Plant Archives Vol. 25, Supplement 2, 2025 pp. 2649-2654 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.336

ENTITY RELATIONSHIP MAPPING FOR DSS IN INTEGRATED FARMING SYSTEMS: A CONCEPTUAL FRAMEWORK

Priya Pallavi, Basant Kumar Jha*, Neetu kumari, Ritesh Mukherjee, Venktesh Jha, Shweta Kumari and Anup Kumar
Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India.
*Corresponding author E-mail: basantbkjha@gmail.com
(Date of Receiving : 09-04-2025; Date of Acceptance : 01-07-2025)

ABSTRACT

Integrated farming system (IFS) approach is believed to be an adaptable and holder farming system sustainable model of cultivation applicable for small especially in diverse agro-climatic region such as Jharkhand. For facilitating Decision Support System (DSS) was developed in data-driven business selection a the form of a structured relational database. This article describes the tables process of building DSS's backend: ER (entity-relationship) modelling, design and logical flow. The DSS allows personalized business advisories condition season and according to land condition, irrigation facility, climatic the period. This database-driven method improves the accuracy, flexibility, and IFS planning tool. usefulness of
***Keywords*:** Integrated Farming Systems, Decision Support System (DSS), Entity Relationship Diagram (ERD), Agricultural Informatics, Jharkhand

Introduction

The shift towards IFS the development in agriculture is also one of the key paradigms shifts in sector, particularly for ecologically diverse and resource-starved areas like Jharkhand. IFS allows farmers to generate multiple income streams, recycle and water use by managing a combination of nutrients and maximize land enterprises collectively such as crops, animals, fish, trees, forestry-based IFS requires and allied activities. However, the wide spread adoption of decision-making instruments which are able to transform the heterogeneity of field conditions in operational recommendations.

Evidence is deemed increasingly clear, that use of Decision Support Systems (DSS) can be considered as a corner-stone of precision and smart agriculture, with farm coupled at the input side, and data-driven guidance as its specific variables of output side. A fundamental prerequisite for any DSS lies in the development an effective data schema that can handle and normalize multi-domain the structural model supporting this agricultural data. The metadata ERD is functionality and making it possible to logically interrelate inputs as the location, soil status, endowment, water status, farm layout, enterprise preference and economic targets.

A number of researches the requirement of a comprehensive data system in agriculture. have highlighted relational database for the farm For instance, Gupta *et al.* (2019) designed a advisory system based on ER modeling, and it was integrated into a mobile app based recommendation interface for the farmers of Bihar. Similarly, Jain & use of normalized ER diagrams for the maintenance of Sinha(2021) showed the soil health record and the recommendation of crop plans with a relational backend. Raut *et al.* (2022) developed a DSS based on GIS and ERD for crop in Vidarbha region, with the importance of spatial and agronomic planning variable mapping.

wider global In a setting, (Guevara *et al.* (2024) utilized model-driven ERD logic in developing an prototype for an edge computing real-time data IoT-based agricultural model as is an important aspect for the design flow towards farm decision systems. ERD of fertilizer advisory systems and the potential influence of data structure and input decision accuracy was confirmed by Kumar and Kaur (2023). ERIC-based was used by Mohanty and Nayak (2020) in a resource management MySQL ERD design DSS for the tribal farmers of Odisha.

At India, Dwivedi and Thakur (2021) presented a domain-specific DSS model ER schema for horticulture *et al.* (2020) designed a scalable DSS backend for enterprise and Patel of Madhya Pradesh based on ERD principles. Verma, Shefali, agro-climatic zones Bhattacharya (2018) designed a livestock integration model and Deepak Kumar using ER-mapped inputs in combination with landholding and irrigation logic.

However, there are few framework for Jharkhand which can simulate and integrate publications on a DSS gap by proposing a modular the farming system parameters. This paper fills that ERD (Entity-Relationship Diagram) that used to implement DSS for IFS in Jharkhand. The schema is designed to take into account local variables, like irrigation limitations, and soil land situation (upland/midland/lowland), nutrient status (N P K), and enterprise preferences. We aim to provision a backend system for deployment, that sustains recommendation logic aligned with and the potential agro-ecological diversity of the region. farmer's objectives

Material and Methods

1. Research Design

framework To develop an ERD based for a DSS for IFS in Jharkhand, the explorative approach for conceptual and design procedures of system development is adapted in the study. The methodology consists of identifying important data elements, determining how these elements relate to one another, and developing a normalized schema that farmer level decision-making. will support multi-dimensional

2. Input Table Development

The front-end of the DSS is organized as a complete Farmer Input Table (FIT) for capturing essential attributes for localized and resource specific recommendations. farm/household

Key input fields include:

- Geographical block, village (drop-down lists) identification: State, district,
- Geo-coordinates Latitude and longitude (for geography)
- Attributes (upland, midland, lowland), size and irrigation status of land: Land types
- Irrigation & of irrigation (Kharif, Rabi, rainfed) b. Sources water resources a. Type of water (canal, tubewell, etc.)
- Soil parameters: Soil fertility status, nutrient tests (N, P, K; mg/kg or ppm)
- Type enterprise: Agriculture/Crops/ Livestock/Fishery/Lac/Apiculture, etc. (With of checkboxes)
- objectives: Economic Target net income (numerical value)

As illustrated, this and it is linked directly to domain OO entities table is a multi-modular intake form in the DSS.

3. Entity Identification and Relationship Mapping

Entities were conceptualized based on the fields in the input table and domain logic of integrated farming. The ERD includes:

The entities were fields in the input table and the domain logic of defined considering the integrated farming. The ERD includes:

- tbl_user_registration (Farmer profile)
- tbl_land_area_irrigation_situation (Plot mapping)
- tbl_soil_type, tbl_irrigation_situation, tbl_land _situation
- tbl_crop, tbl_crop_type, tbl_enterprise_ preference
- tbl_state, of location hierarchy) tbl_district, tbl_block, tbl_village (levels
- tbl_soil_test and tbl_income_projection

entities All of the are related with each other through foreign keys and composite relationships, preserving the integrity of the references. Many-to-many relationships (e.g., preference of enterprise vs. land) are resolved via junction tables for clean normalization.

4. ERD Construction

The ER Diagram is MySQL Workbench and it's like: created on

- Third Normal Form (3NF) to reduce redundancy.
- entity Explicit naming and datatype assignments.
- Scalability for integration with climate APIs, market pricing tools, and nutrition databases.

The entire structured tables that held visual richness regarding ERD unfolds as 18 spatial, agronomic, and socioeconomic components.

DSS Workflow Integration

According to the ERD, assumed DSS process is as follows: the

1. Farmer through a form-based GUI. inputs data
2. The backend. data are decoded into relational
3. The used to execute queries to: logic trees are
- Match suitable crops/livestock based on soil/land/water availability.
- Recommend enterprise mix per farmer's goals.
- Project income using soil test and yield potential.
4. Suggest mix for a farmer's objective. enterprise
5. Generate yield potential. income projections based on soil test and

Tools and Resources Used

- Modelling: Workbench, dB diagram. io MySQL
- Prototyping: Sheets MS Excel, Google
- Schema design principles: Based on ICAR, FAO DSS guidelines
- System Jharkhand farming system documents, soil test methodologies boundary:

Results and Discussion

A theoretical Jharkhand was formulated framework for a DSS on integrated farming systems in which led to the development of comprehensive ER design. ERD forms the basis for structured data storage where each of these inputs geographical, agronomic, resource-based, and economic related to the farmer are logically processing. connected for system level is to furnish The purpose of the DSS personalized, context-specific, resource efficient recommendations to farmers (especially small farmers) by converting raw data to actionable intelligence through a structured movement of data.

Entity Relationship Design Output

The final ERD joined thematic domains: geographic hierarchy, 18 core tables classified under six farmer and household profile, land and irrigation formation, soil and crop factors, climatic conditions, and enterprise economics is shown in Fig 1. This structure allows for referential integrity, reduced redundancy, and flexibility additional modules in the future (e.g. weather api, market price to extend to database, mobile advisory apps).

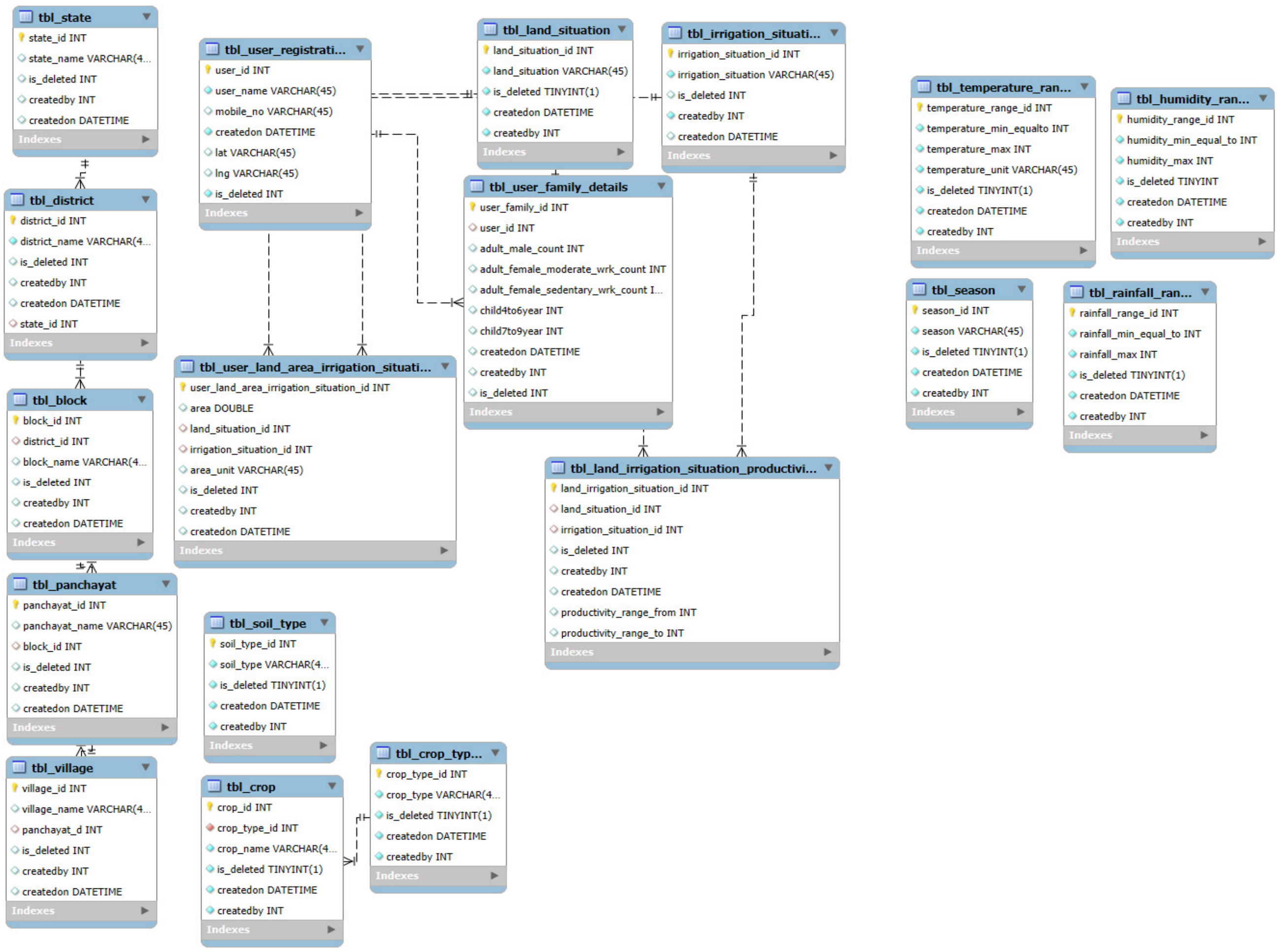

Fig. 1 : Entity Relationship Diagram (ERD) for the DSS in Integrated Farming Systems

Input Field Integration and Backend Mapping

The organized Farmer Input attributes for the DSS. It is characterized by Table is used as the main frontend data such as land status, irrigation status, soil test for N etc., soil test for P, soil test for K, and expected income, each of which can be mapped to a backend table in the ER, as can be seen in Table 1. This map is a way of persisting the module to farmer's nominees and its tier is a logic to process this from the module on a module side to the system side.

Table 1: Mapping of Farmer Input Fields to ERD Entities

S. No.	Farmer Input Field	Mapped ERD Table	Purpose
1	State	tbl_state	Geographic tagging for location-specific recommendations
2	District	tbl_district	Regional hierarchy management
3	Village	tbl_village	Last-mile targeting and analytics
4	Land Situation	tbl_land_situation	Determines terrain-based suitability
5	Irrigation Condition	tbl_irrigation_situation	Water availability for crop planning
6	Soil Test (N, P, K)	tbl_soil_test	Soil nutrient profiling for input advisory
7	Enterprise Preference	tbl_enterprise_preference	Activates enterprise-specific DSS modules
8	Expected Net Income	tbl_expected_income	Aligns decision outputs with farmer goals

Use Case Simulation: Conceptual Model

A conceptual test case with hypothetical inputs from the operational logic of the ERD. This the farmer were created to underpin experiment presents a concept and confirms the capacity of the proposed data multi-enterprise structure for interpreting farmer attributes into personal ideas of alternative. In district this simulated exercise, we consider a farmer belonging to the Ranchi of Jharkhand and having the following profile.

- Land: 1.5 acres (classified as Midland)
- Irrigation: Only Rabi irrigation available
- Soil Test Results: Nitrogen = 140 mg/kg, Phosphorus = 22 mg/kg, Potassium = 60 mg/kg
- Soil Fertility Status: Medium
- Enterprise Preferences: Crop and Livestock
- Expected Annual Net Income: Rs. 1,20,000

the backend logic designed from the ERD, With these parameters and implementing such indicative recommendations were provided as in the Table no 2 below.

Table 2 : Sample DSS Output Based on Simulated Farmer Profile

S. No.	Recommendation Module	System Output
1	Cropping Plan	Rainfed rice followed by Rabi mustard and seasonal fodder
2	Livestock Model	2 dairy animals integrated with vermicompost
3	Fertilizer Advisory	Compost enriched for low phosphorus and potassium
4	Enterprise Calendar	Crop-livestock integration with staggered schedule
5	Water Optimization	Rainfed Kharif; no Rabi irrigation
6	Projected Income	Estimated Rs. 1,15,000 (depend on yield potential)

System Readiness and Implementation Considerations

A robust conceptual foundation was formed by the designed ERD, for an Integrated Farming System-based DSS. The model comes with several advantages:

• Scalable : Modulized table design scaling to more regions or enterprises. allows easy Prevents

•Normalization: double entering and keeps data consistent.

• Relevance: Represents relevant factors in the real-world such as irrigation, fertility, enterprise and economic planning. preference

Ready • Integration-Ready: to integrate live data sources (weather APIs, market prices, soil health cards) in the future.

However, because this in the design stage, the findings are not field-tested. Actual study is implementation would require:

Data collection from actual farmers by field surveys,

• Independent review recommendations, and validation of the proposed implementation of a user interface (web or mobile), the DSS through

• Indicator of zones. performance across diverse agro-ecological

In order to have ERD has been logical grouping and facilitate subsequent system expansion, divided into six categories on a modular basis where each category corresponds to a vital dimension of the integrated farming ecosystem. All the 18 backend tables are listed in Table 3 based on its usage for the respective complexity support system (DSS) for Integrated Farming System in of the decision Jharkhand.

Table 3: Summary of ERD Tables by Functional Module

Module	Table Name	Description
Geographic Hierarchy	tbl_state	Stores list of states
Geographic Hierarchy	tbl_district	Stores districts within states
Geographic Hierarchy	tbl_block	Stores blocks within districts
Geographic Hierarchy	tbl_village	Stores villages within blocks
Farmer Profile	tbl_user_registration	Farmer identity and registration details
Farmer Profile	tbl_user_family_details	Demographic and household details
Land and Irrigation	tbl_land_area_irrigation_situation	Land parcel and irrigation type linkage
Land and Irrigation	tbl_land_situation	Classifies land as upland/midland/lowland
Land and Irrigation	tbl_irrigation_situation	Captures irrigation availability
Soil & Crop	tbl_soil_type	Soil classification categories
Soil & Crop	tbl_soil_test	Farmer-specific NPK values
Soil & Crop	tbl_crop	List of supported crops
Soil & Crop	tbl_crop_type	Classifies crops by type (Kharif, Rabi etc.)
Climate Parameters	tbl_temperature_range	Seasonal temperature bands
Climate Parameters	tbl_rainfall_range	Rainfall ranges for location-matching
Climate Parameters	tbl_humidity_range	Relative humidity data
Climate Parameters	tbl_season	Time segmentation into seasons
Economics	tbl_expected_income	User-defined income goal
Economics	tbl_enterprise_preference	Selected farming enterprises

The Geographic Hierarchy module includes tbl_state, tbl_district, tbl_block, and tbl_village, which collectively define the spatial hierarchy for tagging location-specific data. These are essential for generating localized recommendations based on agro-climatic conditions. The Farmer Profile module encompasses tables like tbl_user_registration and tbl_user_family_details, capturing core demographic and household attributes. These fields form the personalized foundation for any recommendation engine. In the Land and Irrigation module, tables such as tbl_land_area_irrigation_situation, tbl_irrigation_situation, and tbl_land_situation record details on terrain types and water availability. These are crucial for defining land use logic and crop-water compatibility. The Soil & Crop segment includes nutrient testing (tbl_soil_test), crop information (tbl_crop and tbl_crop_type), and soil classification (tbl_soil_type), forming the core of agronomic advisories. Climate-related attributes such as rainfall, temperature, and humidity are stored in the Climate Parameters module. Tables like tbl_temperature_range, tbl_rainfall_range, and tbl_season enable eventual integration with real-time APIs for seasonal planning. Lastly, the Economics module features tbl_expected_income and tbl_enterprise_preference, helping align DSS outputs with the farmer's economic aspirations and preferred enterprise combinations.

Benefits of This Structure: Key

- Provides and referential integrity. clean normalization
- Support types scalability. for region and farm
- Links up for potential future integrations with other APIs (weather, markets)
- direct Embraces coupling of data capture into logic flows (DSS).

Conclusion

This article demonstrates a systematic and modular model for structuring an Entity Relationship Diagram (ERD), which can be used as a base for developing a in Decision Support System (DSS) for Integrated Farming Systems (IFS) scalable schema to facilitate Jharkhand. The system provides a normalized, complex farm-level decisions using 18 core relational tables, which are grouped into six thematic modules that describe geographic hierarchy, farmer profiles, land- irrigation, soil-crop linkages, climatic parameters, and economic goals.

A structured Farmer collection. Input Table was developed to serve as the main front end for the real-time data table, allowing logical Individual input fields were associated with a backend coherence and modular extension. The simulated use case supported the inner logic of the schemata by demonstrating that farmer-tailored recommendations such as cropping plan, livestock incorporation and fertilizer recommendation even at the conceptual level. were possible

Though the present study not field-tested, the back-end model logic is strong enough to framework is of enable pilot application. The ERD aims to be extensible with external sources data like weather APIs, market intelligence systems, and nutrition databases. the real data of the farmers, it will evolve to a fully When implemented with implemented, adaptive DSS for regional requirements.

Future Directions

While the conceptual framework lays a strong foundation, its true effectiveness will emerge only through iterative real-world application. To go from design to deployment, design are key. The field validation, technology improvements, and user-centred the DSS is pathway that is expected to increase the utility and the value of described in the following manner:

Field validation and participatory redesign: Run on-site experiments in different agro-climatic technicians. zones of Jharkhand, and include the feedback of farmers and agrarian

User-friendly mobile/web interface: Develop simple and easy digital platforms for local with the DSS. relevance to ensure real time farmer interaction

AI/ML models demand prediction, integration: Implement predictive analytics for yield or pest alerts, and adaptive enterprise prioritisation.

API linkage: DSS with Integrate the DSS with APIs of weather, soil health and market price to provide context-aware advice.

Incorporation of sustainability metrics: Extend the ontology to evaluate ecological factors such soil health patterns. as input-use efficiency, carbon footprint, and

References

Chatterjee, S., & Narayan, V. (2021). Building farm-level intelligence using ER-diagrammatic logic: A case of eastern plateau zone. *Indian Journal of Farm Informatics*, **14**(1), 12–21.

Dwivedi, P., & Thakur, R. (2021). Entity-based modeling for horticultural DSS: A domain-specific approach. *Horticulture Informatics Journal*, **7**(1), 15–22.

Guevara, I., Ryan, S., Singh, A., Brandon, C., & Margaria, T. (2024). Edge IoT prototyping using model-driven representations: A use case for smart agriculture. *Sensors*, **24**(2), 495.

Gullick, A., Sinha, R. K., & Singh, R. (2005). Use of information technology in education. *Indian Psychological Review*, **64**, 179–184.

Gupta, V., Sharma, N., & Prasad, R. (2019). Design of a farm advisory system using ER modeling for Bihar farmers. *Indian Journal of Agricultural Sciences,* **89**(5), 815–820.

Jain, A., & Sinha, R. (2021). Normalized relational schema for soil health-based crop recommendations. *Journal of Farm Informatics*, **13**(2), 102–110.

Kumar, R., & Kaur, G. (2023). Fertilizer advisory system design using ERD and decision trees. *Journal of Precision Agriculture*, **19**(1), 55–66.

Mishra, U., & Barman, R. (2019). Decision support architecture for marginal farmers using DSSAT and ERD models. *Agroinformatics International*, **5**(1), 25–34.

Mohanty, A., & Nayak, S. (2020). MySQL-driven decision support system for tribal farming resource management. *Odisha Journal of Agricultural Systems*, **12**(3), 45–53.

Patel, S., Mehta, V., & Sharma, K. (2020). A DSS backend for climate-aligned farming decisions using relational data design. *Indian Journal of Agro-Economic Systems*, **66**(4), 390–396.

Raut, R. D., Kamble, S. S., & Ghadge, A. (2022). GIS-integrated decision support system for cropping pattern optimization in Vidarbha. *Computers and Electronics in Agriculture*, **195**, 106823.

Singh, B. K., & Chaudhary, R. (2018). Integrated decision support systems in Indian agriculture: Trends and gaps. *Indian Journal of Agricultural Economics,* **73**(4), 550–560.

Singh, R., & Yadav, N. (2022). Role of DSS in enhancing IFS adoption in rainfed regions. *Journal of Agricultural Management and Development*, **10**(4), 105–112.

Tripathi, P., & Pradhan, L. (2020). Smart DSS for nutrient and water optimization: A relational data perspective. *Water and Soil Informatics Journal*, **4**(2), 19–27.

Verma, M., & Bhattacharya, P. (2018). Integrated livestock model using land and irrigation variables in a DSS framework. *Livestock Technology Review*, **10**(2), 28–34.