# Sorghum Database Development to Enhance Technology Spillovers

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## Introduction

For the last 25 years, joint efforts by ICRISAT and national agricultural research systems (NARS) have generated many improved cultivars and management practices to increase sorghum productivity throughout the world. These technologies are usually targeted at a particular environment or location. However, many of these technologies have been adopted beyond the target environments. For example, ICSV 112 (SPV 475) was primarily intended for India, but was released in Mexico (UNAL 1-87), Nicaragua (Pinoleso), and Zimbabwe (SV 1). This variety yields 3.4 t $ha^{-1}$ and matures in 115-120 days (ICRISAT 1990). Another ICRISAT sorghum germplasm line, IS 9830, has been released in Sudan as a *Striga*-resistant variety named Mugawim Buda 2, and as IS 2391 and IS 3693 in Swaziland (Mengesha 1993). It has also been adopted in *Striga*-affected areas elsewhere. Applicability of a technology beyond its target environment is termed 'technology spillover'. Such spillovers may occur randomly or through planned intervention. Randomly occurring technology spillover depends on chance, while planned spillover depends on well informed and judicious intervention in research and development. Careful and systematic consideration of all critical factors (agroecological, biological, and institutional) should be followed by conscious efforts to realize any planned spillovers. The identification of potential spillovers, and the steps needed to realize these spillovers, can be fostered by creating a database containing all relevant information.

This paper discusses the importance of a sorghum database for enhancing technology spillover among CLAN member countries, and presents the types of data to be assembled, maintained, and distributed among research partners for this purpose.

## Role of the Sorghum Database in Enhancing Spillovers

Resources for agricultural research are becoming increasingly scarce. Fund scarcity demands more efficient utilization of available resources and greater collaborative efforts among scientists in different institutes or countries to generate indirect benefits via technology spillovers. The extent of potential spillover of an agricultural technology depends on agroecological similarity (usually measured by rainfall, temperature, seasonal distribution of rainfall and temperature, and soil type and quality). Realization of

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potential spillovers, i.e., actual spillover, is influenced by such factors as historical and cultural links between countries, geographical proximity, institutional factors (e.g., research networks, quarantine laws, property rights), and the complexity of the problem (Byerlee 1997).

Exchange of information and technology and collaborative research efforts are vital for technology spillover. Several regional sorghum research networks operate — CLAN in Asia, the SADC/ICRISAT Sorghum and Millet Improvement Program (SMIP) in southern Africa, the West and Central Africa Sorghum Research Network (WCASRN), and the Comision Latinoamericana de Investigadores en Sorgo (CLAIS) in Latin America. These networks provide a forum for regular exchange of information and research products and for joint research planning. For example, collaboration under SMIP has led to the full integration of ICRISAT's program into national research and extension systems in southern Africa.

Research partnerships and channels for information exchange among Asian sorghum scientists are in place. Initially, these operated through the Cooperative Cereals Research Network (CCRN), which had a mandate extending beyond Asia. Partnerships for legumes research operated through the Asian Grain Legumes Network (AGLN), which was solely Asian. The Cereals and Legumes Asia Network (CLAN) was formed by merging AGLN and CCRN to establish a unified network for all ICRISAT mandate crops. It was envisioned that collaborative breeding research to develop cultivars adapted to local conditions, and exchange of germplasm and breeding populations with sources of resistance to major stress factors, would be major areas of collaboration among the network member countries (Byth 1993).

International nurseries and trials and germplasm exchange were helpful for sorghum crop improvement in the past. But this approach was not cost effective since the majority of the lines distributed were not useful to the recipient countries. Consequently the emphasis has changed to supplying specific, improved breeding material. Germplasm distribution has also shifted from unrestricted distribution to a system that is selective and responsive to requests from users. In addition, member countries can exchange materials (germplasm/varieties) bilaterally or multilaterally. Currently available technologies in the region can help improve productivity in other member countries, providing spillover benefits. For example, sorghum cultivars developed in India seem very promising for use in Thailand and Indonesia. In the same manner, improved cultivars released by different member countries may also be useful in other countries.

A major constraint to realizing technology spillovers among network member countries is the lack of information. Information gaps can be minimized by developing and maintaining a consistent system of data collection, processing, and dissemination. A database containing information on elite cultivars in the region would encourage targeted and efficient exchange of germplasm. The database would also help quantify the impact (both direct and spillover) of collaborative research, development, and diffusion by ICRISAT and the national programs. Development of a sorghum database is one of the proposed objectives of Asian sorghum researchers: "to develop efficient databases and sharing of information". The recommendations of the 1993 sorghum researchers meeting also included such a database as one of the objectives of CLAN (Gowda and Stenhouse 1993), but this has not yet been realized.

## Minimum Data Requirement

Four types of data need to be maintained in the sorghum database. These are: recommended sorghum cultivars and their characteristics, status of sorghum cultivation, research capability, and economic factors affecting sorghum production.

### Sorghum cultivars and their characteristics

The first requirement for the database is a complete list of all recommended sorghum cultivars in different countries and their characteristics. This should include information about origin of the cultivar, type of cultivar (i.e., variety or hybrid), pedigrees, the year of release, morphological characteristics (grain color, insect and disease resistance), ecological niches (humid, subhumid, moist semi-arid tropics, dry semi-arid tropics) for which they are released, commercial success (area cultivated), and the reasons for release (grain, forage, dual purpose, etc.). This information will help scientists understand what elite cultivars are available in different countries and where else they could be useful. Information about the performance of enhanced germplasm materials and their traits observed during the Advanced Line Adaptive Research Trials (ALART) in each country would also be useful. National breeding programs can utilize elite cultivars and advanced lines available in other countries and thereby increase their own research efficiency.

### Status of sorghum cultivation

Information on the status of sorghum cultivation (area, production, yield) in different countries by environment and by cultivar will provide a clear understanding of the spread and popularity of different cultivars. Therefore, information on area under different cultivars (hybrids, improved varieties, local varieties) must be an integral part of the sorghum database. The composition of sorghum cultivars grown in farmers' fields changes over time. New cultivars often replace old ones for different reasons such as higher yield or resistance to biotic and abiotic stresses. Information on the spread of different cultivars and cultivars replaced by the new releases will help understand the comparative advantage of different cultivars at farm level. Information on yield gaps between farmers' fields and research stations, and the reasons for such yield gaps, will also be useful for this purpose.

### Research capability and infrastructure

The level of research capacity by public and private research organizations is also important for technology spillover. Information about research capacity reflected through the number of scientists involved in sorghum improvement in public and private research organizations is important for the database. Information on subsequent efforts to promote and produce improved seed (number of seed companies operating in the country) will provide a clearer perspective of efforts on sorghum productivity enhancement in each country.

## Economic factors

Time series information on economic factors affecting sorghum production (consumption, prices of inputs and outputs, credit availability, price support by the government, demand and supply elasticities) are important components of the database. If this information is compiled for different regions, provinces, and districts for each country, it can be analyzed to understand the spatial and temporal influence of these economic factors on sorghum production. This will help design appropriate policy packages to boost sorghum production.

# Ongoing Efforts at ICRISAT

ICRISAT has already started assembling the information required to build a sorghum database. The Research Evaluation and Impact Assessment (REIA) compendium (Bantilan et al. 1998) contains a list of sorghum cultivars developed and released in different countries using ICRISAT-supplied material. Adoption data are collected through country-level studies conducted under the impact assessment project. Secondary data aggregated at the state and district level for area, production, yield, and adoption of high-yielding varieties are also included in the project database. CLAN has also collected some information. However, the data collected on released cultivars and their characteristics are incomplete; information gaps remain for certain variables. To fill these gaps in cultivar-related information, the spillover impacts study team has sent questionnaires to the different NARS. Eventually a comprehensive list of all released cultivars, along with their traits and area cultivated, will be compiled.

As part of the 'Spillover Impacts Study', the REIA project is analyzing FAO data on area, production, yield, and sorghum prices for all sorghum-producing countries for the period 1961-96. For India, the analysis will cover the period 1966-94, using district-level data on sorghum area, production, and yield, and monthly rainfall collected from the Directorate of Agriculture of various states. Similar data need to be compiled and computerized for all other member countries.

Once compiled, the data should be systematically documented and updated. Systematic development of a database requires:

- A data-file naming convention applicable to information from all countries
- A standardized file structure for each type of data, and data file linkages to eliminate duplication
- A file entry and retrieval system that facilitates retrieval and analysis.

# Conclusions

Information is the key to planned development. And in order to enhance technology spillover among CLAN countries, it is vital to have fast, easy access to accurate information. Providing the right information to the right people at the right time will help maximize technology spillovers. A carefully documented sorghum database can serve as the information source for this purpose. Being an international institute, ICRISAT should take up leadership in assembling, maintaining, and disseminating such data to enhance both germplasm exchange and technology spillovers among CLAN countries.

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