Shepherding the Digital Revolution: Smart Sheep Breeding

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Mary had a little lamb
Its fleece was white as snow
If only she had a smart tool
To track it on the go!

Could she get this little tool?
And get it very cheap
And make her farm really smart
with the Internet of Sheep?

A young researcher dreamt this dream. She did so because she, like Mary, loved animals and also like the other Marie (Curie), she loved science. She also grew up in the beautiful Valley of Kashmir where sheep are an integral part of the pristine landscape. The union territory of Jammu and Kashmir (J&K) in India has two divisions, one of which is Kashmir.

Sheep rearing has been practiced in this part of the world since time immemorial, yet this sector is underperforming. Kashmir offers nutritious pastures and favorable climatic conditions for the sheep to thrive; they in turn provide mutton, wool, pelt, manure, and even company to the locals. Mutton is the meat of choice in this region and a major ingredient of *Wazwan*; the traditional multicuisine scrumptious feast. Their wool is prized too, as it is soft and warm like a hug during bitter winters.

Despite all this, there is a chronic demand-supply gap, which means animals have to be imported in large numbers from other states. As per a Government report, about 1.5 million sheep and goats are imported into J&K annually, most of which are sheep. The situation worsens during snowy winters when the National Highway, the only road linking J&K to the rest of the country, closes. Prices inflate causing an economic burden of a whopping 10.500 billion rupees ($126.45 million) per year.

Unable to turn a blind eye to this mammoth issue, she conducted an extensive survey which revealed a crucial lacuna: farming practices were and still are unscientific and age-old, resulting in suboptimal usage of all resources. Livestock businesses, like all enterprises, require wise decision-making for profitability and sustainability. This can only be done using reliable and accurate data. Since this is not available to the farmers, most of their decisions are intuition-

based and imprecise. Even government-run farms face the same issue. There is also almost no scientific selection of animals, which is otherwise necessary to breed the best animals for producing superior progeny. Therefore, sheep of high genetic merit end up in slaughterhouses. Also, there is no system in place to link sheep farmers to veterinarians. A consolidated market for sheep and sheep products doesn't exist either.

This insight brought up a tirade of new questions in the mind of the curious researcher. "Doesn't Australia have agroclimatic conditions similar to Kashmir, yet its economy is said to be riding on sheep's back? What could we do to attain a similar kind of self-reliance and ensure that sheep farmers could double, triple, or even quadruple their incomes?" she asked.

She knew that the answer lay in her dream; the all-embracing technological revolution could come to the rescue of this sector and possibly revolutionize it. Disruptive technologies like Artificial Intelligence (AI), e-commerce, and IoT (Internet of Things) had to somehow be brought into the households of sheep farmers. The idea was to build a powerful and intelligent Decision Support System (DSS) to provide all possible assistance for successful sheep farming. However, hitting upon the solution was not enough, there still was a major implementation problem. A person capable of developing such a tool had to possess sound knowledge of veterinary and animal sciences, advanced statistics, and machine learning (ML) as well as the ability to translate it into digital technology using computer sciences. The glitch: there was no such person around her!

So, despite being a biologist and despite the tangible gender stereotype in technology, she decided to step into interdisciplinary research and become that change agent. For this, she took up multiple additional courses to build a strong knowledge base. It was a leap of faith that, if successful, would yield enormous socio-economic benefits. In the words of Bradbury, "Jump off the cliff and build your wings on the way down".

Thus, with support from her mentor, she succeeded in developing India's first, AI and IoT based multi-use online DSS for sheep farms. This tool includes a web-based application and an Android app. IoT-based data capture devices are also being incorporated into the system. These tools would ensure that all sheep data could be communicated over the internet to the farmers' devices, the internet of sheep!

The DSS that she built is a multi-use tool catering to all aspects of sheep farming. It automatically collects farm data and uses it to generate useful information for decision-making. This hybrid tool effectively blends the power of science and technology with the art of management. Its core has been built using knowledge from genetics, veterinary sciences, management, statistics, information technology and AI. This tool is capable of e-linking all farms and selecting the best animals (based on their genetic merit) across all these farms. These

superior animals can then be used for producing generations of highly productive animals throughout J&K ultimately resulting in increased returns (Figure 1).
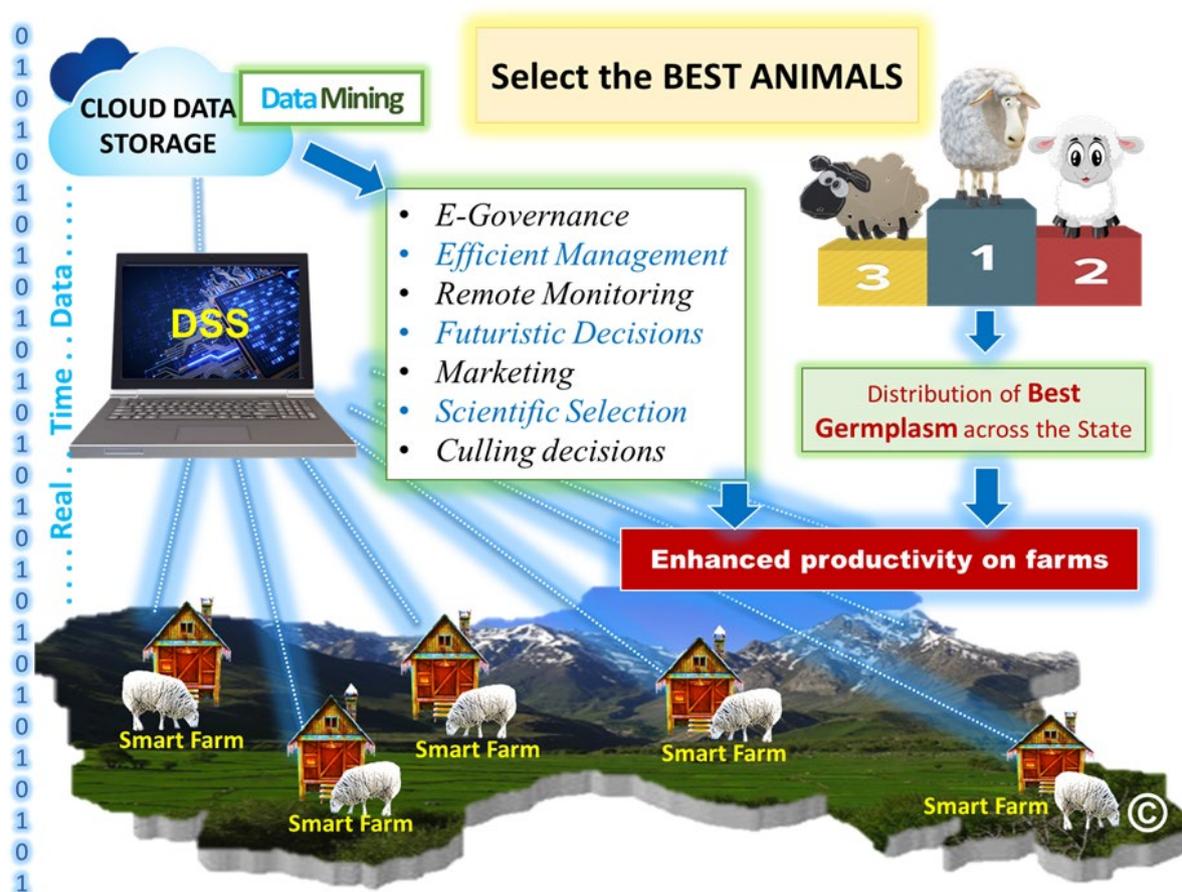

Figure 1[1]: E-linking sheep farms across J&K

The DSS generates more than 40 types of real-time, custom-tailored reports and lucid graphs on all aspects of each farm. It also provides specific farming assistance and support on animal feeding, management, health, welfare, and farming schedules, only to name a few. It is also a useful e-governance tool wherein the administrators can remotely monitor the activities of all farms under their jurisdiction in real time and make futuristic decisions. The tool provides an effective marketplace (*e-mandi*) for the sale and purchase of sheep and their products, and also has an inbuilt intelligent health services network so that veterinary services can be a click away at all times. It also has integrated AI-based models for making farm-related predictions. In addition, machines that could enable automatic data gathering over the internet are also part of this system. These are capable of gathering many kinds of data including biometrics and images. The development of such IoT enabled devices was a part of her National Post Doctoral

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[1] Graphics designed by the Author.

Fellowship in India. She firmly believes that if big data collection could be automated, it would be the fuel that powers the future.

Due to its wide-ranging utility, this DSS has been very well acknowledged in diverse forums. For this idea, the researcher was declared as one of the winners of the India Innovation Growth Programme-2.0 (An initiative of Dept. of Science and technology, Govt of India, Lockheed Martin, and Tata Trust). She also won the Dr. N.S.R. Sastry Young Scientist Award, Sri. Thirunahari Murahari Award for Young Lady Scientist, Sri. Cherala Bhagya Raja Ram Award for Innovative Research and many other awards for this work. She, along with her mentor, has filed a patent application and has also been granted a copyright for the same.

This decision support system has been officially released and also adopted in the J&K's Livestock Breeding Policy. Nearly all Government sheep farms are registered with the system and private entrepreneurs are jumping in too with positive feedback.

The usability of this tool is not limited to Kashmir, and it can be extended to other regions and also to other livestock species. The idea was planted as a seed in her M.V.Sc which developed into a sturdy, deep-rooted tree during her PhD and it is still growing with her Post Doc. Now she is at UW Madison: an institute par excellence, as a Research Associate. UW Madison is widening her horizons and opening doors she did not know existed. She is using computer vision technology to identify animals, analyze their behavior, detect health issues, and make predictions for the future. She believes that computer vision could practically make us look at the animal world with new eyes! Her ultimate goal is to identify and breed resilient animals that can thrive in challenging conditions, ensuring food security, socioeconomic upliftment and improved welfare, today and tomorrow. By combining the power of next-generation technologies and animal genetics, she's working towards a better world for all creatures, great and small.

Mary now has many lambs
They all are the very best
She makes money on the go
and finds the time to rest