Summary of Scope of Work

Funding is requested to supplement the research currently supported by NSF grant #0314404, "Biotechnology and the Political Ecology of Information in Andhra Pradesh." This 2003 proposal concerned the introduction of Bt cotton as the first genetically modified (GM) crop in India; however its scope went beyond the controversies over that new technology's performance, to address larger theoretical questions on social aspects of information access, management skill, and technology adoption.

The past few years have brought intense debates on how farmers (especially in developing countries considering GM crops, such as India) made decisions on technology. The dominant perspective is of the farmer as a discriminating farm manager, making independent choices based on what was has come to be called *environmental learning* (referring to the farmer's own observations of agronomic phenomena). This perspective, shared by such stakeholders as Monsanto (Hindu 2002), pro-industry farm leaders P. Chengal Reddy, and international agricultural administrator and now professor Per Pinstrup-Anderson (Pinstrup-Anderson and Schioler 2001:108), is epitomized by Andhra Pradesh Agriculture Minister V. S. Rao: "let the farmers finally decide on the usefulness of Bt cotton . . . farmers are wise enough to adopt anything good and discard things that do not work" (Venkateswarlu 2002). The assumption is that agricultural decision-making such as technology adoption is driven purely by environmental learning.

Social science has long recognized a critical social aspect to technology adoption, but traditionally [this approach] treated this social aspect as a special case of environmental learning. Ryan and Gross's (1943) classic study of adoption of hybrid corn by Iowa farmers, early adopters got information on the seed from salesmen, but after that, most farmers learned from the experiences of adopters, and from their own experience with small trials. Thus the take-off in adoptions, leading to the famous S-curve, was not driven by purely social processes, but by environmental learning from both direct observation and social "harvesting" of others' environmental learning. Subsequent models have gradually recognized more purely social aspects to technology adoption (or decision-making in general). Granovetter's (1978) threshold model interprets innovation adoption as a function number of other adopters. Boyd and Richerson (1985) distinguished between environmental learning and cultural transmission biases that are instrumental in human behavioral change, and subsequent work has applied this approach to agricultural technology adoption (e.g., Henrich 2001).

The current project uses the special case of GM cotton in India to develop theory on social aspects of agricultural decision-making in new directions. Its core questions center on the social and political dynamics of "agricultural skilling," defined as the processes of acquiring information and adopting management practices based on that information:

(1) How does the pace of technological change affect adoption and agricultural skilling? Rate of change tends to be ignored as a potential problem for Third World smallholders, and high rates of change are lionized in writing that often equates "latest technology" with desirability.

(2) How so the unique characteristics of transgenic crops affect the social process of skilling? Farmers cannot "skill on" all aspects of production: learning which laborers are the most reliable or how to apply a fertilizer is quite different from learning to evaluate a seed market into which CRY genes are being introduced into different germplasms.

(3) How do the interventions by parties with stakes in GM struggles, who are engaged in a global rhetoric war (Stone 2002a), affect agricultural skilling? Previous models have been largely devoid of information politics, but farmers in small Indian villages are being inundated by lobbying efforts funded transnationally. What is the outcome when intensive "manipulated transmission" meets the indigenous technical knowledge emphasized by many anthropologists?

(4) How so the new GM seeds and their attendant campaigns affect several NGO-based "reskilling" movements seeking to promote non-chemical integrated pest management.

The research venue is Warangal District, a cotton-growing area in Andhra Pradesh. Warangal was also the site of an epidemic of suicides by cotton farmers that has been used by both GMO proponents and opponents as support for their case (Stone 2002b). The research plan began with an agricultural ethnography of villages in two mandals differing in ethnic makeup, prosperity, education, and involvement in cotton cultivation.[1] Main information sources for the ethnography were (a) an agro-economic census over several hundred households, (b) a detailed farm management analysis in which carefully trained recorders noted all labor, inputs and outputs in a sample of 12 farms,[2] (c) a set of detailed farmer interviews on management and decision-making, (d) an analysis of various (mainly NGO-based) IPM programs in Warangal, and (e) a multi-year study of information flow in Warangal, including news and advertisements and farmer meetings. The fieldwork also has a major ethnographic component, including me spending much of two summers in Warangal and one winter research trip, with other data gathering managed by collaborators A. Sudarshan Reddy and Robert Tripp.

Progress to Date

Fieldwork to date has been quite productive. Two large household agricultural censuses have been collected. The 2003 census focused on the 2 mandals discussed in the proposal and provided the basis for a preliminary analysis. In 2004 an enhanced agro-economic census was designed with A. Reddy; it comprised improvements based on the 2003 experience, and added a detailed decision-making schedule for each crop grown. For 2004 the study area was also expanded to include villages in 3 other mandals (including one with an extremely high commitment to cotton, and one with very little cotton and more “traditional” information flows and management practices). This census was trialed and collected between July-October 2004, entered and checked in November. It then underwent preliminary analysis in December, producing intriguing findings discussed below.

The detailed farm inputs study has proceeded well, and has been extended to collect two complete years for both areas (one a fairly prosperous literate area, the other a poor illiterate area). The importance of the 2-year datasets is discussed below.

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[1] India is divided into large states, which are divided into districts, which are divided into mandals. A typical US county is between a district and mandal in size.

[2] This was an enhanced version of a research method used extensively by Stone, Netting and Stone (1990) in Nigeria.

The majority of the detailed skill interviews have been completed, and these interviews along with general participant observation have greatly strengthened my ethnographic depth and ability to interpret patterns of agricultural decision-making.

Robert Tripp has conducted interviews on reskilling movements and on the dynamics of the Indian cotton seed market and contributed two substantial reports which have been invaluable. He is likely to conduct one more period of fieldwork this year.

Preliminary analyses of the 2003 agro-economic household census and the intensive farm inputs datasets were conducted in spring 2004 to check the instruments and to give direction for adjustments in subsequent data collection. Some findings from this work, and including farmer interviews and monitoring of information flows, were used in the first publication on this research (Stone 2004). That article analyzes different categories of information in the skilling process, and shows how skilling in cotton production was impeded even before the arrival of GM cotton in 2002. The model of the ignorant cultivator in need of a technological fix may be a misinformed caricature (as many anthropologists and geographers have argued), but at the same time there are crucial blind spots in the countervailing model of the ingenious peasant. I described three general impediment to information flow that can cripple the skilling process, and then showed how the arrival of GM crops have exacerbated the already-serious problems in flow of all three types of information. The article also broached some new relationships between environmental learning and cultural transmission processes. For instance, it pointed out one of the political aspects of conformist transmission bias: GM crops have brought to Warangal an intense struggle over the *appearance* of conformity, with both corporate interests and green NGO's pushing their own summaries of adoption patterns.

Rationale for Continuing Research : Culture and Unpredictability

The principal aim of supplemental funding is to support a study of cultural responses to unpredictability (a secondary aim is to support a Research Experience for Undergraduates project, described in a separate section). The recent preliminary analysis of the 2004 census has brought to light a pattern in agricultural decision-making that is not only remarkable in its own right, but also highly suggestive of a line of empirical research that bridges with recent theory-building in behavioral ecology. The finding concerns the key issue of how farmers choose their cotton seed.

Southern India is the only place in the world where hybrid cottons are widely grown, and the poorly controlled market offers farmers an exceedingly large and rapidly changing array of commercial cotton seeds. In 2004 there were 79 cotton seed companies registered to sell in Warangal District, and an estimated 150 different cotton hybrids. Every year several dozen new seeds appear on the market while several seeds are taken off. All seed dealers I have interviewed have confirmed that there are few known differences among the seeds; some make claims on time of maturity, boll size and water requirements, but these claims are sometimes inaccurate, and they are often not made at all. Seed integrity is very poorly monitored, and every year brings cases of problematic ("spurious") seed. In short, there are far too many seeds and too little information for farmers or even dealers to evaluate; even if they could evaluate the seeds, there is little variation among them; even if they could evaluate and identify optimal seed types, there is no guarantee the seeds would perform according to specifications. Let us examine the patterning in seed choice in this situation, and then consider its theoretical significance: Table 1

shows cotton choices for 2004 for the sample of 420 household censuses in 6 villages (Bandanagaram, the non-market-oriented village, had too few cotton planters to display).

Gudeppad (135)	Kalleda (46)	Ravuru (43)	Pathipalli (83)	Saireddypalli (45)	Tekumatla (108)
Chitra 18 (0)	Gemini 28 (0)	Bunny 32 (35)	Dyna 25 (5)	MECH-12 Bt 22 (16)	Durga 40 (15)
Ganesh 12 (20)	Brahma 15 (40)	Brahma 13 (38)	Bunny 10 (16)	Brahma 17 (32)	Atal 14 (2)
Dhanno 10 (10)	Bunny 13 (29)	Gemini 6 (0)	Tulasi 9 (11)	RCH-2 Bt 13 (0)	MECH-12 Bt 13 (0)
RCH-2 Bt 9 (0)	Dassera 10 (2)	Atal 6 (0)	Sidhartha 9 (0)	Satya 8 (6)	Indra 3 (2)
Teja 8 (0)	Satya 8 (0)	Tulasi 4 (3)	Brahma 4 (12)	Bunny Bt 8 (0)	Amoch 3 (0)
Vishwanath 8 (22)	Tulasi 4 (2)	Bollgard 4 (0)	Indra 4 (4)	RCH-2 6 (0)	RCH-2 2 (2)

Table 1: Local Cotton Seed Favorites. The top five cottons chosen in 2004 are shown for 6 sample villages. The numbers following the village name is the number of 2004 cotton choices reported for the village. In the table, the name of the cotton seed is followed by the percentage of 2004 cotton choices; the following number in parentheses shows what percentage of the 2003 cotton choices this cotton accounted for. For instance, the top choice in Guddepad in 2004 was Chitra with 18% of the total 135 cotton choices; the previous bear it was not planted by any of the censused farmers. Kalleda and Ravuru are adjacent villages (although they have different ethnic makeups) which accounts for their similarities.

The data show the emergence of a dramatic pattern of local favorites. For instance, Chitra, the top choice in Guddpad village, was not planted in any other village to a significant degree, and was not planted at all the previous year in Guddepad. Gemini was a heavy favorite in Kalleda village but was almost absent from other villages (except for neighboring Ravuru); it was not planted at all the year before. The heaviest favorite in the entire study was Durga in Tekumatla, accounting for 40% of that village's choices, but it was virtually absent from al other villages. In Saireddipally, the three GM cottons (Bt versions of MECH-12, RCH-2 and Bunny) comprised a very high 43% of cotton choices for 2004, although no other villages planted more than 15% GM seeds.

A goal of my Jan. 2005 research trip to Warangal was to begin investigation into the social and agro-ecological bases for these local preferences. Consistent with this project's focus on information flow, the aim is to go beyond whatever "objective" company specifications were available on hybrid traits (e.g.: "RCH-2 cotton seed is a late-maturing, irrigation-requiring, medium-sized boll cotton"), to investigate information in its social context. This research trip showed the need to study the informational basis for seed selection at 3 levels:

(1) First is the level of the seed company: what traits does the seed company claim for the hybrid? Sources of information were company publications and interviews with company representatives.

(2) Second is the level of the dealer: what do shopkeepers tell farmers about the hybrids' traits? Shopkeepers are not simple conduits for company information: they do not know the specifications each company claims for all of its products, they may not believe the specifications, they may have ulterior reasons for distorting company specifications, and they

may have customers that do not ask about seed specifications (this turns out to be remarkably common). Shopkeeper reportage cannot be studied simply by interviewing shopkeepers, as they have reasons for dissembling to a researcher. Therefore shopkeepers are interviewed, but farmers also have to be interviewed on what shopkeepers told them.

(3) Third is the level of the farmer: what information actually reaches the farmer about hybrid traits, and how do they interpret it? The primary source of such information is obviously the farmers. The agro-economic census asked farmers to cite the main seed trait(s) that led them to select each seed; this provides a large but shallow set of data. Intensive farmer interviews have been very helpful in this, and the upcoming interviews can now become more specific and targeted to learn what traits the farmer wanted, expected, and what led him/her to believe the chosen seed provided it. These interviews will be augmented by focus group discussions on seed characteristics. They will also be augmented by shop-keeper interviews: just as farmers can help shed light on shop-keeper opinions, shop-keepers are a valuable source of information on insights on farmer beliefs.

The January interviews led to the development of this general strategy for subsequent research (for summer 2005), but they also confirmed my suspicions on the agro-ecological basis for preferences: *there is virtually none.* I conducted several interviews with dealers familiar with the sample villages and none were aware of any agro-ecological basis for the strong local traditions. I conducted a mini-study of the Kalleda village's preference for Gemini cotton. In 12 interviews with Gemini planters in Kalleda, there was not a single instance of the adoption being based on Gemini's seed specifications, and indeed none knew much about Gemini's specifications. Only two of the 12 farmers mentioned first-hand knowledge of Gemini's performance (both had seen a field of Gemini the year before). Instead, the following factors emerged as the drivers for Gemini adoption:

- A large number of Kalleda farmers buy their seeds from Krishnaveni Fertilizers in Warangal. The owner, E. Laxman Rao, is from large and influential Kalleda family that has traditionally had a paternal relationship with may small farmers in the area. As the sole distributor for Gemini in Warangal, Laxman gets a high profit margin on this seed, and he recommends it strongly to his customers.
- The Gemini company had a marketing campaign in Kalleda several months before the 2004 cotton season. Farmers who made advance purchases of Gemini seed got scratch cards for prizes.
- One of the owners of Gemini Seeds is the first cousin of the wife of Davender Rao, the president of the mandal Kalleda. Davender is a respected local figure (although not for his farming per se) and he recommended Gemini.
- One of the early (2003) adopters of Gemini was a prosperous cotton farmer and he happened to get a good crop (not all adopters of Gemini got good crops) .
- Many farmers adopted Gemini simply because "other farmers around here were planting it."

This is an investigation of only one local favorite and I need to finish the investigation of the factors driving the local preferences. But it is a striking preliminary finding that the decision-

making process for this vital cash crop has been overtaken by cultural transmission processes, including "manipulated transmission," at the expense of environmental learning. Understanding why and how this occurs is obviously of practical importance because it affects if, and how, transgenics are adopted, and how farmers "skill on" the new technologies. But it is also of theoretical importance to understand why decision-making has taken this form. This situation offers an unusual opportunity for an ethnographic study of the political, cultural and ecological complexities of a process now being studied in simplified form by micro-society simulations: cultural adaptations to environmental unpredictability.

Theories of payoff unpredictability are of much interest. Stone (2004) discussed different impediments to skilling, but these impediments shared *unpredictability*. Boyd and Richerson (1985) and other behavioral ecologists have theorized social aspects of the adoption and transmission of behaviors. Important patterns in environmental learning versus emulation (such as conformist transmission) are attributed to environmental unpredictability at various levels. This theory is explicitly evolutionary and deals primarily with relatively long-term patterns, such as the emergence of different cultural patterns in similar environments (e.g., Boyd and Richerson 1985; Henrich and Boyd 1998:232-234). However, recent work has begun to investigate adaptation to unpredictability over the short term. Richerson et al. (2004:10-11) have designed experimental games to monitor how players' reliance on social learning changes with environmental instability; environments are made more unstable by making payoffs less predictable. How environmental unpredictability affects actors' reliance on environmental information versus social information is very much open to question, and is being investigated at present. As Richerson et al. (2004:6) point out, microsociety simulations to date suggest that payoff unpredictability leads actors to seek social information, but not necessarily to be influenced by that information.

In Warangal we have local mini-traditions emerging from mostly social information in under conditions of high payoff unpredictability. (The value of the case study is enhanced by the fact that one of the local favorites is the GM cotton that originally inspired this project). Thus while researchers hone theories of socio-cultural responses to unpredictability under conditions of artificial simplicity -- including the emergence of local traditions -- the Warangal project can investigate actual mini-traditions that have arisen under conditions of extreme payoff unpredictability. This study can both test propositions under investigation in experiments and describe factors that complicate matters in real life.

A particularly important real-life factor that this case showcases if the effect of interested parties who are manipulating perceptions of payoffs, leading to “manipulated learning.” The simple introduction of a random factor in player payoffs makes for a credible experimental model of environmental unpredictability in cotton cultivation. However, lacking in the Boyd/Richerson body of theory in general (and in the Richerson et al. research design in particular) is the political-economic element discussed above. Warangal farmers' information space contains much more than the environmental experiments and payoffs of themselves and other local "players" in the agricultural game: in fact, the preliminary analysis suggests that environmental learning and social learning from other farmers are both outstripped in importance by external input from parties with a vested interest in particular behavioral outcomes. (In the example above the parties were local, but obviously the larger issue of concern are larger

players, such as Monsanto and Hivos, who are highly active in debates over GM crops.[3]) This political-economic element of "manipulated learning" does not lend itself to theory building (it would be easy enough to introduce "lobbyists" into an experimental game, but such experiments would be unlikely to generate general theory).

Proposed Research Extension

The plan to further the research aims outlined above has two components: (a) extending the current research to characterize and measure the environmental variability/unpredictability in cotton cultivation, and (b) collect a large dataset on cotton adoptions and the relative role of environmental learning, social learning, and "manipulated learning" in adoption patterns. These two components require further explanation:

Project (a). Since the original research design was developed before the importance of unpredictability emerged, it did not make provision for inter-annual fluctuations in factors affecting payoff predictability. In most ways it was a synchronic comparative study, although it has generated some multi-year data (e.g., the household census and intensive farm inputs study were both run over two years). With a one-year extension on the research period and additional funding, I propose to collect these types of data on inter-annual payoff variability:

(1) Reconstruction of a history of hybrid cotton offerings. As noted above, this must be approached on three levels: what cottons were registered for sale (and what their characteristics are), what cottons were actually offered in shops frequented by my censused farmers, and what cottons choices the farmers were actually aware of.

(2) Study of product reliability. Farmers will be interviewed on what products (mainly seed and pesticide) performed as they were led to believe it would over the course of the study.

(3) Reconstruction of local insect histories. Farmers are able to recount pest outbreaks back several years. "Skill interviews" with farmers have already made it clear that pest outbreaks are highly erratic, but I need to piece together a rigorous history of local variation in outbreaks of the 8 most important cotton pests. Farmer interviews will be augmented by interviews with local agricultural officials, especially the entomologist and head of Warangal Research Station, Dr. Jalapathi Rao.

(4) Precipitation/temperature reconstruction. Several sources of weather information are available, and these will be used to characterize variability over the course of the study (and back several decades, to provide a larger context).

[3] Hivos is a Holland-based funder of anti-GMO and other initiatives in developing countries. For instance, they are a major funder of Vandana Shiva's NGO, and indirectly fund one of the organic farning "reskilling" movements in my research area.

Project (b). The 2003-04 household economic-agricultural census collected detailed information on a medium-sized sample stratified to represent different categories of prosperity, information access, and involvement in cotton cultivation. It was not designed to reveal the spatial and temporal dynamics of social transmission processes, but it did reveal the striking emergence of local non-agronomic traditions that indicate reflect social transmission processes having overridden environmental learning. I will now administer a much broader and shallower **Cotton Choice Census,** optimized to reveal the temporal and spatial contours of these mini-traditions. This census will mainly consist of a year-by-year list of cotton choices, augmented by very limited information on caste, education and landholding.

I have been able to use Warangal's Multi-Purpose Household Survey (with information on every household in the District) to draw stratified random samples for the household census; it will again be used to design samples for the Cotton Choice Census, stratified on several variables likely to affect information flow and cultural transmission (caste, education, landholdings). This census will document cotton choices as far back as the farmers can reliably remember, thus revealing the "lifespan" of local mini-traditions.[4] The census will be administered not only in the widely separated villages from the household census, but also in adjacent villages; this will reveal the size of mini-traditions and also their shape (e.g., whether preferences change gradually or abruptly across the landscape). The census is planned to yield 1500 cotton choice histories in 24 villages. This quantitative study will be coupled with ethnographic inquiry into selected mini-traditions to learn the local factors shaping the emergence and decline of the preferences.

I am proposing to spend 6-7 weeks in Warangal District in July-August 2005. During this time I will be able to complete Project *a*. I will also be able to design the Cotton Choice Census sample and questionaire for project *b*, participate in trial interviews, refine the form, and assure that the logistics are in place to complete the census during September and October.

Research Experience for Undergraduates : Probing the Nature of Agricultural Deskilling

This research project begins with conviction that impacts of new agricultural biotechnologies cannot be understood apart from the cultural context of information flow. Results to date have highlighted the importance of disrupted processes of information acquisition and interpretation, and have led to consideration of the nature of *agricultural deskilling*. As I have argued (Stone 2004), this is a vital concept that differs substantially from the better-known industrial deskilling, and there is a pressing need to better understand how agricultural deskilling occurs in different contexts.

A highly talented Washington Univ. junior anthropology student, Robyn D'Avignon, has read the recent work on deskilling and has designed an ethnographic project to further explore the nature of deskilling. Her project capitalizes on the spread of contract poultry-farming in Arkansas. In these contract operations, formerly-independent poultry producers become

4 Numerous interviews in Warangal have shown that most farmers can provide a history of cotton choices going back around five years with relatively little error. In some cases the farmer can give details going back much further, and, remarkably, some farmers are unsure of the exact cotton type they are currently growing. I have often been able to determine cotton types by usine other information the farmers can usually provide (such as the color of the box, and other nearby farmers who planted the same seed).

employees of Tyson or other poultry firms, raising birds according to specified procedures with some supplied inputs. Her preliminary work in Washington Co., Ark., has identified contract producers and independent producers that are amenable to comparisons. Her research will compare the decision-making processes in the two groups. She is particularly interested in identifying the kinds of information acquired by the two categories of producers, the principal hazards affecting poultry production, and their ability to apply different kinds of management skill to mitigating risks. Parallelling the unpredictability study described above, she will collect information on specific types of unpredictability affecting poultry production.

D'Avignon is conducting a pilot project this semester, to be written up as part of a paper for my graduate/undergraduate seminar Political Ecology, and then intends to undertake the full study during Summer and Fall (results will be used for an honors thesis in Spring 2006). Since I will be collecting data on unpredictability in the summer, and writing on the nature of agricultural deskilling in the Fall, the projects will parallel each other and will be able to inform each other.

In providing comparative perspectives on the nature of agricultural deskilling, D'Avignon's project contributes to the intellectual goals of this research; the theoretical importance of deskilling is discussed above. It also contributes to its broader impacts because deskilling is a crucial process affecting American as well as Indian farmers.

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