# AN EFFICIENT ONLINE OFFLINE DATA COLLECTION SOFTWARE SOLUTION FOR CREATING REFERENCE POPULATION TO ESTABLISHED GENOMIC SELECTION UNDER SMALL HOLDERS' DAIRY SYSTEM IN INDIA

Y S Gaundare, S A Joshi, N K Punde, K G Bhave, T V Shirsath, V V Potdar, V Dhanikachalam, S Jadhav, A S Joshi and M Swaminathan

Central Research Station, BAIF Development Research Foundation, Pune 411058, India

#### ABSTRACT

This article as part of an Enhanced Genetics Project assumes special significance in the light of emergence of electronic mode of data collection system. Pen and paper method of data collection although very familiar to field people, but is generates the errors and requires digitization and data cleaning. The software solution surveying is easier mode of ensuring uniformity in data collection, reducing errors and better storage and analysis of data. In this regard, this article gives a clearer picture of the digital tablet based data collection system employed part of the Enhanced Genetics Project across 49 selected Data Recorders (Data Enumerators) in Maharashtra, Uttar Pradesh, Jharkhand, Punjab, Odisha, Gujarat, Andhra Pradesh, Rajasthan, and Bihar. The manual outlines the processes to be fulfilled by the digital mobile based solution, the user interface involved and the software and hardware infrastructure to support such a platform independent system. In this project we have enrolled the 33,293 dairy animals and collecting there production, reproduction, body weight data, as well as, collecting the baseline & herd management information of that farm. This system increase Data Accuracy GPS (Global Positioning System) enabled data collection system for genomic evolution. This is very unique software solution developed for to collect the structured phenotype data of the dairy animals in Indian conditions on realtime basis. As well, show case the robust data collection system for the Genomic Selection for dairy animal's initiative. This sub-system also focused on the various activities and operations related to molecular biological laboratory. In this software solution system the two major feedback systems for actively participation of the farmers were participation certificate and Graphical Animal Ranking system for the farmer and animal. The locational data collection with seamless interfacing with the user and the data repository for Genetic Improvement Data collection system. Data capture system was quite successful in gathering field phenotype data for Genetic Improvement Program in the complex dairy production system like India.

## **KEYWORDS**

Data Collection, Data Enumerators, GPS, Farmer Feedback.

## **1. INTRODUCTION**

Department of Animal Husbandry & Dairying under Ministry of Fisheries, Animal Husbandry & Dairying attributes critical importance to livestock. Also, the collection and availability of up-todate and accurate data related to livestock, as they are the important component of the rural economy. For proper planning and formulation of any programme meant for achieving further improvement in this field and its effective implementation and monitoring, data validation are

DOI: 10.5121/ijcseit.2023.13401

required at every decision-making stage. Present scenario of livestock data in Indian scenario data The Livestock Census is the main source of such data in the country. The livestock census is conducted across the country periodically since 1919. The census usually covers all domesticated animals and head counts of these animals are taken. The uniformity of data is really important of data quality. Uniformatity of data quality removes the duplications of data and improves quality of data. Using manual data entry with pen and paper in the software, Excel or any database is risk to data reliability and manual errors. The present project phase is going to emphasis on not just crossbred but also indigenous breed of cattle and buffalo as well. Apart from that we are going to focus other important traits like fertility (Age at first calving, Service period, calving interval etc.), other important production traits (milk components like fat, SNF), conformation traits, disease incidence traits, heat tolerance traits etc. The emphasis will be given on female farmer preferred traits like temperament trait as well. This way of genomic evaluation will allow selection of farmer desire good type and associated traits associated with profitability and sustainability of farmer.BAIF has a historical evolution of implementing several electronic data capturing systems starting from heavy data loggers to mobile based platforms Potdar et al., (2017). Even before the Enhanced Genetics Project, data collection using windows phones, palm mobiles was experimented. However, considering the unavailability of windows phones, palm devices and emergence of smart phones, it was decided to go with Windows Tablets with Windows based operating system of 8/10. In this stage, the system was like an interactive assistant to various levels like Data Recorder, Supervisor, State Monitoring officer and HO-Central Research Station. The BAIF organization is committed to improving the livelihoods of the poor with deep-rooted focus on development research. With its implementation across several states in India and a major change-maker in the lives of many, the monitoring and improvement of different programmes of BAIF assumes significant importance. Enhanced Genetics Project for genetic improvement based on genetic evaluation of smallholder dairy production system in India (Al Kalaldeh et al. (2021). Every project requires a good monitoring programme, however, this project, in particular, being concerned with the future prospect of up scaling and moreover related to the core of BAIF's focus, necessitates a better genetic analysis and genomic evaluation. This demands that the raw data collected from the field is documented in the right format for future accuracy of the analysis carried out. In this regard, a change from the traditional book-keeping system to digital database management seems unquestionable.

# 2. METHODOLOGY

49 Data Recorders (Enumerators) were selected for this project in 42 districts of Maharashtra, Uttar Pradesh, Jharkhand, Punjab, Odisha, Gujarat, Andhra Pradesh, Rajasthan and Bihar. On an end-to-end basis the project was operational from November 2016 till August 2021.

In 2015-16 we have started to develop the data structure of this data collection system with help of national & International Genetic Experts. We have listed the exhaustive data points and make the list of all the data points. Then we have develop the online-offline mode software on windows tablet platform for data collection, this software we have developed in Microsoft dot net and Microsoft SQL server technologies.



Figure 1: Software solution cycle

Above figure gives an Idea about the software solution methodology adopted for the design of this data collection system.

Architecture of software solution designed in various layers of sub-architectures is as follows:

- At the base of the design is the process architecture, which encompasses design and layout of all the business processes and activities that we plan to automate.
- On top of this is the solution architecture, which encompasses the design and layout of information flow (structure of information, systemic check and constraints, business logics etc.) and various modules and user interactions handling the information flow.
- On basis of process and Solution architecture the software architecture develop, which encompasses the design of software modules and concrete implementation of solution architecture on a specific technological platforms, (namely, Microsoft .Net 4.0/4.5, Microsoft SQL Server 2008/2012, Windows 7/8/10 and Windows Server 2008/2012).

## 2.1. Back-End Infrastructure

This topic explains about the back-end infrastructure of Enhanced Genetics Project. The architecture was designed taking into account the activities to be carried out, organisational hierarchy, etc.

The architecture consists of the software and hardware portions. The software is concerned with the development of different software modules and application interfaces. The hardware consists of the infrastructure in which the software will be housed and their field deployment.

## 2.2. Software Architecture

Software architecture consists of four parts which form the different layers:

- 1. Primary framework
- 2. Secondary implementation components
- 3. Tertiary database facilities
- 4. Quaternary user interface

The primary core of the architecture is the framework which is the information structure model. It will simulate all the data collection activities (like production, breeding, feeding and body weight) and participating entities (like animals, sires, farming households).

The framework/model is then implemented by a set of secondary software components, referred as Implementation components, which incorporate the logics, validations and rules pertaining to each and every research activity and participating entities.

Further these modules depend on the database management facilities which form the tertiary layer in the software architecture. There are two sets of components, one developed for Windows Tablets platform on Microsoft SQL Server and another for Windows Server platform on Cloud Azure Microsoft SQL Server.

The tertiary and last set of software components are the user interfaces, also referred to as consoles, both on Windows tablets and PC platform. These have all the necessary display forms for all user reporting and other interactions.



Figure 2: Software Architecture with User interphases

The Performance Recorder's software edition is deployed on Windows tablets with the Data Recorders. This is the primary source of recorded information. The District Supervisor edition is deployed on web-portal at District level. Information collected by the Data Recorders is transferred and synchronized on Cloud servers through internet. The State unit is deployed on web-portal at State level. Information collected by the Data Recorders is directly accessed by the State Monitoring Officers. Additional reporting utilities, dashboards are developed for day to day data monitoring & reporting. The Central Research Station-HO is deployed on web-portal at the central office (CRS, Uruli Kanchan). Information collected by the all Data Recorders is available on this web-portal. As well as, cloud servers data real-time synchronised with the in-premises physical server for a data repository, research and data analysis was done.

## 2.3. Hardware Architecture

Initially, considering the processing power, internet connectivity issues, etc. an online-offline hardware infrastructure was envisaged wherein data from Data Recorders tablet was automatically get synchronised at Cloud servers further all the data from district level cross checked with the district supervisors and at state level and eventually all the project data was stored in the Cloud server & it gets replicated on Central Research Station's physical server.



Figure 3: Hardware Architecture of Software Solution

# 3. SCOPE OF THE SOFTWARE SOLUTION

Following are the sets of software modules and sub-modules that planned, designed, developed and deployed during project period,

- **Data management service:** This software module designed, developed and implemented as a database on Microsoft SQL Server 2008/2012 on Microsoft Azure Platform. Primary responsibilities of this module will be storage of data, back-up and restoration etc.
- Solution service: This software module deployed on a Microsoft Azure Web App Service. It will be background service software, hosting various sub-modules. These sub-modules will be implementing the systemic checks, business constraints and business logic as envisaged in the solution architecture.
- User-interface service: These tablet as well as web based software modules used by end-users and supervisory staff to interact with the solution service. Software installed on Windows Tablets at Data recorders level and web -applications for others.
- Security management console: This console used to configure and set the solution service settings for security sub-system management
- Solution consoles
- Administration console: This console used to configure and manage settings for solution sub-system modules.
- State Office Console: This console used by state office staff for day-to-day activities related data monitoring & reporting.
- District Office Console: This console used by district level supervisor staff for day-to-day activities related data monitoring & reporting.
- Data Recorder Console (Windows Tablet software): This console used by data entry operators for day-to-day activities (as listed above) happening at the data recorder level. This console running on an online-offline mode on Windows Tablet.
- Reporting Console: This console provided to other data consumers who are more interested in reports and data for further analysis at various levels.

# 4. FARMER FEEDBACK SYSTEM

Any field recording system is active if we give the feedback to the stakeholders, in this software solution system we have developed the following feedback systems for actively participation of the farmers.

## 4.1. The participation certificate for the farmer:

Digitally generated certificate is available at an online portal. As well as we are in process for the physical printing at central level.

			•				
tate: District:		CDC:					
Ilage: Farmer Name:		ne:	Species & Breed: Last Calving Date:				
nimal Tag N	mal Tag No.: Lactation No.*:						
ecord No.	Recorded Month	Record Day	Milk Yield in kg.	FAT%	SNF %		
1						Portificate of Participation	This certificate is awarded to
2						computer of sumption	
3						BAIF Development Research Foundation	
4						Central Pasearch Station	in recognition of your participation in the test day mil
5						E E E E E E E E E E E E	recording programme of the animal having tag no
6						Uruli Kanchan, Pune, Maharashtra	. under Enhanced Genetic
7						$\sim$	Beiler beilen sid be Batte Berlen in Berne
8							Project implemented by BAIF Development Researc
9							Foundation, during to
						C N/orth	

Figure 4: Farmer Feedback System: Farmer Participation Certificate

## 4.2. Graphical Animal Ranking system

This is also available on an online portal a state/district/data recorder level animal ranking system on the milk yield rating, FAT/SNF/Protein rating. As well as, Milk recorders are able to show this ranking to participated farmers.

BHURI BAIF-3	70000998-1936					
Name Tag Sex Date of Birth Age (years) Stage Back to Registered an	BHURI BAIF-370000998-1936 Female 04-Oct-2011 (Tentative) 7 Adult	Species Breed Type Breed Participating	BUFFALO Non Descriptive Breed NON DESCRIPTIVE True	Owner Village Centre Milk recorder District/City State/Province	DINESH & RAM DULARE BHOOLI PALHARI EGPUPDR2 LUCKNOW UTTAR PARDESH	
Back to Household						
Back to Household						
Back to Household Animal Rating Milk yield rating	Fat conte	ent rating	SNF content rating	Protein	content rating	
Back to Household Animal Rating Milk yield rating Near ave	Fat conte age M	ent rating oderately above average	SNF content rating Slightly above average	Protein	content rating Inderately above average	

Figure 5: Farmer Feedback System: Animal Ranking System

#### **4.3.** Prerequisites of hardware and software

- 1. Software modules hosted as follows:
- 2. Data management service on MS SQL Server running on Microsoft Azure Platform.
- 3. Solution service on Internet Information Server running on Microsoft Azure Platform.
- 4. User interfaces for end-users on Window Tablets with Operating System Windows 8.1 & 10 and Windows/Linux PCs with Internet Explorer.
- 5. Dot Net Framework 4.8
- 6. SAP Crystal Reports for Visual Studio (SP30) runtime (32-bit & 64-bit)

#### 4.4. Software solution Availability

Demo version of software is available on request on following link, https://baifonline.org/EnhancedGenetics/Home/Downloads

# 5. **Results**

As we know the Data is the new fuel for any organization in this digital world. An Organizations have the difficulties in getting the field data from various location in structured manner. As well, it is difficult to maintain the quality of incoming data. So to overcome this problem our software solution is the good tool to adopt and replicate.

Following tables gives the idea of the volume of data we have collected through this mechanism for various research purposes.

State	No. of Distr icts	No. of Cattle Breeding Centers	No. of Villages	No. of Data Recorders	No. of Farmers / herds	No. of Animals Registered	No. of Animals under performance recording
Andhra Pradesh	2	18	72	2	211	1,300	1,300
Bihar	4	12	152	4	2078	4,476	3,262
Gujarat	6	12	60	7	970	2,727	2,694
Jharkhand	4	42	267	6	1666	5,554	5,094
Maharashtra	3	21	90	5	1599	6,665	5,842
Odisha	4	10	127	4	1342	3,314	2,560
Punjab	4	12	161	6	1358	4,858	4,306
Rajasthan	2	2	25	2	538	1,158	1,025
Uttar Pradesh	13	26	396	13	3563	8,559	7,210
Total	42	155	1,350	49	13,325	38,611	33,293

Table	1.	State	wise	coverage
1 auto	1.	Suuce	W100	coverage

#### International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.13, No.4, August 2023 Table 2: State wise & Breed Wise total Animals Registered

Stata		Buffalo			Grand				
State	N. D.	Indigenous	Total	HF X	Indigenous	JR X	N. D.	Total	Total
Andhra Pradesh		211	211	-	1,089		-	1,089	1,300
Bihar	405	602	1,007	2,387	181	278	623	3,469	4,476
Gujarat	151	1,907	2,058	49	607	7	6	669	2,727
Jharkhand	117	221	338	3,404	229	1,298	285	5,216	5,554
Maharashtra	186	1004	1,190	4,595	132	621	127	5,475	6,665
Odisha	23	8	31	184	447	2,345	307	3,283	3,314
Punjab	447	1,423	1,870	1,893	532	353	210	2,988	4,858
Rajasthan		11	11	202	881	64	-	1,147	1,158
Uttar Pradesh	1,448	2,088	3,536	3,106	489	605	823	5,023	8,559
Total	2,777	7,475	10,252	15,820	4,587	5,571	2,381	28,359	38,611

Table 3: State wise & Breed Wise total Animals under phenotype performance recording

State		Buffalo			Grand				
State	N. D.	Indigenous	Total	HF X	Indigenous	JR X	N. D.	Total	Total
Andhra Pradesh		205	205	44	1,025	26	-	1,095	1,300
Bihar	276	423	699	1,789	111	197	466	2,563	3,262
Gujarat	138	1,914	2,052	48	584	5	4	642	2,694
Jharkhand	97	215	312	3,262	205	1,127	188	4,782	5,094
Maharashtra	158	904	1,062	4,024	101	552	103	4,780	5,842
Odisha	9	5	14	167	336	1,797	246	2,546	2,560
Punjab	410	1,293	1,703	1,705	449	307	142	2,603	4,306
Rajasthan		9	9	202	761	53	-	1,016	1,025
Uttar Pradesh	1,183	1,699	2,882	2,742	410	510	666	4,328	7,210
Total	2,271	6,667	8,938	13,983	3,982	4,574	1,816	24,355	33,293

#### International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.13, No.4, August 2023 Table 4: State wise data recorded on various parameters

State	No. of test day milk records	No. of test day milk quality records	No. of Body Measurement records	No. of feeding records	No. of breeding records	No. of animals body type trait records	No. of Bio-logical Sample records	No. of Animals Genotyped
Andhra Pradesh	11,591	11,976	3,739	9,922	131	-	170	-
Bihar	47,590	30,540	10,166	26,538	1,535	48	2,288	1,002
Gujarat	35,551	24,902	8,861	25,076	6	22	2,044	44
Jharkhand	152,248	41,952	27,581	57,895	2,317	1,404	2,413	1,955
Maharashtra	94,080	10,611	24,838	41,415	7,141	1,862	2,623	985
Odisha	16,030	12,667	17,576	21,778	135	-	671	184
Punjab	100,820	31,870	5,056	7,711	291	-	2,844	1,266
Rajasthan	6,196	3,253	481	628	-	-	-	-
Uttar Pradesh	126,613	73,010	32,649	73,311	1,151	1,953	3,570	1,546
Total	590,709	240,781	130,947	264,274	12,707	5,289	16,630	6,982

# **6. DISCUSSION**

## 6.1. Need of Software Solution

The software solution needs to help in data management involved in the services of Data Recorders. It is like an interactive assistant which notes daily appointments and pending tasks. The various activities involved in a software solutions are explained in the following sections. The exhaustive data point list with category is as follows,

## 6.2. One time data

- 1. Locality data: State, District, Recorder, CDC, Village.
- 2. Farmer data: Farmer details, Farmer baseline with land, major crops, economic status, animal holding and income-asset data etc.
- 3. Herd Management data: Animal housing, Feeding practices, Animal treatment, Animal sale-purchase and general herd details like, replacement source, milking etc.
- 4. Animal enrolment: Tag number, Species, Breed, Age, Dam & Sire, Lactation and last calving information.
- 5. Biological sample collection data: Date and sample reference number.
- 6. Animal body type trait data: we are collecting the 27 body type trait data.

## 6.3. Transactional Individual animal wise data

We have fixed the frequency for following repeatedly data collection,

- a. Milk yield data: Morning and evening with or without sucking.
- b. Milk component data: FAT, Protein, SNF etc.
- c. Mastitis instances.

- d. Breeding & Follow-ups: AI/Natural service, PD and Calving follow-up.
- e. Body measurement: Length, Girth, Height and body weight.
- f. Vaccination & Immunization instances
- g. Feed and Fodder data: Green, Dry, Mineral and concentrate etc.
- h. Disease instances and approximate cost for treatment & days to recover.
- i. Animal disposal: Sold, Died or left out from the project due various reasons.

Simultaneously we have harmonised the state team and recruited the Enumerators (Data Recorders). As well as we have developed the various SOPs for the selection of farmer, herd and animal and circulated to state teams.

After successful development of this windows based software we have tested the software thoroughly. In August 2016 we arranged the 3-4 days training of State coordinators, Monitoring officers, Supervisors and the Data Recorders about the Genetic component project information, need and objectives. As well as we had trained them how to operate the software. Initially we have started this component in 6 states and subsequently we added more states and recorders as our scope changes. For daily monitoring purpose we have developed the web-portal www.baifonline.org with role management and created the various login credentials according to the role of the person.



Figure 6: Interface of Software Solution

#### 6.4. Achievements

- 1. The data capture and management system under Enhanced Genetics Project is a proof-ofconcept for multi locational data collection with seamless interfacing with the user and the data repository for Genetic Improvement Data collection system.
- 2. Despite involving implementation of multiple validation checks and logics the data capture system was quite successful in gathering field phenotype data for Genetic Improvement Program in the complex dairy production system like India.
- 3. The data capture and management is the right MIS tool for better monitoring and evaluation through fast and effective feedback and timely corrections.
- 4. The data analysed subsequently has provided much needed inputs for scientific and management research.
- 5. The data capture system will provide an opportunity to superimpose newer field based scientific and operations research plans.

6. In view of the versatility of the system, it has proved to be a standard and would be worth applying in other similar programmes in the country.

## 6.5. Challenges

- 1. There is a definite reluctance of Data Recorders/Supervisory staff to switch over new technology because it may be quite unfamiliar. This may lead to improper handling of device, internet, etc.
- 2. The software is being in English causes difficulties to some Data recorders who are not fully conversant. Hence there could be misinterpretation of some parameters and spelling errors. But those minimized after conducting the multiple revive trainings with them.
- 3. When a lot of details have to be recorded the Data Recorders may be impatient and may not enter the precise data.

## 6.6. Recommendations and Future Scope

- 1. Considering the massive usage of smart phones especially with the younger generation, it would be desirable to opt for electronic system of data capture although a complete shift may be gradual due various reasons.
- 2. Taking into account the familiarity and availability of Internet Connectivity and Smart Phones, it would be desirable to make next generation apps on the Web based platform. So we are in process of upgrading this software solution on platform independent Progressive Web App.
- 3. Geo-tagging and audio/video recording features could be included to ensure validity of the data.
- 4. Provision for noting comments/unstructured data could be made.
- 5. Newer versions in development as the software evolve and regular review trainings and follow up for Data Recorders.
- 6. Trainings for smooth English input and exercises to reduce spelling errors.

## 7. CONCLUSIONS

This is very unique software solution developed for to collect the structured phenotype data of the dairy animals in Indian conditions on real-time basis. As well, show case the robust data collection system for the Genomic Selection for dairy animal's initiative to the funding agencies, Government of India and amongst the stake holders of the projects is successfully achieved. Our future work will primarily focus on expansion of this software solution amongst the country wide phenotype performance recording of the dairy animals with the various technology upgrades & validation. As well, we will develop the platform independent and more user friendly software solution in future.

#### **ACKNOWLEDGEMENTS**

We acknowledged the President of BAIF, Vice President and colleagues.

We also acknowledged the extensive contributions of field level Data recorders, District level supervisory staff, and State level monitoring officer's, for tireless works in BAIF's Enhanced Genetics Project.

12

International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.13, No.4, August 2023

## REFERENCES

- Genomic evaluation of milk yield in a smallholder crossbred dairy production system in India: Mohammad Al Kalaldeh1\*, Marimuthu Swaminathan2, Yuvraj Gaundare2, Sachin Joshi2, Hassan Aliloo1, Eva M. Strucken1, Vincent Ducrocq3 and John P. Gibson1. December2021, Genetics Selection Evolution 53(1),10.1186/s12711-021-00667-6.
- [2]. BAIF Experience in Field Data Collection: Vinod V Potdar\*, Bhave K, Gaundare YS, Khadse JR and Pande AB Department of Genetics, BAIF Development and Research Foundation, India. August 2017, 10.36876/ijas.1004

#### AUTHORS

**Yuvraj S S Gaundare** More than **17 years** of operational and functional experience in the software development, deployment, data analysis and data monitoring. Proficient in R, C#, SQL programming languages. Strong experience in basic and statistical analysis of gathered data. Currently working with "BAIF Development Research Foundation" Central Research Station, UruliKanchan, Pune, as a Thematic Program executive since 2010. Completed the Post-Graduation MBA in the Information Systems and Graduation Degree in Bachelor of Engineering in Computer Science. Around 17 research articles published to date.

**Dr. Sachin Joshi** is a post graduate in Veterinary Medicine and working as Chief Thematic Programme Executive at BAIF Development Research Foundation. Since 2014, he is working in the capacity of Coordinator in implementing the piloting of sorted semen under varied production environment in India and understanding the success rates (conception rates and calf sex ratio) and adoption of sorted semen among the small holder dairy farms in India. He has 23 years of working experience in the area of livestock research and development. In addition, he has notable experience of managing a large organized commercial dairy farm for the captive qua

experience of managing a large organized commercial dairy farm for the captive quality milk production. He is the author and co-author of over 45 research publications in various journal.

**Nikhil Punde**, Post graduate in computer science at University of Pune and currently working as a Information Technology Specialist for BAIF in Pune. I work on Data Management and Analytics.

**K. B. Bhave, PhD** in Animal Genetics and Breeding, working as a Thematic Program Executive in BAIF Development Research Foundation.

**Tejashree Shirsath**, Post graduate in computer science at University of Pune and currently working as a Information Technology Specialist for BAIF in Pune. I work on Data analysis Management and Server Administration. Around 16 research articles published to date.









13

#### International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.13, No.4, August 2023

Dr.Vinod Vijay Potdar completed his Masters in Animal Genetics & Breeding (M.V.Sc.) from Maharashtra Animal and Fishery Science University, Nagpur in year 2003.Presently he is working at Animal Genetics and Breeding Department, Central Research Station of BAIF Development Research Foundation at Urulikanchan, Pune, and Maharashtra.. He is the author and co-author of more than 30 research articles in national and international journals.

Dr.Santoshkumar JADHAV, Last 8 years working in the area of genomics. Working as a thematic program executive in BAIF Development Research Foundation.

Dr.Velu Dhanikachlam,PHD in Biotechnology Last 8 years working in the area of Biotechnology. Working as a thematic program executive in BAIF Development Research Foundation. He is the author and co-author of over 16 research publications in various journal.

Dr. A S JOSHI, M.V.Sc. in Animal Genetics and Breeding, currently working as Senior research Officer in BAIF, Development Research Foundation

Dr. M Swaminathan, A Veterinarian with specialization in animal breeding and animal production systems, having more than 25 years of experience in livestock-based smallholder agriculture and agribusiness development program management and dairy farm operations in several countries, worked in strategizing and implementation of the climate-resilient livestock production, animal health technologies and marketing strategies for the uplift of rural livestock farmers in developing countries.







