasp the prepuce behind its opening and direct the fully erected penis into the lubricated end of the AV. The penis should not be touched. The handler may rest his shoulder against the bull's flank and move with the movement of the bull as he thrusts. The AV should be held so that the bull withdraws as he dismounts, and should not be pulled away from the penis. The ejaculate should be taken immediately to the evaluation room. Handling of semen should be always done with great care to avoid cold shock, contamination, excessive agitation and direct sunlight.

h. Evaluation of semen

i) Macroscopic examination

The semen should be transferred to a water bath maintained at 35±1^{o}C. Visual evaluation for volume, colour, consistency/density, odor and observation for presence of foreign material (blood, pus cells, dung, hair, etc.) shall be made and recorded. If dung or hair is found in the semen, filtration with a special semen filter is advised.

b) Microscopic examination

Microscopic evaluation is done using a simple or phase contrast microscope for mass activity (wave motion) and individual motility. Determination of concentration is done with a hemocytometer or a calibrated photometer. At this point, if required, smears can be made for morphological studies and live/dead count. Nigrosin-eosin stain is recommended.

Buffered nigrosin-eosin solution is mixed with a drop of semen and smeared on a glass slide for morphological examination. It should be dried and examined under oil immersion. Automated computerised machines for recording motility and concentration and calculating the required extensions are now frequently used in AI centres that can afford them. Semen used for artificial insemination should be of high quality. The following are guides to the values of semen characteristics in the bull that indicate good reproductive function:

- Motility (moving actively forward): > 60%
- Concentration: > 500 million /ml
- Live sperm: > 70%

- Abnormal sperm: < 20% (range for bulls with good fertility is 8–12%)
- Proximal droplets: < 4 %; Distal droplets: < 4%
- Tailless: < 15%; Singly bent tails: < 8%; Double bent tails: < 4%; Coiled tails: < 3%
- Cells other than spermatozoa: none, or very few leucocytes or epithelial cells.

A further technique that can be used to evaluate the semen is the hypo-osmotic swelling test (HOST), which indicates the functional integrity of sperm membranes. Centers should develop a system of morphological assessment and guidelines for limits beyond which semen is discarded. Morphological examination is generally reserved for borderline samples. The assessment is also valuable in helping to reach a diagnosis when a bull begins to fail to produce semen of processable quality as assessed by concentration and motility.

The definition of motility is often ambiguous. Since the important criterion is "progressive forward motility", this should be the basis for judgment. If there are 70% or more of spermatozoa moving actively forward the semen sample is of good quality and acceptable for processing. If there are 40% or more of spermatozoa moving actively forward after freezing and thawing the quality is acceptable for AI. For election/rejection purposes it does not matter very much if the others are slow, swimming backwards in circles (singly bent tails) or immotile. However, these characteristics are important for diagnostic purposes, because they help to define the disturbance of function.

Some systems of evaluation characterize motility as follows: (a) % direction motility (moving forward); (b) % local motility (wiggling around without going forward); and (c) % no movement (possibly all dead). To judge this under the microscope, the general picture is first assessed, and then the type of motility of those moving is assessed. To be acceptable, more than 50% should be moving, and of these more than 70% should show progressive motility.

Many artificial breeding centres have standardised their own way of assessing semen quality and, provided they serve the purpose effectively, can be recommended for use.

i. Extension

The Extender type and extension ratio depends on the type of semen produced: deep frozen semen (DFS), chilled semen (CS) or room temperature semen (RTS).

For **DFS** the recommended diluents are:

- Egg yolk - citrate - glycerol extenders
- Skimmed milk - egg yolk - extenders
- Tris buffer - egg yolk - glycerol extenders

For **CS** and **RTS** the recommended extenders are:

- Coconut milk - egg yolk extender
- Egg yolk - citrate extenders (cattle)
- Tris - egg yolk extenders (buffalo).

j. Processing and packaging

A standardized daily routine should be adopted for all types of semen processing. For example, the following routine is recommended:

- Extender preparation;
- Semen collection and evaluation;
- Extender A at 35^{o}C added to semen 1:1 and allowed to cool to room temperature (approximately 20 minutes);
- Complete dilution with Extender A at room temperature and placed in 4–5^{o}C for at least 4 hours;
- Extender B is held at 4–5^{o}C and added in two steps, 30% and then 70% at that temperature;
- Fill, seal and label straws at 4–5^{o}C;
- Place straws on freezing racks in liquid nitrogen vapor to -140°C over 8–10 minutes (straws should be 5 cm above the liquid nitrogen surface; in the absence of freezing machines this step can be done in a large semen storage tank or a big polystyrene container containing liquid nitrogen);
- Place racks in liquid nitrogen at -196^{o}C;

- Collect straws with a gloved hand and store in goblets in liquid nitrogen;
- Wash and sterilise glassware for the next day.

In this system the extender is added in two fractions. Fraction A contains no glycerol, fraction B contains 14% glycerol. The final concentration of glycerol is 7%. The 4 hour time lapse between adding fraction A and the first part of fraction B is to allow antibiotics to work before they are inhibited by glycerol.

The common types of packaging used for processed semen are:

- **DFS** - packaged and sealed in straws, mini (0.25 ml) or medium (0.5 ml), or as pellets. Straws and pellets contain a minimum of 20–30 million spermatozoa per dose.
- **RTS** and **CS** - packaged and sealed in ampoules or airtight vials of 1.0 ml, containing 15–20 million spermatozoa. In some cases this can be reduced to 5 million spermatozoa (e.g. the caprogen diluted semen used in New Zealand). Vials containing chilled semen are transferred to a beaker with water at 35^{o}C and the beaker is transferred to the refrigerator at 4–6^{o}C.

k. Preservation and storage

DFS is preserved in liquid nitrogen at –196^{o}C. Transferring of semen must be done quickly. Canisters containing packages when raised from the tank should remain in the neck of the tank for less than 10 seconds. Liquid nitrogen is dangerous and must be handled carefully.

CS is refrigerated at 4–5^{o}C. RTS is held at ambient temperature (18–26^{o}C). The containers of straws, ampoules and pellets should be properly labeled and records maintained on their location and contents.

l. Post packaging quality control

Motility of samples from processed batches of semen should be checked before dispatch. Post thaw motility should be 40% or more for DFS. All semen storage containers should be regularly checked for liquid nitrogen level and replenished as required.