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Integrating Water Management Practices with Modern Irrigation Technologies in Aalo, West Siang District, Arunachal Pradesh

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Abstract:
This research addresses the imperative of harmonizing traditional water management practices with contemporary irrigation technologies to ensure sustainable water use in Aalo, West Siang District, Arunachal Pradesh. Given the pressing need to optimize water resources for agricultural pursuits while upholding environmental integrity and socio-economic progress, a multidisciplinary methodology is employed. Aalo faces multifaceted challenges such as water scarcity, erratic rainfall patterns, and escalating agricultural demands. While traditional water management methods have historically upheld agricultural livelihoods, the advent of modern irrigation technologies presents promising avenues for bolstering water efficiency, crop productivity, and sustainable development. Through a mixed-methods approach, including quantitative analysis, qualitative assessments, and participatory research methods, the study endeavors to comprehensively understand water management practices and irrigation technologies in Aalo. Surveys, interviews, and field observations will facilitate the assessment of traditional water management systems' efficacy in mitigating water scarcity and supporting agricultural productivity. Concurrently, the study will evaluate the adoption and impact of modern irrigation technologies on water use efficiency, crop yields, and socio-economic indicators in the region. Anticipated findings are poised to unveil synergies and prospects for integrating traditional wisdom with modern irrigation practices to fortify sustainability and resilience in water management. Consequently, the study will offer actionable recommendations targeted at policymakers, agricultural extension services, and local communities. These recommendations encompass preserving traditional water management systems, promoting the uptake of modern irrigation technologies, fostering knowledge exchange, capacity-building initiatives, and nurturing community engagement in water management endeavors. Through these initiatives, the research aims to foster a holistic approach towards sustainable water management practices in Aalo, poised at the nexus of traditional knowledge and contemporary innovation.

Keywords: water management practice, irrigation, community engagement.

INTRODUCTION:

The study focuses on creating a well-thought-out plan for irrigation in Aalo, West Siang, Arunachal Pradesh. To develop guides how water is used for farming in this area. To ensure that farmers have access

to the water they need to grow their crops while also considering the sustainability of water resources and involving the local community in the planning process. To understand how much water is needed for crops in Aalo, West Siang. This involves studying factors such as crop water requirements, soil conditions, and climate patterns to determine the optimal water supply for agriculture. examining the current systems in place for supplying water to farms. This includes assessing the condition and efficiency of irrigation infrastructure such as dams, canals, and pumps to identify areas for improvement. To find out where things can be done better to make irrigation more efficient. This involves identifying bottlenecks, inefficiencies, and technological gaps in the existing irrigation systems and proposing solutions for enhancement. The local people in the planning process to ensure that the irrigation plan fits their needs. By consulting with farmers, community leaders, and other stakeholders, to gather insights and perspectives that will shape the development of the irrigation plan. It is crucial to ensure that the irrigation plan does not harm the environment and can be maintained in the long run. We will incorporate principles of sustainability into the plan, focusing on water conservation, ecosystem preservation, and resilience to climate change

The West Siang district in Arunachal Pradesh is heavily reliant on agriculture, with a major focus on cereals like rice, maize, millets, and wheat, as well as horticultural crops such as citrus, pineapple, banana, and medicinal plants like ginger and turmeric. However, crop productivity is higher under irrigated conditions compared to rainfed ones. Currently, the district faces a significant gap between water demand and availability. The gross cropped area spans 25011.08 hectares, with the majority of cultivation occurring during the kharif season (16229.58 ha) followed by the rabi season (4737.50 ha). Paddy constitutes over 70% of the gross cropped area, while oilseeds, pulses, coarse cereals, and horticultural crops share the remainder. The region's topography comprises lofty snow-clad mountains in the north and hilly terrain, with the Siang River forming a vital part of the district's topography. Despite the abundance of water resources in the valleys and foothill areas, groundwater development remains largely untapped. Existing irrigation schemes primarily rely on river sources, with limited scope for expansion due to water availability constraints. However, there is considerable potential for groundwater irrigation in areas like Aalo East and West, as highlighted by the Central Ground Water Resource Report. The present water demand in the district is estimated at 151.05 million cubic meters (MCM) annually, predominantly for crop production. However, the current water availability is only 38.05 MCM, indicating a significant shortfall. With projections indicating an increase in water demand, urgent efforts are needed to bridge the gap through sustainable water management practices. In Aalo, West Siang district, the focus should be on developing irrigation infrastructure, promoting rainwater harvesting, and enhancing groundwater utilization to meet the growing water demand for agricultural activities. This requires strategic planning and implementation of water conservation measures to ensure long-term sustainability and agricultural development in the region. Aalo, located in the West Siang district of Arunachal Pradesh, heavily relies on agriculture as the primary source of livelihood. However, agricultural productivity is hindered by the dependence on rainfed farming, leading to inconsistent yields. This literature review aims to explore the existing research and initiatives related to irrigation in Aalo, identifying challenges and proposing strategies for sustainable agricultural development. Aalo's agricultural landscape comprises predominantly cereal crops such as rice, maize, millets, and wheat, alongside horticultural crops like citrus, pineapple, banana, and medicinal plants. The district faces a significant gap between water demand and availability, with irrigated conditions showing higher crop yields compared to rainfed ones. Existing irrigation schemes primarily rely on river sources, with limited expansion potential due to water availability constraints during lean periods. Groundwater potential remains largely untapped, with feasibility for groundwater

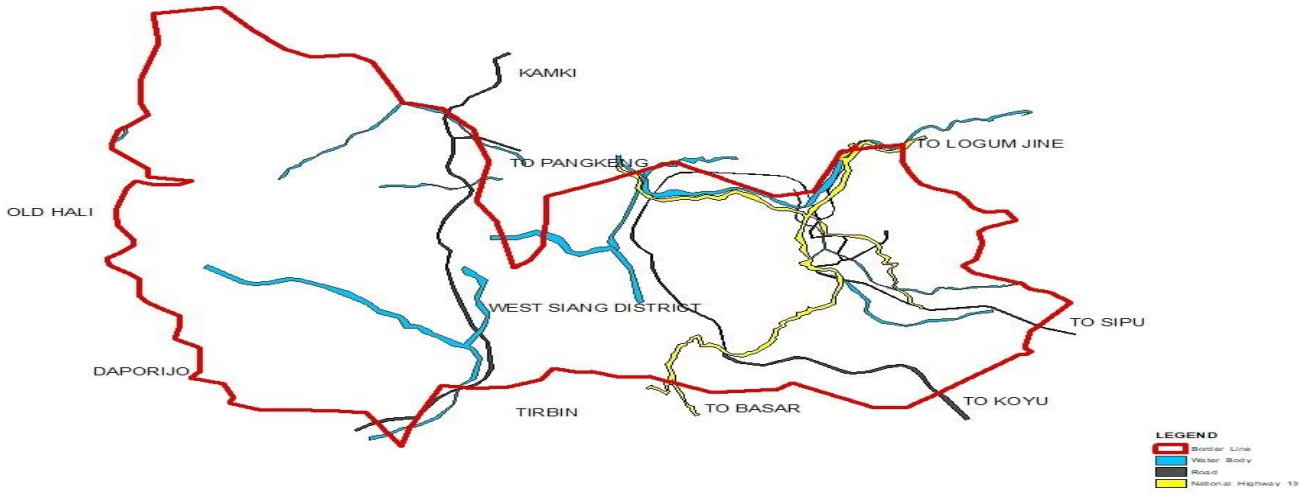
irrigation highlighted in certain areas like Aalo East and West. Limited groundwater development and reliance on rainfed farming pose challenges to agricultural productivity and food security in Aalo. Water scarcity during dry periods and the mismatch between water demand and availability hinder sustainable irrigation practices. Promotion of rainwater harvesting and soil conservation measures to augment water resources and mitigate the impact of erratic rainfall patterns. Development of efficient irrigation systems, including tube well construction and resistivity surveys, to harness untapped groundwater potential. Integration of community-based approaches, such as participatory water management and farmer cooperatives, to ensure the equitable distribution of irrigation resources. Implementation of policies and programs, such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), to incentivize states and stakeholders to invest in irrigation infrastructure and water management.

METHODOLOGY

In planning for irrigation development in West Siang District, Arunachal Pradesh, several key steps are essential. Initially, a thorough assessment of water availability, demand, and utilization patterns is conducted, taking into account factors such as crop types and seasonal variations. Identifying key stakeholders, including farmers, government agencies, and technical experts, is crucial to gather inputs and prioritize irrigation needs. Data collection involves gathering information on climatic conditions, land use patterns, and socio-economic factors to analyze gaps and opportunities for development. Stakeholder consultation through workshops and discussions ensures inclusivity in decision-making processes and goal setting. Clear objectives are then defined, aligned with broader development goals, and translated into SMART targets. Strategy development integrates various approaches such as rainwater harvesting and efficient irrigation technologies, with a focus on prioritizing interventions based on feasibility and potential impact. Detailed action plans are formulated to guide implementation efforts, with monitoring and evaluation mechanisms in place to track progress and make necessary adjustments. Capacity building initiatives and institutional strengthening support the enhancement of knowledge and skills among local stakeholders, fostering effective implementation and governance of irrigation policies and regulations.

BASE MAP- WEST SIANG DISTRICT, ARUNACHAL PRADESH

Figure 1 BASE MAP



DATA COLLECTION

Developing irrigation in West Siang, Arunachal Pradesh, would require a comprehensive approach that involves gathering data from both primary and secondary sources.

1. Primary Data Collection:

Field surveys are a critical component of gathering firsthand information for understanding and improving irrigation practices in West Siang, Arunachal Pradesh. These surveys involve physically visiting the region to assess various aspects of irrigation. Firstly, they entail evaluating the current irrigation methods employed by local farmers, which offers insight into the efficiency, sustainability, and challenges of existing practices. Secondly, identifying available water sources such as rivers, streams, ponds, or wells is essential to ascertain the potential for irrigation expansion and sustainability. Thirdly, conducting interviews with farmers, agricultural experts, and local authorities helps to understand their perspectives on irrigation needs, challenges, and potential solutions. Structured questionnaires and interviews gather information on irrigation practices, water requirements, crop types, and existing policies or initiatives related to irrigation development. Seeking expert opinions on suitable irrigation techniques and infrastructure requirements further enriches the understanding of potential solutions. Additionally, direct observation of irrigation infrastructure, water availability, and agricultural practices provides valuable insights into the practical realities on the ground. Systematically documenting these observations supports the research findings and informs future interventions aimed at improving irrigation efficiency and agricultural productivity in the region.

2. Secondary data collection:

Various sources are tapped to complement the firsthand information gathered from field surveys. Government reports and publications from local, state, and national agencies furnish valuable insights into the region's agricultural development plans, irrigation projects, and water resource management strategies. These documents shed light on existing policies and initiatives, providing a broader context for understanding irrigation challenges and opportunities in West Siang. Academic journals and research papers offer in-depth analysis and findings on irrigation techniques suitable for hilly terrains and their impacts on agricultural productivity and water conservation. By focusing on studies conducted in similar geographical regions, researchers can glean relevant insights applicable to the context of West Siang. Non-Governmental Organizations (NGOs) reports contribute additional perspectives, drawing on their on-the-ground experience and community-driven initiatives related to irrigation projects and best practices. Finally, leveraging remote sensing and GIS data enables researchers to assess land use patterns, water bodies, and terrain characteristics in West Siang with spatial precision. This information serves as a crucial foundation for planning and implementing effective irrigation infrastructure tailored to the region's unique geographical and environmental conditions. Integrating data from these diverse secondary sources enriches the research endeavor, providing a comprehensive understanding of the irrigation landscape in West Siang and informing evidence-based interventions for sustainable agricultural development.

DATA ANALYSIS

In 1980, a portion of West Siang district was transferred to East Siang district, and later in 1999, this area became part of the newly formed Upper Siang district. Notable archaeological artifacts discovered at the Malinithan site in West Siang are displayed at the Jawaharlal Nehru Museum in Itanagar. West Siang, now divided into Upper Siang and Lower Siang, covers an area of 8,325 square kilometers and ranks 9th in Arunachal Pradesh and 97th in India. Located at 28°15'N latitude, 94'75'E longitude, and an altitude of

578 meters, the district boasts 88.44% forest cover as of 2021. It shares borders with China, Upper Siang, Assam, East Siang, and Upper Subansiri districts. Major rivers flowing through the district include Yomgo or Siyom, Seit, Yangyapchu, Rimi, Sike, Shiet, Hiru 5, Sigen, and Hirik. The climate remains pleasant, with most rainfall occurring during the monsoon season, totaling 2127.2mm in 2021-22.

Figure 2 MAP OF WEST SIANG DISTRICT, ARUNACHAL PRADESH

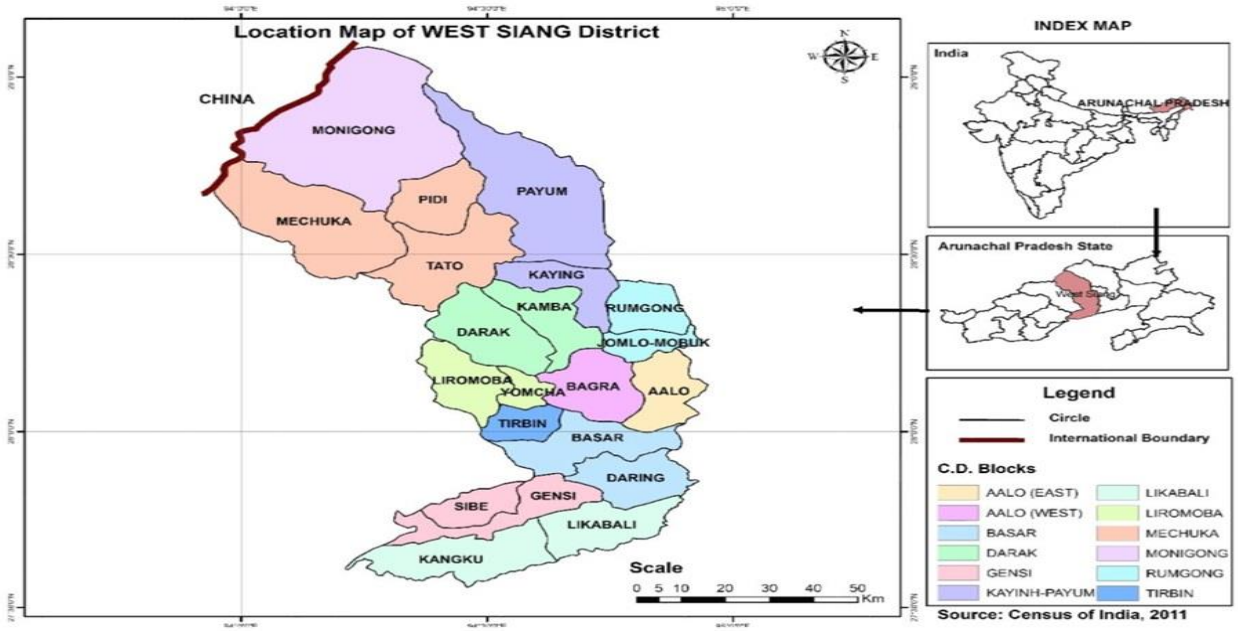


Figure 3 WEST SIANG DISTRICT

Administratively, West Siang is divided into 21 sub-districts, 2 towns, and 461 villages, with English as the administrative language. The district headquarters is located in Along Town, approximately 304 kilometers from the state capital. There are seven legislative assembly constituencies in the district, with the majority forming part of the Arunachal West Lok Sabha constituency.

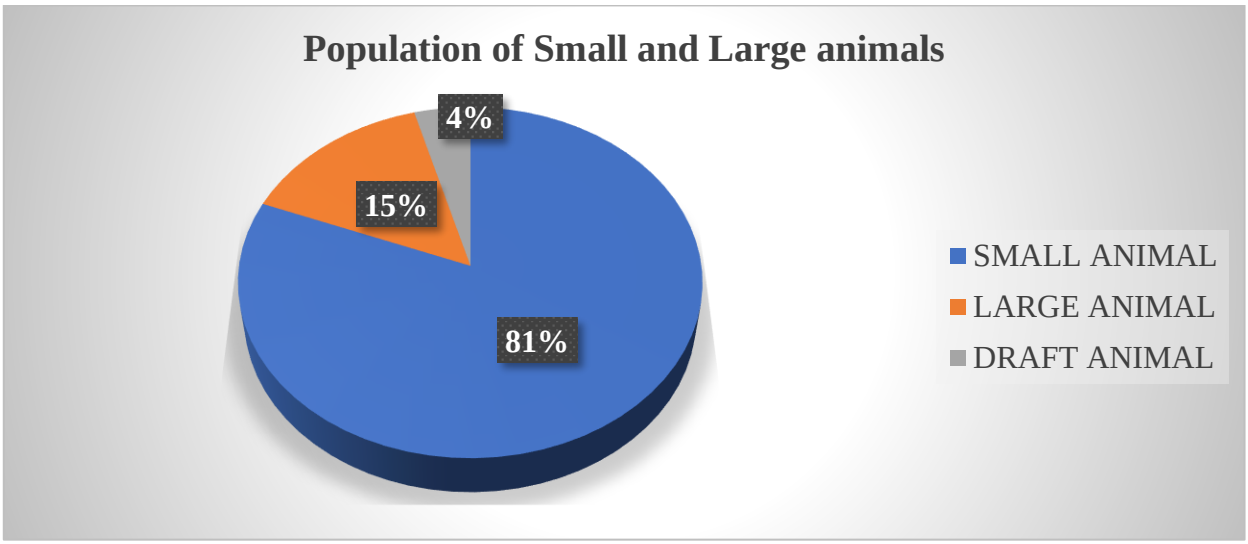
Figure 4CENSUS OF INDIA 2011, WEST SIANG DISTRICT

WEST SIANG, ARUNACHAL PRADESH			
AREA	BLOCK	VILLAGES	POPULATION
1661.27 sq. kms	12	461	112274
			Source: Census of India,2011

According to the 2011 census, West Siang had a total of 20,474 households and a population of 112,274, making it the 4th most populous district in Arunachal Pradesh. The population density is 22 persons per

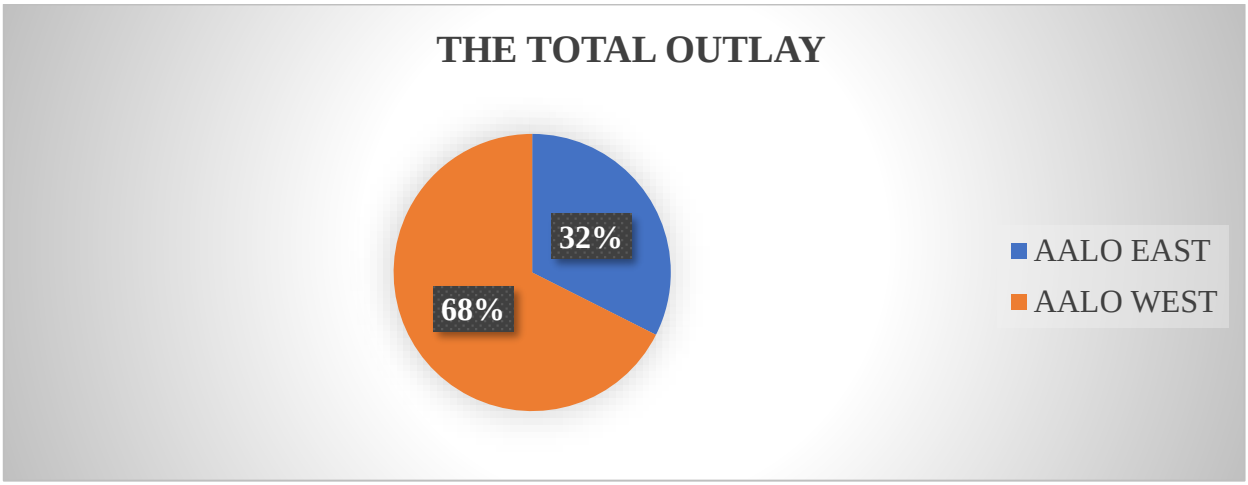
square kilometer, with a sex ratio of 930 females per 1000 males and a child sex ratio of 941 females per 1000 males. Christianity and Hinduism are the predominant religions, with a population growth rate of 8.04% from 2001 to 2011. Adi is the principal language spoken by 78.54% of the population.Economically, agriculture is the mainstay of the district, with more than half the population engaged in farming, producing high-quality paddy, millet, rice, ginger, potato, and other crops. The district also boasts rich mineral resources such as coal, graphite, limestone, marble, clay, and ferrous minerals. In 2021-22, the district's gross domestic product was Rs. 206,352 lakhs at current prices.Education-wise, the district has a literacy rate of 66.40%, with prominent educational institutions like Dorty-Polo Government College and North East Frontier Technical University. Tamiya Taga, from the Bharatiya Janata Party, is a notable political figure in Arunachal Pradesh, having served as a central minister of state for Urban Development. The district also boasts historical and religious sites like Malinithan, Akashiganga waterfall, and Mechuka monastery, drawing tourists from across the country.In West Siang District, there are currently 283 government and private canals supporting irrigation across 6571 hectares of land. These canals draw water from five perennial rivers and valleys: Siang, Kameng, Subansiri, Lohit, and Tirap, with River Beas as an additional source. However, during dry periods, only the Siang River reliably supplies water.Yet, there are areas like Aalo East, Aalo West, Gensi, Likabali, Darak, Mechuka, Monigong, and Rumgong Kaying-Payum that remain untapped for irrigation potential. According to the central groundwater resource report, these areas hold significant potential for groundwater irrigation.Demand for water sources The present water demand of the district has been assessed to be 151.05 MCM annually. Out of the total water demand, 144.99 MCM (95.99 per cent) is the required for crop production. Nearly 4.23 MCM is required for domestic and drinking purposes (2.80 per cent) and another 1.83 MCM (1.21 per cent) is required for livestock water requirement purpose. Among the blocks, Aalo East has highest water requirement with 35.19 MCM (23.30 per cent), followed by Aalo West with 26.82 MCM (17.75 per cent). As per Livestock census 2011, a total of 1,79,861 livestock was recorded.It has seen a decrease of approximately 13% in the total livestock population which was recorded as 2,06,670 during Livestock census 2007.

Figure 5 POPULATION OF SMALL AND LARGE ANIMALS IN WEST SIANG



Department of Animal Husbandry has stated that the main reason for this reduction is migration of youth from rural to urban areas and dwindling profits that accompany rearing of livestock.

Figure 6THE TOTAL OUTLAY OF THE WEST SIANG DISTRICT



The total budget for the district is Rs.107479.20 lakhs, divided among various blocks. Aalo West block receives the largest share, accounting for 25.36% of the total budget.followed by Aalo East block with 12.17%, and Darak with 9.50%.

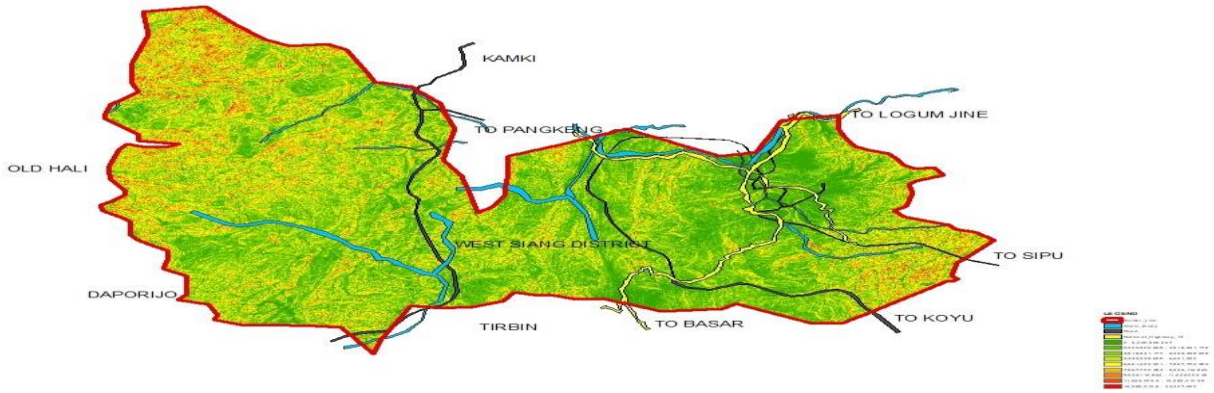
Figure 7 SOIL TYPE

SOIL TYPE AND PERCENT AREA COVERED BY DIFFERENT SOIL TYPE		
MAJOR SOIL (COMMON NAME LIKE SHALLOW RED SOIL, ETC	AREA ('000 HA)	PERCENT (%) OF TOTAL
LATERITE SOIL	516.2	62
ALLUVIAL	174.8	21
BLACK	141.5	17
SOURCE: AGRICULTURE CONTINGENCY PLAN OF DISTRICT, 2014-15		

The maximum area of district falls under the category of AES-2 which is medium altitude sandy clay loam. The soil type in Aalo, West Siang, Arunachal Pradesh, can vary, as the region may have a mix of soil compositions. However, in general, the soil types found in the state of Arunachal Pradesh are diverse due to its varied topography and climatic conditions.

Figure 8 CONTOUR MAP

Figure 9 SLOPE MAP ,WEST SIANG DISTRICT



RESULT AND DISCUSSION

The study found that the water needs for crops in Aalo, West Siang, Arunachal Pradesh vary depending on factors such as crop type, soil conditions, and seasonal variations. Through data analysis and consultation with local farmers, it was determined that there is a significant demand for irrigation water, particularly during the dry seasons. This highlights the importance of ensuring adequate water supply for agricultural activities to support crop growth and enhance productivity.The assessment of existing irrigation infrastructure revealed both strengths and weaknesses in the current systems. While there are government and private canals in place to irrigate a substantial portion of the agricultural land, the reliance on river sources poses challenges during lean periods. Moreover, the lack of alternative water sources such as tube wells limits the flexibility and resilience of the irrigation systems. Addressing these infrastructure gaps is crucial for improving water access and efficiency in agricultural practices.Several improvement areas were identified to enhance irrigation efficiency and sustainability in Aalo. These include investing in rainwater harvesting and groundwater recharge systems to supplement surface water sources, promoting the adoption of efficient irrigation technologies such as drip and sprinkler systems, and implementing measures for soil moisture conservation. Additionally, there is a need for capacity-building initiatives to empower local farmers with knowledge and skills in water management and conservation practices.Community involvement emerged as a key factor in the development of an effective irrigation plan. Engaging with farmers, community leaders, and relevant stakeholders allowed for the identification of local priorities, preferences, and concerns regarding water use in agriculture. This participatory approach ensured that the strategic plan was tailored to meet the specific needs and circumstances of the local population, thereby enhancing its relevance and acceptance.The study emphasized the importance of incorporating principles of sustainability into the irrigation plan to minimize environmental impacts and ensure long-term viability. Strategies such as promoting water-saving practices, adopting climate-resilient crop varieties, and integrating ecological principles into irrigation management were proposed to enhance the sustainability of agricultural production in Aalo. By prioritizing environmental conservation and resource stewardship, the irrigation plan aims to support both current and future generations of farmers in West Siang.

PROPOSAL

The proposal to address water scarcity challenges and enhance agricultural sustainability in West Siang District, Arunachal Pradesh, through the promotion of efficient irrigation technologies, capacity building

for farmers, implementation of rainwater harvesting systems, and construction of tube wells and groundwater recharge facilities.

1. **Promotion of Efficient Irrigation Technologies:** Efficient irrigation technologies such as drip and sprinkler systems offer precise water application, minimizing water wastage and maximizing crop yield. The proposal includes: Conducting awareness campaigns and workshops to educate farmers about the benefits and proper use of drip and sprinkler systems. Providing financial incentives and subsidies to encourage farmers to adopt these technologies. Collaborating with agricultural extension services and private vendors to facilitate the procurement and installation of drip and sprinkler systems.
2. **Training and Capacity Building for Farmers:** Training and capacity building are essential to ensure farmers effectively utilize water-efficient agricultural practices. The proposal involves: Organizing training programs on water-efficient irrigation techniques, crop water requirements, and soil moisture management. Establishing demonstration plots to showcase the effectiveness of water-saving practices and technologies. Facilitating farmer-to-farmer knowledge exchange and peer learning networks to promote adoption and dissemination of best practices.
3. **Implementation of Rainwater Harvesting Systems:** Rainwater harvesting systems can augment surface water sources, particularly during the monsoon season. The proposal includes: Conducting site assessments to identify suitable locations for rainwater harvesting structures. Installing rooftop rainwater harvesting systems in households and community buildings. Constructing check dams, percolation ponds, and recharge wells to capture and store rainwater for agricultural use. Providing training on maintenance and management of rainwater harvesting systems to ensure long-term functionality.
4. **Construction of Tube Wells and Groundwater Recharge Facilities:** Harnessing groundwater resources through tube wells and recharge facilities is crucial for ensuring water security in West Siang District. The proposal involves: Conducting hydrogeological surveys to assess groundwater availability and recharge potential. Constructing tube wells equipped with efficient pumping systems to access groundwater for irrigation. Implementing recharge structures such as percolation ponds and infiltration basins to replenish aquifers. Training farmers on sustainable groundwater management practices and monitoring groundwater levels to prevent overexploitation.

CONCLUSION:

In conclusion, the strategic planning of irrigation in West Siang, Arunachal Pradesh, holds significant promise for enhancing agricultural sustainability and community well-being. Through the assessment of water needs, evaluation of existing infrastructure, and identification of improvement areas, this study has laid the groundwork for developing a comprehensive irrigation plan tailored to the unique needs and circumstances of the region. By involving the community in the planning process and considering principles of sustainability, the proposed strategic plan aims to address challenges related to water scarcity, infrastructure limitations, and environmental impact. By fostering efficient and sustainable agricultural practices, the plan seeks to contribute to the overall prosperity and resilience of the region's agricultural sector. However, it is important to acknowledge the limitations of this study, including constraints related to funding, technical resources, and regulatory frameworks. Addressing these limitations will be essential for the successful implementation of the proposed irrigation plan and for overcoming challenges associated with unpredictable weather patterns and existing legal constraints.In summary, the findings of this study provide valuable insights and recommendations for policymakers, agricultural authorities, and

local communities in Aalo, West Siang, guiding them towards the development and implementation of a strategic irrigation plan that ensures the long-term sustainability and prosperity of the region's agricultural sector.

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