Herbicide Damage Tracking System – A Database Design Case

INTRODUCTION

Dan and Brett knelt down in the dusty field, the dirt still dry and crumbly despite their attempts to irrigate the crop. Dan knew that if the drought conditions persisted they were going to have to reduce the acreage that they farmed in the future. This year their best fields were planted in potatoes, a more profitable crop than the wheat that was planted in the fields last year. Crop rotation serves to balance the fertility demands of various crops to avoid excessive depletion of soil nutrients, but all crops are not equally lucrative.

Today they were checking the condition of the potato crop. Brett watched his father dig carefully to check the size and development of the potatoes. What Dan found left a sick feeling in his stomach. He shot a stricken look at Brett as he uprooted the entire plant. The tubers were small and under-developed, and so misshapen that it was difficult to imagine that there would be a sellable crop. Brett quickly stood up and walked away. If the entire crop was like this they were ruined. What could have caused this? They had farmed in drought conditions before and had never experienced anything like this.

As they got back into their truck and headed back across the field to the main road, they tried to figure out the cause of their problem. "These fields yielded a decent wheat crop last year," Dan stated. "Sure, we had problems with grassy weeds like foxtail and wild oats that were competing with the wheat, but once we applied that new herbicide we got them under control."

"You mean that WheatGuardian?" Brett asked.

"No, Wheatgard," Dan corrected.

"Oh yeah, that's right. I couldn't remember what it's called since we didn't have to spray the crop this year. WheatGard is designed to treat wheat, not potatoes."

"I wonder if that might be a clue," Dan speculated. "One of the agricultural extension bulletins had an article a while back on herbicide residual, or something like that. Maybe there is residue in the soil from last year's application of WheatGard that did something to our potatoes. We're still getting hit hard by this drought. The article mentioned that under normal conditions herbicide residue is not a problem because herbicides generally break down fairly quickly when applied, but with dry conditions it doesn't break down as well."

"I don't know, Pop," Brett replied. "All I know is that we'll have to play out the hand that we've been dealt, because it's too late to try to get in another crop, and we couldn't afford it anyway. Maybe if we water as much as we can afford we'll be able to dilute any herbicide residue that might remain."

However, when harvest time rolled around their fears were realized. Yields were much lower than they should have been, and the potatoes were of extremely poor quality. They were in a financial hole so deep that they might never get out!

INTRODUCTION TO AGCONSULTING, LTD. AND THE PROJECT

Jack Searle is the chief agricultural consultant for AgConsulting, Ltd., an agricultural consulting company that provides its services to a number of clients to perform efficacy studies that are used to make crop and farming recommendations. Jack called Terri and David, recent graduates of an information systems program and relatively new hires, into his office early one Monday morning. "Well, we have a dicey problem. Agdefender Chemical and Bioengineering, an international subsidiary of a large conglomerate, specializes in different types of chemicals for agricultural uses including pesticides, herbicides, fertilizers, growth enhancers, etc. Ed Morgan, their regional representative, just retained our

services because it looks like one of their products, WheatGard, could have caused some herbicide carryover damage to the potato crop in the area and a lot of farmers are going to lose their shirts.

"Ed is familiar with our reputation for studying the effectiveness of different types of chemicals on crops, analyzing crop damage, and acting as expert witnesses in legal proceedings. He says that Agdefender wants to act responsibly and is willing to compensate farmers for any crop damage caused by their chemicals. Our job is to determine the extent of herbicide carryover damage to help put a dollar amount on the damage experienced by each grower so they can be compensated fairly. We are to serve as an unbiased middleman, trying to determine fair compensation for each grower while not overwhelming Agdefender with claims."

Underlying Problem

"Let me explain the underlying problem," Jack continued. "What do you know about weed killer?"

"Uh, you spray it on weeds to kill them?" David queried.

"Well sure, but what else? In general terms, I mean." Jack replied.

"Hmm. Usually there are specific plants that a particular weed killer can safely be applied to, and any other plants not listed on the product's label might be damaged if they are sprayed. Also, the weed killer usually lists certain weeds that it is designed to kill," David mused.

"Right!" Jack said. "But what you may not know is that once in a while chemicals designed to help control weeds or insects adversely affect the plants that they are intended to help, primarily because they were applied under environmental conditions for which they were not designed. Certain environmental factors can cause chemicals to react differently in different regions or different soil types," Jack explained.

"Wow, I didn't know that!" Terri exclaimed.

"Well that is what we are speculating happened in this case. Remember it's just speculation!" Jack warned. "WheatGard was used by hundreds of farmers in the area to treat both spring and winter wheat. It is a selective post-emergent herbicide designed for control of green foxtail, wild oats, and certain broadleaf weeds. Unfortunately WheatGard was tested in areas with soil having a higher moisture content than our dry and highly calcareous soil. Apparently the WheatGard used in this area bonded with the soil and residual traces caused rotational crop damage the following year. The crop most affected was potatoes grown the year following the wheat treatment, and farmers experienced decreased yields and quality. Additionally, in some cases chemical reactions with the environment altered the chemical composition in such a way that the herbicide residue damaged even the wheat crop that it was designed to treat. Unfortunately, because there can be many causes for a poor crop it took more than one growing season to determine the cause of the problem, and some growers applied WheatGard for three consecutive seasons before they became aware of the problem."

"Holy cow!" Terri exclaimed. "That must have been devastating to some of the smaller farms."

"It certainly has been," Jack agreed seriously.

Terri and David's Task

Terri glanced at David and then brought up the point that was on both their minds. "What is our involvement in this, Jack? David and I have IS degrees. We were hired for systems analysis and design and database design. David has a pretty extensive agricultural background because he grew up around here and worked on his dad's farm, but we don't know as much as the agricultural experts on the payroll here."

"Exactly," Jack boomed. "As soon as we started our preliminary investigation we realized that it is going to be necessary to design and implement a system to track information for damage claims. "

"Oh, I see," Terri exclaimed. "We'll probably have to develop a database system to handle it."

"That's up to you," Jack replied, "But let me re-emphasize a point. Your system will track the information used to determine a claim settlement. It will NOT calculate claims because those will be negotiated by Ed and maybe some attorneys that Agdefender retains based on a variety of factors that will be recorded by your system. Perhaps at some point in the future they will propose a formula that will allow us to calculate a suggested settlement amount, but at this point the system will simply collect all the information pertinent to reaching a settlement.

"Oh, that brings up a good point about future versions of this. Agdefender makes several products besides WheatGard that could potentially experience similar problems under certain conditions. Can you make the system flexible enough so that it is capable of tracking not only current claims related to WheatGard, but can handle any of the products owned and distributed by Agdefender? That would make our work more valuable to the client. If the scope extends beyond currently known requirements and is able to cover all future claims as well they will be more likely to hire us in the future."

"Sure," David answered. "That is one of the things that our professor hammered into our heads. We must have been told to design for maintainability and modifiability a thousand times. I think we must do it automatically by now, but we'll be sure to keep it foremost in our thoughts during the design process."

"Great," Jack approved.

Company Background

"Can you give some company background?" David asked. "I don't mean to sound cynical, but why is Agdefender so willing to pay up? Have they been sued in the past? How vulnerable are these types of companies to lawsuits?"

"Well, let's give Ed a call and ask him. Try to be a little more tactful though," Jack warned.

Jack dialed Ed's office and soon had the regional rep on the line. "Ed, I have you on speakerphone with Terri Rogers and David Hayes from our IT group. I was explaining Agdefender's situation to them and they had a few questions for you. They asked me what prompted the company to act responsibly and try to compensate growers for damaged crops, and I thought I'd let you address that."

"Jack," Ed responded, "I think that question is a bit insulting. I also don't think it's the least bit pertinent to your task!"

"No offense intended, Ed," Jack said. "But sometimes recent college grads can be a bit cynical about the real world." He winked at Terri and David. "They weren't trying to be insulting, but rather were trying to get a handle on the whole situation. It just seems unusual for a company to behave so ethically in this day and age."

"Well, I supposed I overreacted," Ed replied. "Let me be straightforward. First, let me state that we've never had a lawsuit filed against us for poor products. Part of the reason for that is that the agricultural community is a close-knit community, and we HAVE to act responsibly or we'll be out of business before you know it. Our customer service strategy has always been this: if we know that there is a real chemical problem, and not just poor farming practices, we do what we can to mitigate our clients' losses. There are several reasons why that is a good policy. First, if we don't step up to the plate there would certainly be some sort of legal action taken. By acting first we can generally avoid any legal action. Further, the growers are our clientele. We can't afford to put them out of business because we need them around to buy our products. Finally, word of mouth is a killer. As I noted earlier, if we don't behave responsibly the growers will simply quit dealing with us. Again, we have to keep our clients happy. So for the cynical out there, and I mean you, Terri and David, I suppose our motives aren't entirely pure, but we do try to behave like good neighbors for whatever reason."

"Thanks Ed," David interjected. "We didn't mean to imply anything, and we appreciate the explanation."

"No problem," Ed responded. "Sorry I got a little heated there, initially. Any other questions?"

"No, I just started filling them in," Jack answered. "We'll be sure and call you back if we feel the need to insult you further!"

"You do that," Ed laughed, and then broke the connection.

"Sorry Jack," Terri said. "We didn't mean to put you on the spot and we sure didn't mean to insult a client."

"Oh, don't be too concerned," Jack said. "I've known Ed for several years, and although he gets irritated quickly he is pretty level headed and I knew he wouldn't get too upset at your question."

"Okay, thanks," Terri answered. "Sorry we interrupted you."

System Overview

"Now, to give you a basis on which to get started let me give you an overview of the type of information that the system will be responsible for," Jack resumed. "You can talk to our other ag experts for more details. Our agents will have to interview the farmers who were affected and gather information ranging from characteristics of their fields to their farming practices. We need to be able to determine what part of their loss was due to the use of WheatGard as opposed to the part that was due to bad farming or poor soil, for example. Regarding poor soil, another big consideration is how the field has performed historically. Factors such as the cost of acreage rental, costs of fumigant, fertilizer, fertilizer application, ground preparation, costs for shipping potatoes from a more distant field, loss of potato seed value, and loss of income potential from having to grow an alternate crop must be determined and stored. The system also has to be able to store the wealth of contact information that we accumulate."

"Since this will be one of the largest database systems that we've developed, here is how I suggest we approach it," Terri stated. "We'll start by coming up with a database design that captures all of the required information, and is capable of producing any forms and reports that might be needed. We'll have to determine those as part of our requirements gathering. Then we'll have to normalize the database for optimization and error reduction. Then we'll build a prototype so that we can demo the system to get user feedback from the ag consultants and from the negotiators who will be using it. We'll start by implementing the tables per our design, and then populating them with some representative data. We'll develop some sample data entry and data display forms, and also include some sample queries to show users how data can be accessed and manipulated. Along the same lines we'll generate a few sample reports. Of course we'll get user feedback at several points along the way. Does that sound like a good approach?"

"That sounds fine!" Jack enthused. "I certainly like the idea of developing a prototype. Why don't you make all of this part of an overall system proposal, and preface it with an executive summary. I'd like that executive summary to start with a justification for the new system–in other words, the situation that made the system necessary. Follow that with the system goals, your intermediate results, and recommendations. Oh, and mention any problems that may crop up and hinder system development. Then include details about your database design that you mentioned, followed by prototype details. Finally, end with a summary that recaps how your system addresses our current needs. Before you get started I recommend that you do some background research on herbicide carryover.

"Now that you know your part in this, get to work! I have faith in you to provide us with what we need!"

Terri and David started work immediately. First they formalized their system proposal format. (See Table 1). Then they started boning up on the types of damage that agricultural chemicals like WheatGard

can cause by borrowing some literature from the agricultural experts, calling the county extension office, and searching the Internet for information. The results of their study are shown in the appendix. After becoming familiar with the topic of agricultural chemical damage and establishing a basis on which to interview the stakeholders, they determined that they should next discuss the issue with the agricultural experts at AgConsulting to determine what specific information needed to be collected and stored in the system.

Table 1. System Proposal Format

1. Executive Summary
    a. System justification
    b. System goals
    c. Intermediate results
    d. Development hindrances
    e. Recommendations
2. Entity-Relationship Diagram
3. Normalized Relational Schema
4. Prototype
    a. Database Table Creation
    b. Data Entry Forms
    c. Data Display Forms
    d. SQL Query Design
    e. Sample Reports
5. Summary

DETERMINING CRITICAL VARIABLES

Terri and David at first thought they were dealing with a fairly simple record-keeping scenario. With their research on herbicide carryover as a basis, they set up a meeting with Seth Duke, the ag consultant who was overseeing the WheatGard analysis, to confirm some details. They met with Seth in his office.

"All right, Seth," David started. "We have a few questions for you."

"Want a donut?" Seth interrupted.

"Uh, no thanks," David replied. As Seth chomped into a Krispy Kreme, David got down to business. "It all looks pretty straightforward. A grower plants a crop on his land, buys some type of chemical from a retailer, and applies it to his crop. We're dealing with herbicide carryover, so we simply need to determine who applied WheatGard, when they applied it, what crop they applied it to, and the damage they experienced. Does that cover everything?"

"What about the applicator?" Seth mumbled past his mouthful of donut.

"Applicator?"

"Yes, the applicator." Seth swallowed and continued. "Growers don't always handle the spraying themselves. Sometimes they contract an applicator to do it. That means that you need to store data about the applicator in addition to the grower. Now that you mention it, there are some other details that you have overlooked liked retailers, consultants, etc. It's not as simple as you seem to think. Let's go over it from the beginning, and you'll hear more about the applicator too."

As Seth settled in for the explanation Terri could feel a serious headache coming on. She gave into temptation and reached for a maple donut.

"Let's start with farmland and growers," Seth said. "Growers can be individual farmers or multiple-owner companies in which several people, usually family members, share the decisions made about one or many of the grower's fields.

"Farmland is subdivided into fields. All of the fields farmed by a grower may not necessarily be in the same area, but can be located in different counties or even different states.

"Growers don't necessarily own the fields that they farm. They often lease land from someone else and farm it as if it were their own. Leases change from year to year so the relationship between growers and land owners is not static. Fortunately, though, most leases last an entire season and do not switch hands in mid-year. Are you with me so far?" Seth asked.

"Uh, so growers don't necessarily own the land they farm because they might lease the land. However, those leases might change from year to year. Right?" David asked.

"So far, so good. But it gets a lot more complicated," Seth continued. "Growers are often assisted by one or more independent consultants who guide the grower concerning issues such as fertilizer application, chemical application, and the timing of those events. Growers usually use the same independent consultant from year to year, although they don't have to.

"A field undergoes a series of spray procedures throughout the year. Each of these sprays is applied by an applicator that may or may not be the grower himself. In some cases it is performed by third party applicators that contract with the grower to take care of their spraying needs. An applicator may not perform all applications to a particular field in one season, and may not spray every field farmed by a grower. To make matters more confusing, an applicator may supply his own product or it may be supplied by a chemical retailer."

"Wow!" Terri exclaimed. "So far we have a grower, fields, possibly a landowner and leases, an independent consultant, the applicator that you mentioned earlier, and whatever chemicals are applied to the fields. Oh, and the chemical retailer that you just mentioned. Do we need to know anything about him?"

"More than likely," Seth said. "Retailers have several contacts that work as representatives for the retail company. The grower's main retail contact is a salesman who has a business relationship with the grower. This salesman is usually called a 'field man' or 'crop consultant'. In addition to selling products to growers, the retailer often also acts as the applicator. When evaluating a field, records must be kept about the applicator and retailer as well as any information about the spray methods and types of application, treatment coverage, and dates of applications."

"Okay, I'm having trouble figuring everything out. The applicator could be the grower, the retailer, the independent consultant, or a specialized third party applicator?" Terri asked.

"Yes," Seth congratulated.

"This is pretty confusing, but I'm trying to take good notes. Are there any other details that we need to know?" Terri asked.

"Well," Seth said, "certain field characteristics like the crop may change from year to year while other factors like soil type, irrigation methods, and soil pH generally stay static. Field locations never change, so some effort must be made to keep coordinates like longitude and latitude on each field so that it can be easily identified for geo-referencing and analysis purposes. As you probably know, each year crops are rotated throughout the fields since different crops require different nutrients, and rotation gives soil time to regenerate. One year a field may be planted in potatoes, the next year it can be used for a wheat crop, and the third year to grow sugar beets. Sometimes a field may grow a crop like wheat for two

consecutive years. Crops like alfalfa may be planted in a field for four or more years. Each type of crop has a specific variety associated with it. There are several varieties of potatoes, for example, such as Ranger Russet, Russet Burbank, or Russet Norkotah."

"How are settlements going to be handled?" David asked/

"Ah, you want the legal details. These were explained to me yesterday." Seth leaned back with a sigh and continued. "A settlement is an action taken by Agdefender to compensate growers for crop or rotation damages caused by WheatGard. Each settlement disperses one reimbursement that covers the costs of damage for one grower's crop. Since growers may have more than one crop that was damaged, they may have more than one settlement. The reimbursement is not necessarily cash, but may be a replacement product. Also, each settlement generally covers one grower's crop, not one field, because several of the grower's fields may have the same crop and are therefore all covered by one settlement. However, there are occasional exceptions. The settlement has a claim number that identifies a grower's claim against WheatGard as well as Agdefender's reimbursement to the grower, if they deem the claim to be valid. All claims, whether settled or not, are tracked.

"Furthermore, information is tracked for all growers who applied WheatGard and may file claims against Agdefender in the future. In the event that WheatGard carries over more than one season and causes damage to more than one crop in the same field, each year is settled individually. Incidentally, in some areas we've seen carryover for up to three years! Records are kept on each grower's crop-planting intentions for the next year. This information should be cross referenced and compared against what was done the previous year."

Terri piped up, "How will they calculate the settlements, Seth? This seems pretty complex."

"Well," Seth explained, "there is no single formula for calculating settlements. In fact, most will be negotiated based on specific conditions."

"I bet we could write an algorithm to take care of that," David bragged. "Surely you can factor in all of the variables and come up with a dollar amount."

"Well, as we become more familiar with the process we can suggest that to the client, but right now our responsibility is to design the system that Agdefender requested," Seth remonstrated. "Don't ignore the client's wishes and develop a system that they don't want!"

"Right Seth," Terri agreed, as she shot a warning glance at David. "I'm sure David was pondering future enhancements. Is there anything else that we need to know about the variables that we need to track?"

"No," Seth decided. "I think that should do it. I know it's confusing, but go over my explanations a time or two and come back if you have any questions. Once you understand it," Seth chuckled, "I think you'll find that it is even more confusing than you suspect!"

Terri and David both groaned as they left Seth's office. "We have our work cut out for us," Terri told David. "We have to figure out which of these are critical and then determine the relationships between them."

PROCESS DESCRIPTIONS

After their initial meeting with Seth, Terri and David started the task of designing the database. Their classroom experience with database design made them aware that in order to maintain accurate records and to generate any required forms and reports the underlying database model had to realistically represent the situation by capturing all of the required data. Furthermore, they recalled that the model must be extensible to other situations.

"Okay," Terri reflected, "remember how we approached the project in our database design course? I looked over my class notes last night and we started out by trying to develop an entity-relationship diagram that models the system. The notes said that the first step is to determine the entities, relationships, and attributes that make up the E-R diagram from the information that we've gathered so far."

"Uh, what's an entity?" David asked facetiously.

"Cute, as if we could ever forget that definition," Terri griped. "It's a person, place, thing, or event for which information is collected and stored."

"Just testing you," David grinned.

"The notes go on to say that we then need to figure out the relational schema for each relation and then normalize each. Once normalization is complete, other features can be developed based on the resulting implementation."

"Sounds right to me," David agreed. "But let's start at the beginning. How do we get started on one of those ER diagrams? That always seemed to be the toughest part of the whole process."

"It is." Terri agreed. "You may not remember it, but our class discussed several approaches to identifying entities and relationships, including using report requirements and functional analysis. Do you remember those? The class notes say that you can determine entities and their relationships through information gathered by examining the business forms and reports that an organization uses, or by identifying the major functions and activities that a company performs, and determining the objects needed to support their execution. Which of those can we use in this situation?"

"Well," David replied, "there is no existing system, so I think that eliminates using report requirements. We'll have to develop our own. Let's take a crack at using functional analysis."

"Okay," Terri agreed, "in order to perform functional analysis we have to refer to the list of processes that we determined from our requirements gathering phase. Let's start with the one that kicks everything off—submitting a damage claim. I think we'll need to talk to Seth again to get more details."

Grower Submits a Damage Claim

Terri and David scheduled another appointment with Seth Duke to discuss the process of submitting a damage claim. Once they were settled in his office he began to explain.

"Seth," David began, "you indicated that the whole process begins when the Grower Submits a Damage Claim. We both took notes in our meeting the other day and here is the section that pertains to this process:

> "In order to be considered for compensation, a grower must submit a damage claim. This requires that detailed contact information is recorded about the grower and the chemical used, as well as the field and crop on which it was used and the retailer from which the chemical was purchased. Details about the applicator must be recorded as well, and the applicator could be the grower, the retailer, an independent consultant, or field man, or a third party applicator. In the worst case scenario a grower may hire a third party applicator who applies chemical purchased from a retailer, with an independent consultant thrown in the mix at some stage or another."

"Let's start with the grower," Terri stated. "For the grower we need standard contact information, like name, address, phone, cell phone, fax, email address, etc."

"Hold on," Seth exclaimed. "There is more to it than that. First, you need to think of it in terms of the farming company itself. As you said, we need name, but in this case it will be the farming company

name. Then we need address, but we should store specific details like street address or box, city, state, zip, and country, and in this case we should add county too. We also need to include a shipping address in case it differs from the mailing address and in case the farmer opts for reimbursement through a replacement product. Anything else?"

Terri thought back to her accounting classes. "And we should probably record either the social security number if the farm is a sole proprietorship or the tax ID if it is not. We should also include some sort of memo field to record any pertinent notes that may need to be recorded about the grower. Is that it?"

"Nope, not done yet," Seth said. "You're still thinking in terms of a grower being an individual farmer. If it is a company then we need to be able to store details about multiple contacts. We should store last name, first name, business phone, shop phone, mobile phone, fax, pager number, home phone, shop phone, and both business and home email addresses. That should do it!"

"We also need to store data about the Independent Consultant," Terri recalled. "Let's look at that next. It has got to be more straightforward!"

"Well, it is," Seth answered. "As I noted before, growers are often assisted by one or more independent consultants, or crop advisors, who provide guidance concerning issues such as fertilizer application, chemical application, and the timing of those events. We need to be sure that we can associate an independent consultant with each grower."

"So the information stored for Crop Advisor or Independent Consultant should be standard contact information like name, business phone, mobile phone, fax, entries for street and or post office box address, city, state, zip, and probably county and country," David concluded. "Oh, and email. That was pretty simple. Do we have any other easy ones that we can knock out quickly?"

"Sure," Terri answered. "We should be able to handle the Retailer and Applicator in a similar manner. For retailer we should store the company name as well as the last name and first name because of the contact person, their business and mobile phone numbers, fax, entries for street and or post office box address, city, state, zip, and county and country again, and email address. We should store exactly the same items for applicator as well."

"Let's hold off on those for now," Seth said. "I want to show you the form that we designed to collect the data that we have just been discussing. We start out by contacting each grower and filling out a Grower Survey form that consists of three parts: The Grower Information Form, the Field Summary Form, and the Application Detail Form. The Grower Information Form (see Figure 1) will be used to collect data about the farm, the crop advisor, and the grower contact. Take a look at it."

"Hmmm," David mused, "There seem to be a lot of redundant fields."

"Not really," Seth replied. "If you look at them closely you can see that all fields are necessary. The form includes sections for the farm, the grower contact, and the crop advisor, so although there are some fields with similar names, they are associated with different things. There are other forms too. For example, we still need to gather data about the claim itself."

Company Gathers Claim Data

Seth leaned forward as he explained. "In order to gather claim data one of our ag consultants has to visit the field that shows signs of carryover. Soil pH, soil moisture, and soil temperature are measured, and a soil sample is taken to evaluate soil composition. The damaged crop is also evaluated and photos are taken of the field. The grower information should be double checked to insure that there are no missing items. Here are the processes that are involved:

Grower Claim Application

Grower Information Form

Grower/Farm Information

Farm Name:
Tax_ID:

Mailing Address

Address1:
Address2:
City:
State/Province:
Zip:
Country:
County:

Shipping Address ☐ Same As Mailing

Address1:
Address2:
City:
State/Province:
Zip:
Country:
County:

Crop Advisor Information *(Independent Consutant)*

Last Name:
First Name:
Company Name:
Phone:
Mobile:
Fax:
Email:

Mailing Address

Address1:
Address2:
City:
State/Province:
Zip:
Country:
County:

Grower/Owner Contact

First Name:
Initial:
Last Name:
Bus. Phone:
Home Phone:
Mobile:
Shop Pnone:

Fax:
Pager:
Bus. Email:
Home Email:
Web Site:

Figure 1. Grower Information Form

- Collect crop information, including Crop, Variety, Crop Planting Date, Irrigation Method, and Irrigation/Precipitation Notes
- Gather soil information, including Soil Type, Soil pH Range, Percentage Range of Organic Matter, and Soil Type.
- Gather spraying information, including Application Date, Tank Mix, Applicator, Application Method, such as Air, Ground, or Chemigation, Application Type, such as Low Volume, ULV,

Dilute, or Fog, Volume Spray per Area, Volume Type, such as gallons or liters, Area Treated, measured in Acres, Hectares, or thousands of square feet, Area Affected, and Targeted Pests."

"That sounds like it will require a pretty complicated form, Seth," Terri commented.

"Well, it will, "Seth agreed. "In fact, we decided to break it into two individual forms to deal with that. First take a look at the Field Summary Form (see Figure 2). It will be used to collect all sorts of details about an affected field, such as latitude and longitude, soil type, soil pH, irrigation method, crop, etc. There's more information about soil than you probably ever thought existed!"

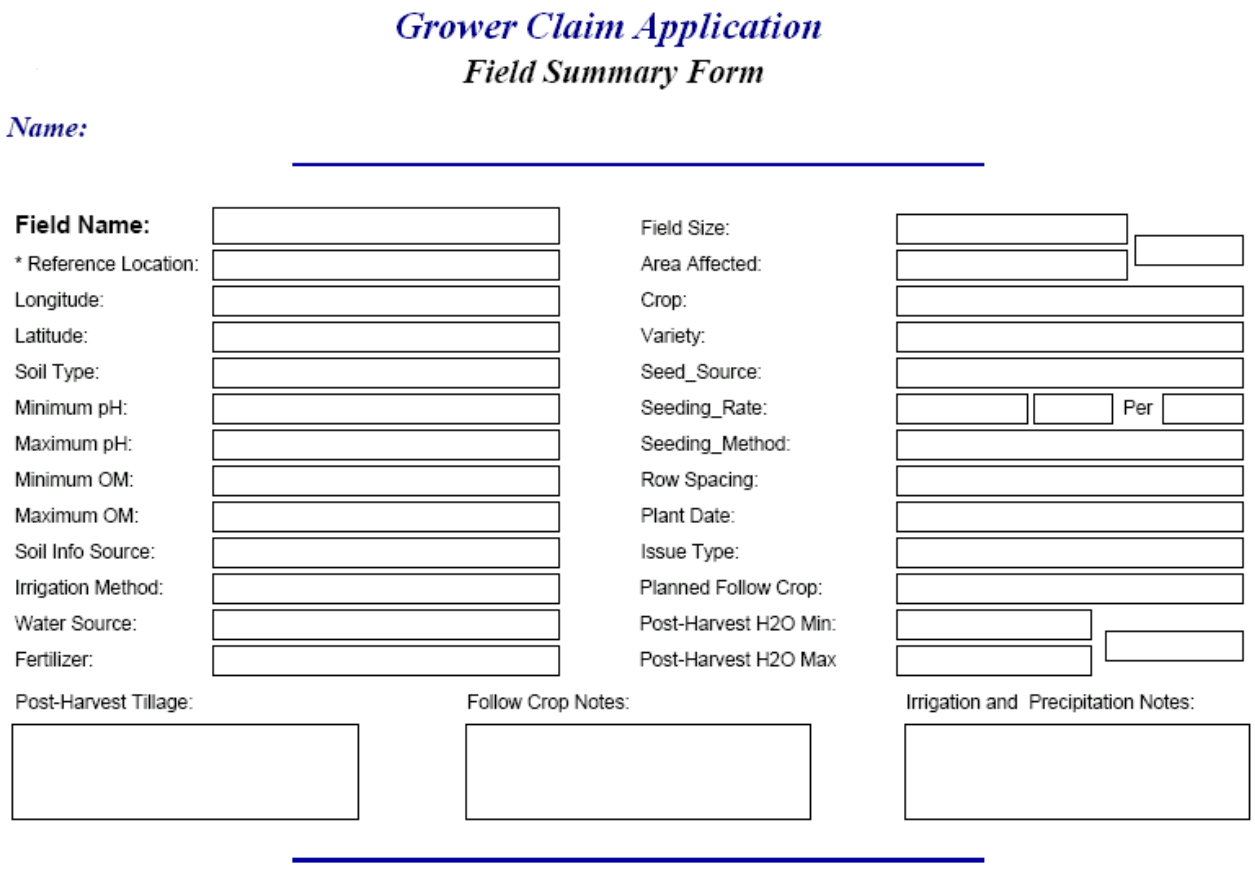


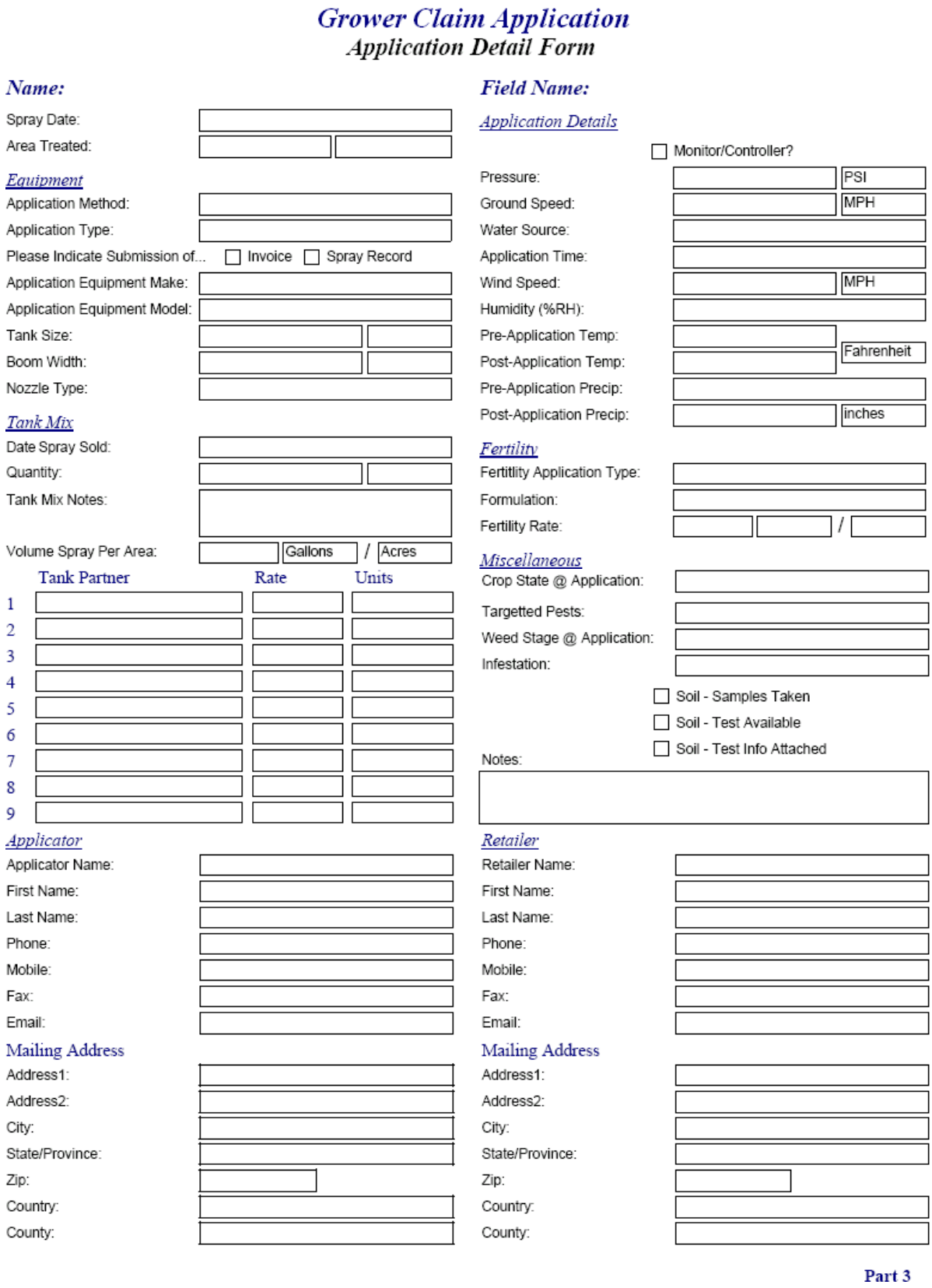
Figure 2. Field Summary Form.

"Hmm, that's not as bad as I expected," David interjected.

"Well, keep in mind that a grower may have several fields, so it can get pretty hairy," Seth corrected. "And that is just field data! Besides that, we still have to review the Application Detail Form that will be used to gather information about how WheatGard was applied to a field. We'll need to record when WheatGard was applied, the application method like air, chemigation or ground, application type, and several other variables that need to be tracked. Take a look at our preliminary Application Detail Form (see Figure 3). It's pretty complex but it has to be to capture all the necessary details."

"I just noticed that the Application Detail Form captures the information about the Applicator and Retailer," David pointed out. "I wondered where that was being collected!"

"Let's take a look at the next process," Terri urged.



Grower Claim Application
Application Detail Form

Name:

Spray Date:

Area Treated:

Equipment

Application Method:

Application Type:

Please Indicate Submission of... ☐ Invoice ☐ Spray Record

Application Equipment Make:

Application Equipment Model:

Tank Size:

Boom Width:

Nozzle Type:

Tank Mix

Date Spray Sold:

Quantity:

Tank Mix Notes:

Volume Spray Per Area: Gallons / Acres

	Tank Partner	Rate	Units
1			
2			
3			
4			
5			
6			
7			
8			
9			

Applicator

Applicator Name:

First Name:

Last Name:

Phone:

Mobile:

Fax:

Email:

Mailing Address

Address1:

Address2:

City:

State/Province:

Zip:

Country:

County:

Field Name:

Application Details

☐ Monitor/Controller?

Pressure: PSI

Ground Speed: MPH

Water Source:

Application Time:

Wind Speed: MPH

Humidity (%RH):

Pre-Application Temp:

Post-Application Temp: Fahrenheit

Pre-Application Precip:

Post-Application Precip: inches

Fertility

Fertitlity Application Type:

Formulation:

Fertility Rate: /

Miscellaneous

Crop State @ Application:

Targetted Pests:

Weed Stage @ Application:

Infestation:

☐ Soil - Samples Taken

☐ Soil - Test Available

☐ Soil - Test Info Attached

Notes:

Retailer

Retailer Name:

First Name:

Last Name:

Phone:

Mobile:

Fax:

Email:

Mailing Address

Address1:

Address2:

City:

State/Province:

Zip:

Country:

County:

Part 3

Figure 3. Application Detail Form.

"Well, I hate to do this to you," Seth interrupted, "but I have another appointment coming in and I'll be out of town for the rest of the week. I would suggest that you set up an appointment with Marcos Ramirez, who has been working closely with me on this. Please keep me in the loop though. Later!"

As soon as she got back to her office Terri called Marcos Ramirez to set up an appointment. They agreed to meet in Marcos' office the next morning.

REMAINING PROCESSES.

When they arrived for the meeting Marcos offered them a croissant and something to drink. Then they got down to business.

"Marcos," Terri said, "as I explained on the phone we had a meeting with Seth yesterday and he described how a damage claim is submitted and the type of information that is recorded to determine whether a claim is legitimate. He went over each of the forms that make up the overall Grower Survey Form. We didn't have time to get to some of the other processes, and Seth recommended that we talk to you."

Company Assesses Claim

"Let's take a look at claim assessment then," Marcos replied. "Given the data collected in the processes that you've already covered, we ag consultants must then make an assessment of the claim. We have to determine what part of their loss was attributable to WheatGard, and what part, if any, was due to bad farming or poor soil, among other considerations. Factors like poor soil require that we know how the field has performed historically. Our investigator arrives at an opinion on a fair settlement that has to be recorded. So other than our decision, most of the data that I just mentioned has already been gathered during the other processes so there probably isn't anything new to record. Still, you asked about processes so I thought I'd describe it. Oh yeah, hopefully Jack or Seth explained that we are not responsible for calculating a claim amount. All we do is collect and assess the data that is critical to negotiating a fair claim. The negotiations are handled by Agdefender representatives, taking our recommendation into account. That wraps this process up. We're on a roll now!"

"Okay," Terri interjected. "So far we have covered the information that needs to be stored when a grower submits a claim, the data that AgConsulting has to record about the grower, the crop advisor, the retailer, and the applicator, the data that we record about each affected field and data about the application of WheatGard. Finally, you explained how our recommendation is stored as part of the claim assessment. Is there anything else that needs to be discussed?"

Company Disperses Settlement

"Well," Marcos replied, "we're reaching the end of the chain of events involved in a claim settlement. As I stated, based on the results of the data analysis and assessment, a settlement amount and/or type are determined by Agdender negotiators. We have a form sketched out for the information that we have to collect during the claim assessment to determine the settlement (Figure 4). It starts with claim ID, date contacted, and the name of the Agdefender negotiator who is handling the claim. It also lists the Association to Issue, which can be applicator, grower, consultant, processor, or retailer. It takes into account the grower's opinion of the problem, the date it was recorded, and their proposed settlement and dollar amount. It then records our counter proposal, including date and amount. Then it lists the manager's final settlement, including date, how the figure was arrived at, amount, and payment form. Oh, and it has details about any follow-up action required. If the settlement involves a cash payment we need to record the submitted date, the date we obtained a release signature, the check number, delivery date, and delivery method. If the settlement calls for the grower to be reimbursed through product, we need to

record what product, how much, and when and how it will be delivered. We'll also track details about the negotiator's visit, including the visit status, date, crop height, crop leaf stage, and investigator opinion. Those are included to provide justification for the settlement."

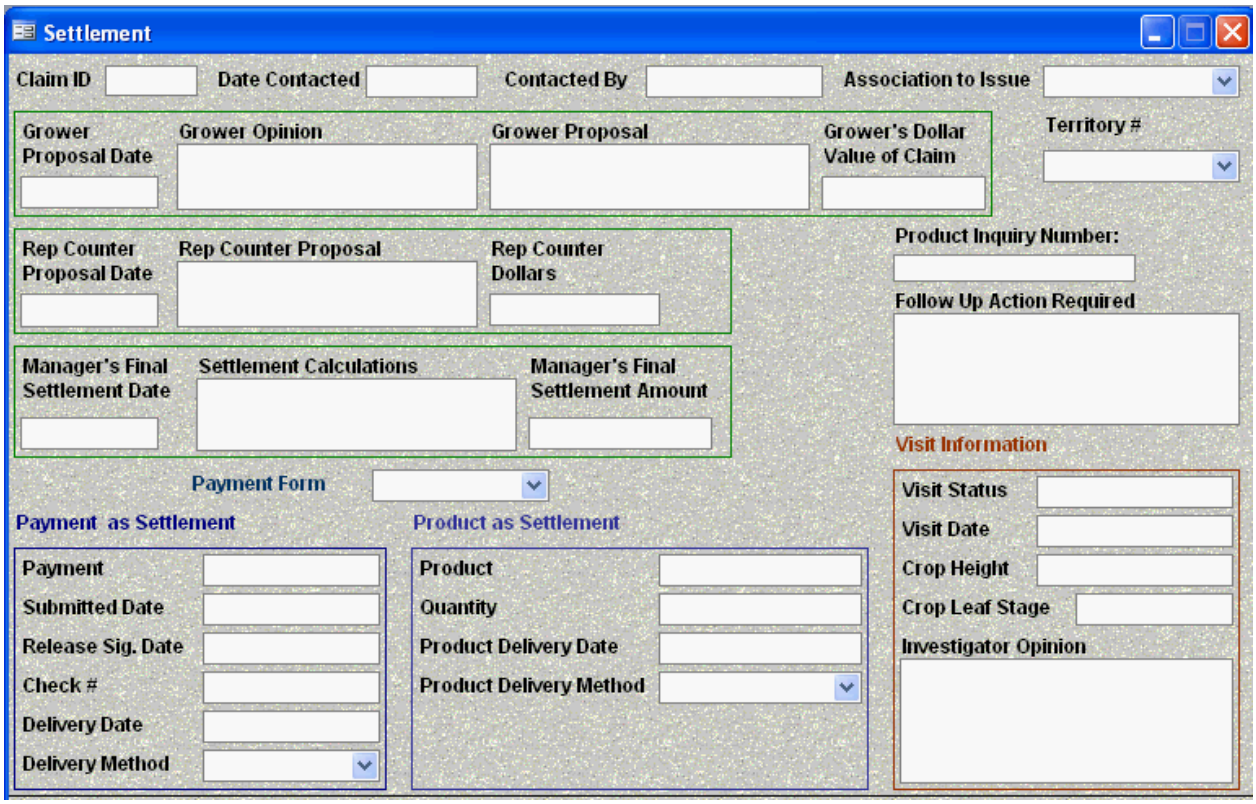


Figure 4. Settlement Detail Form.

"Wow," David exclaimed. "It sure isn't cut and dried, is it? I'm a little confused about when the settlement data is collected. It sure doesn't show up on any of those grower survey forms."

"No, you're right," Marcos answered. "As I said, these details are gathered by the ag consultants and negotiators as the claim is reviewed. There is no formal input form for these items since we record them as we evaluate the claim."

"Okay, but it sure seems like it would be easy to overlook some details without some sort of input form," David opined. "Are there any processes that we have overlooked?"

Track Crop-Planting Intentions

"I'm sure there are several, but the only one that comes to mind is tracking crop-planting intentions," Marcos answered. "The Prior Crop and Relevant Notes have to be recorded. Recall that we mentioned that prior field performance has to be tracked? This should handle that aspect. In addition, we also need to store Planned Following Crop and Recommendations about that crop."

"Marcos," David interrupted. "I think some of that information is included on the Field Summary Form. I recall seeing something about the following crop. And I think that the form includes a variable called Crop that must refer to the Prior Crop."

"Oh, good catch, David," Marcos said with approval. "I'm getting redundant."

"No worries. I think that should be adequate to get started," David replied. "We've at least made a significant dent in learning about the activities involved in the claim process. Thanks for your time, Marcos."

CONCEPTUAL MODELING

"Well," Terri exclaimed to David as they regrouped in their office. "We've got a handle on processes or functions that go into the claim process. Let me look at my old database notes to see what's next. Hmmm, here it is. It makes more sense after we've examined the processes."

"Don't keep it to yourself," David complained. "What does it say?"

"Here it is, word for word. 'For each business activity you should identify all object types that are input to the business activity, all object types that are produced by the business activity, all object types that are modified by the activity, all relationships that are established between participating object types by the business activity, all object types or relationships that are used but not changed by the business activity (ex. government regulations), all object types that control or implement the business activity (ex. policies, government regulations), and finally all operations performed on the object types and relationships by the business activity.'"

"I see," David said. "Let's first list all the objects under each process, consolidate them into one list, evaluate the objects, and then select those that are viable entities, based on the definition of entity, the ubiquitous person, place, thing, or event for which information is collected and stored."

The two worked quietly for a while and then compared their lists. "Here is what I came up with," David said. "First I started with grower, because he is the most obvious. From there I went on to include field and crop. Every crop HAS to have a variety, like Russet potatoes. Then I decided to throw in Retailer, Applicator, and Independent Consultant. Finally there is a Settlement. How does that sound?"

"What about soil and irrigation type," Terri asked.

"Good point,' Davis said. "I wasn't sure how to handle those so I left them out. What do you think?"

"Well," Terri mused, "now that I consider it more I don't think you store information about soil except maybe as an attribute of field. The same holds true for irrigation type, I suppose. Let's try to define an initial set of relations between these entities and see what kind of ERD we come up with. Maybe we can identify attributes of the entities and define the connectivity and cardinality for the relations as we go along."

The two neophyte database designers toiled at their ER Diagram, finally arriving at the ERD shown in Figure 4.

DESIGN VALIDATION AND VERIFICATION

"Let's review our ERD with Seth to be sure that it is capable of capturing all of the relevant data," Terri said. The two designers made an appointment to go over their conceptual model with Seth.

"Well guys," Seth began. "Did you manage to pull it off?"

"Sure, take a look at this," David said as he slid a copy of the ERD across the table. "This is a high level view, so a lot of details aren't apparent, but we managed to capture data about the grower, his field, his crop and crop variety, the retailer, applicator, and consultant, and finally the settlement. Not bad, huh?"

Seth was ominously silent as he studied the diagram. "Remember that I mentioned that the one who applies the chemical can be the grower, the crop advisor, or even the retailer? I'm sure no expert at this type of diagram, so can you show me how that is represented in the model?"

David looked blankly at Terri, who had a deer-in-the-headlights look. "Umm, I think maybe we have some more work to do on this," Terri muttered. "Sorry we bothered you. Thanks for the feedback though."

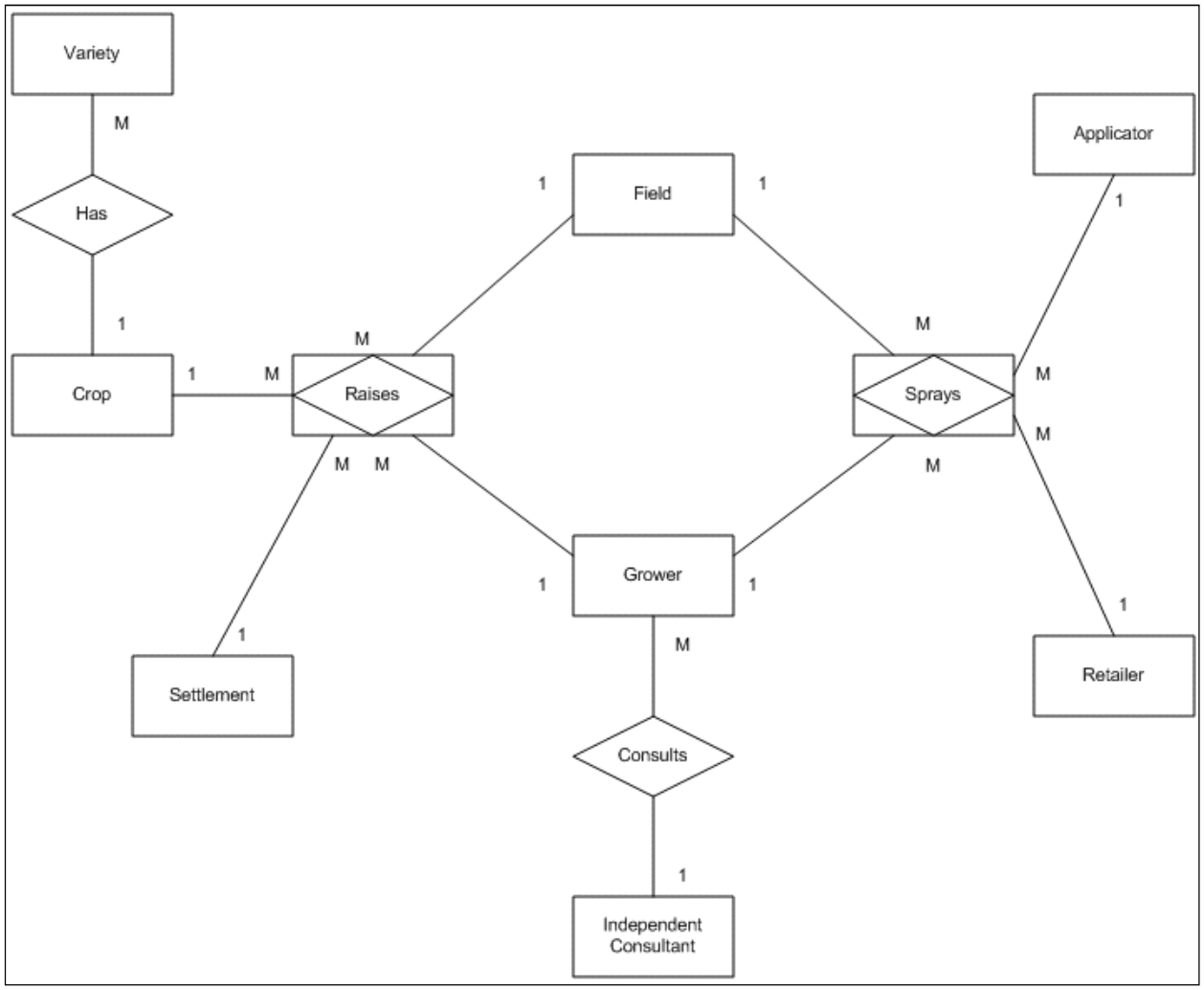


Figure 5. Terri and David's ERD.

As they retreated from Seth's office Terri whispered to David, "I wonder if we can hire our old database professor to consult with us on this. I had no idea it could be so complex! I don't have a clue how to handle that stuff that Seth hit us with!"

David agreed. "Let's give him a call. But I think you'd better refer to him as our 'former' professor instead of our 'old' professor. We want to stay on his good side!"

Seth watched the two continue down the hall and wondered if he would ever have a functional database. He hoped that they could figure out what was wrong and how to fix it. Maybe Jack should

have hired some database professionals with more experience. He made a mental note to have a frank discussion with Jack later that day.

APPENDIX: HERBICIDE CARRYOVER

Agriculture has become reliant on both herbicides and pesticides. Herbicides are chemicals designed to help farmers control weeds, while pesticides are intended to help control insects. In most cases, a particular chemical can be applied only to specific crops; any crop not listed on a product's label will be damaged if the chemical comes into contact with the plant. Further, herbicide labels must be checked and the application rates adjusted to match soil conditions. Even with these precautions, however, herbicides and pesticides sometimes act in an unpredictable manner, adversely affecting the crops they are intended to help. This occurs when certain environmental elements cause chemicals to react differently in certain regions or soil types.

Many farmers experience unanticipated soil persistence when a particular herbicide bonds with the soil and damages a sensitive rotation crop the following year. As a consequence, the company responsible for the chemical is potentially liable for resulting damage claims.

INTRODUCTION TO HERBICIDE COMPLEXITIES

While it is desirable for herbicides to control weeds for the duration of the growing season, it is not desirable for them to persist and affect subsequent crop growth. The ideal herbicide controls weeds throughout the growing season, then instantly degrades, never moving off-site into surface water or groundwater (Simmons, 1998). Further, no residue remains to affect the growth of subsequent crops.

The length of time that an herbicide remains active in soil is called soil persistence or soil residual life. If an herbicide remains in the soil when a susceptible rotational crop is planted, the persistence causes herbicide carryover. For some herbicides there is a fine line between controlling weeds in the intended fashion and persisting to affect a sensitive rotation crop.

The term "half-life" refers to the amount of time required for the dissipation of one half of the original amount of applied herbicide (Colquhoun, 2006). Degradation rates in soil under normal environmental conditions typically reduce herbicide concentrations to sub-lethal levels for rotational crops (Simmons, 1998). However, herbicides vary in their potential to persist in soil, and several factors determine the length of time that herbicides persist (Figure A1). These factors fall into three categories: soil factors, herbicide properties, and climatic conditions. Soil factors include soil composition, soil chemistry, soil pH, and microbial activity. An herbicide's chemical properties include water solubility, vapor pressure, and the molecule's susceptibility to chemical or microbial alteration or degradation. Climatic conditions include moisture, temperature, and sunlight (Simmons, 1998). The primary herbicide-loss pathways in soil are microbial degradation and chemical degradation, primarily driven by reactions with water. Herbicide breakdown rates typically increase as soil moisture and temperature increase, because both chemical and microbial decomposition rates increase with higher temperatures and moisture levels. Water is essential for microbial activity.

Further, nonbiological chemical reactions also typically are enhanced with increased temperature. Cool, dry conditions slow herbicide degradation; thus soil persistence problems are greater in years following droughts (Curran, 1998).

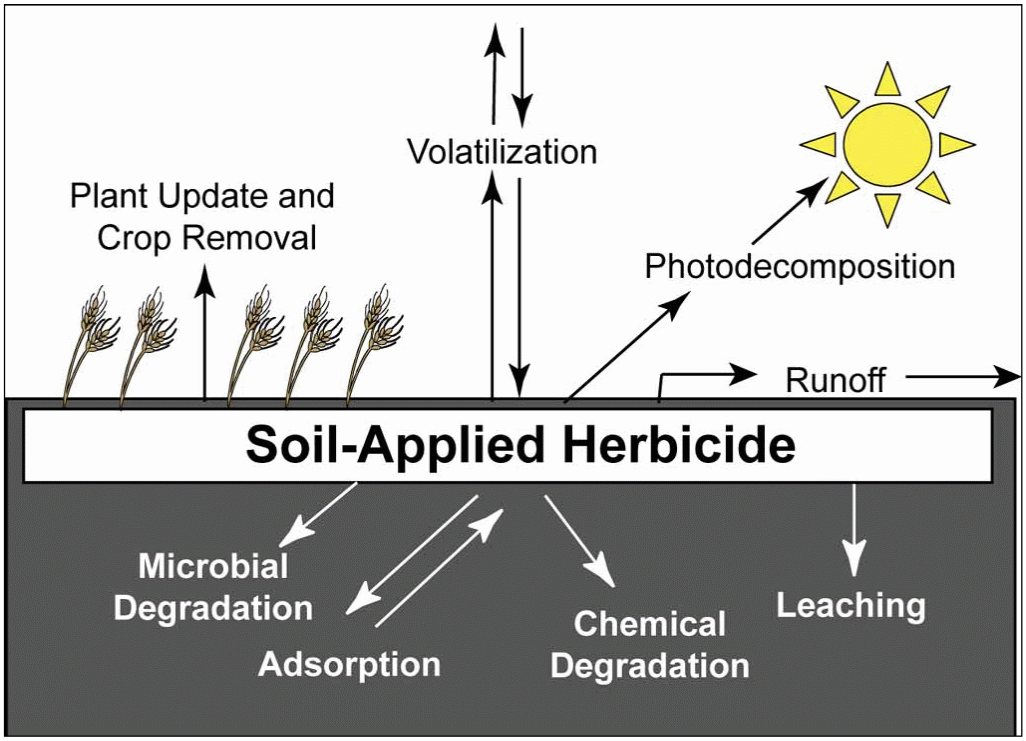


Figure A1. Factors affecting the fate of soil-applied herbicides (Menalled and Dyer, 2004).

Figure A2, from Colquhoun (2006), shows that herbicides persist longer during dry years than during wet years. In the scenario depicted in the figure, the same herbicide is applied in a wet year and a drought year. The herbicide half-life is 40 weeks longer in the drought year than in the wet year, delaying the earliest safe potato planting date without herbicide injury (Colquhoun, 2006).

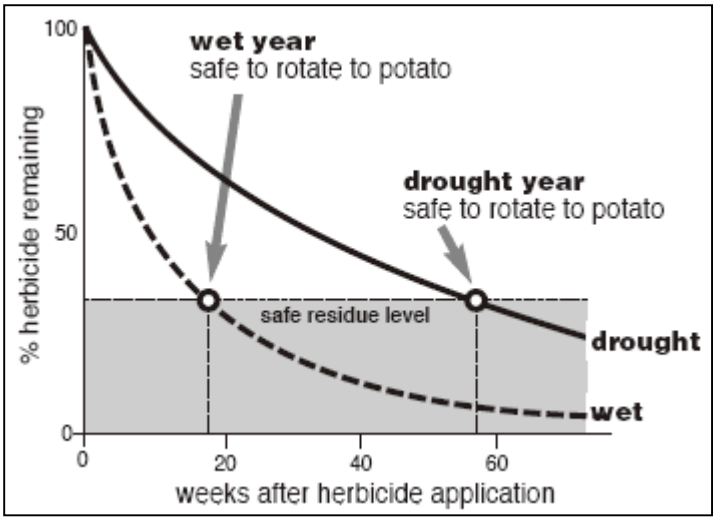


Figure A2. Soil moisture effect on herbicide persistence (Colquhoun, 2006).

Soil pH is another important factor in the stability of herbicides. The pH scale ranges from 0 to 14, where 7 is considered neutral, below 7 acidic, and above 7 basic. High soil pH may reduce herbicide degradation and increase carryover. Calcareous soil is a soil containing accumulations of calcium and magnesium carbonate. It is formed largely by the weathering of calcareous rocks and fossil shell beds, and often contains chalk, marl, and limestone and frequently a large amount of phosphates. They are often very fertile when sufficient moisture for crops is applied, but have a high pH and therefore a high herbicide carryover. The growers who suffered crop damage were farming in an area characterized by highly calcareous soil.

Herbicide carryover is a recognized problem, and there are strategies to reduce crop risk (Colquhoun, 2006). Thorough tillage distributes residual herbicide evenly and dilutes concentration, thus allowing maximum exposure to microorganisms and clay and organic matter that adsorb herbicides. Working the soil can also reduce compaction and increase aerobic microorganism activity. However, tillage will not solve all carryover issues, and in some cases can worsen the situation. Deep plowing can invert residual herbicides, concentrating the residue at soil depths that remain lower in temperature. The herbicide residue can then be brought back to the plant root zone with subsequent deep plowing, thus exposing future crops to potential carryover. It is essential to thoroughly distribute any herbicide residue in the soil (Colquhoun, 2006).

Another option is to plant a rotational crop that is not affected by the herbicide. Alternatively, an herbicide bioassay can be conducted to assess herbicide carryover. Growers can screen for herbicide carryover by growing rotational crop seeds in pots containing soil from the fields. This cannot, however, account for all environmental conditions in the field, and is difficult for some tuberous crops (Colquhoun, 2006). An alternative is to plant a test strip of the rotational crop across the field in question. Finally, a chemical test for herbicide residues can also be done by private laboratories, but such tests are expensive and the results may be difficult to interpret. However, they may be appropriate in cases where bioassays cannot be done or where high value crops are concerned.

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