DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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AI3021 IT IN AGRICULTURAL SYSTEM

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UNIT III NOTES

UNIT III

Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems.

AGRICULTURAL SYSTEMS MANAGEMENT

AGRICULTURAL SYSTEMS DEFINED

- An agricultural system is a specified group of components, operational functions, and processes that are integrated to accomplish a well-defined purpose.
- Agricultural systems managers (ASMs) usually plan, evaluate, and adjust a system or some group of components of a system. In a complex agricultural system one can easily identify or envision systems within systems.
- We might call those systems within systems subsystems, but the main concern is that the system performs to the highest level we can achieve within the parameters or resources at hand.
- The ASM must learn quickly to manage and evaluate subsystems concurrently.

CHARACTERISTICS OF AGRICULTURAL SYSTEMS

- Each agricultural system has some well- defined purpose. The purpose might be stated simply, or more often it might be stated as a group of objectives.
- And those objectives might include some very definite specifications or measures of performance.
- As an example, let's consider an agricultural system that produces potato chips. The overall purpose might be to produce six 1 2= -ounce bags of chips for the consumer market.
- However, the well-defined purpose for the line technical mangers of the processing plant might be production objectives of 1500 bags per hour, less than 0.05% of bags over 0.675 ounces, with less than 8.00% waste, less than 1% under 0.6355 ounces, with less than 0.5 hours line downtime per shift, less than 1 recorded human accident per 6 months, at a cost of less than $0.233 per bag, and meeting the 2002 EPA guidelines regarding odor control in the community.
- In real life this specification list could be much longer, involving hours of planning and discussion with managers, engineers, accountants, labour unions, and lawyers.

We could easily identify the same level of complexity in a production farming operation. The overall purpose might simply be to grow hogs for meat processing. The well-defined purpose might be to produce 1000 barrows, with weight range limited to 205–215 lb, loin eyes of not less than 4.14 sq in or

more than 5.01 sq in, average rates of gain of not less than 1.98 lb/day, at a cost of less than $0.21 per pound, utilizing non GMO feeds, and meeting all local and federal EPA requirements. And, once again, the real pork producers reading this chapter know that an actual specification list for this agricultural system would be much longer. This

discussion of the ‘‘well-defined purpose’’ portion of the definition is well served by the two examples. Looking back at our potato chip processing plant example, we know that to fulfil the well-defined purpose (specifications), numerous operational functions and processes need to be performed. The operational functions and processes are key parts of our definition. Some of those operational functions and processes involving our complete definition of the potato chip agricultural system might be:

- Purchasing of potatoes
- Transportation
- Unloading at the plant
- Storage
- Grading and inspection
- Sorting
- Chemical wash
- Storage
- Waste disposal
- Purchasing of frying oils
- Transportation of oils
- Storage of oils
- Least-cost formulation of ingredients
- Cutting processes
- Line movement of product
- Frying
- Salting
- Packaging/weighing
- Boxing
- Quality control
- Pricing
- Loading
- Distribution and storage
- Sales
- Transport

In this agricultural system each operation or process might require humans, machine components, or a chemical or biological process. And each process will have management-defined parameters for successful operation. We could construct elaborate diagrams or computer programs to inspect or evaluate each component or operational activity. But our mission is to manage agricultural systems to achieve goals. To do that, we must fully understand how each component of a system works and the interacting effect its application might have on other components and the outcome of the system. To predict those impacts, we can rely on mathematical models and tools to forecast outcomes of decision alternatives.

EXPECTED OUTCOMES OR ‘‘DELIVERABLES’’ OF AGRICULTURAL SYSTEMS

There is a real need for the system to deliver well-defined products. Today’s consumer-oriented market demands truth and performance. A system often must meet standards either the consumer wants or governments might demand. Let us consider the challenge a small organic fertilizer bagging plant might have. The manager must meet the desires of the company for profit, of the public for performance, and of the government for truth in packaging. The manager and the company must design a product that meets the specification that satisfy company upper management for profit, establish product features that entice a certain market share of buyers and meets state and federal analysis on the package label. Each fertilizer product becomes very well defined, and the agricultural processing system must meet the goals. Many people from many arenas give critical input.

It is expected that the products the production line delivers are profitable. Agriculture is a business Every business must in the end meet a profit goal. In this small organic fertilizer bagging business we must set production volume targets, estimate fixed and variable costs, and establish costs per bag, pricing, and target profits. If this was all there was to management of this line, it would be easy. However, agricultural systems have to satisfy many other conditions. Profitability is not enough. The product must be safe for use. The manufacturer must also guarantee the safety of the production workers and perhaps meet union work conditions. If the product were edible or a drug it would have to be safe for human consumption Certain aspects of quality control would have to be met and verified.

Our bagging plant would probably produce ‘‘secondary’’ compounds or wastes. They must be managed as well. Those processes and costs become part of the total agricultural system too. The plant is responsible in American society to maintain or enhance the environment. Or at the very least, the product must be produced at environmental costs that society (and the law) deems acceptable. It is not unusual to expect that the bagging plant system also contribute to the general community economic development and well-being.

THE PRIMARY GOALS OF AGRICULTURAL SYSTEMS MANAGERS

An all-too-common mistake of technical management is a failure to identify performance criteria against which the system must be evaluated. These criteria and their measures need to be well established before we ‘‘flip the switch’’ and a system begins to operate.

The goals, criteria for success, and performance measurement assessment should be part and parcel of every planning process and evaluation process. These performance criteria should be established up front and agreed upon by all management.

It is not unusual to see these measures as part of monthly, quarterly, and annual reports. Some primary goals agricultural systems managers must attain are:

1. Optimization of economic costs, profits, and benefits

2. Production of defined levels of product quality and
3. quantity
4. Meeting timelines and schedules
5. Delivery of value-added products and product attributes
6. Attaining acceptable process reliability
7. Maximization of e efficiencies
8. Realization of environmental and regulatory guidelines
9. Optimization of human factors—safety, job satisfaction,
10. performance factors, and perhaps labor union issues

CRITERIA OF EVALUATION

Obviously, production costs per bag of chips would be a key criterion to evaluate, or maybe the total volume over a week, or total production in bags over the year.

So, costs, volumes, and profits are key criteria. Efficiency of the processes can be measured, equipment adjustments made, or replacement of processes effected.

Some of the processes included truck unloading, storage, belt movement, cutting, frying, salting, sorting, weighing, bagging, and boxing. Product quality must also be assessed.

Yes, we all like a beautiful, unbroken chip! The size, colour, weight, etc can all be assessed. Storage life and condition of the package itself can be evaluated and goals set No one likes a wrinkled bag or a misprinted label.

And who wants a six-ounce bag of chips labelled as seven ounces? If we forget that the whole system must have a very high-performance reliability, we cannot achieve any other goals.

To achieve this, we must meet timelines and schedules and attain serviceability and machine replacement goals. In a production plant we are always scrutinizing resource utilization, waste reduction, risk minimization, performance, stability, environmental impacts, FDA guidelines, food safety guidelines, and state and federal regulations.

Today, food processes must meet purity and process standards. Then there is the human element.

Are the plant meeting union agreements? Some additional criteria for evaluation would be meeting goals in plant safety, personnel satisfaction, health, comfort, and plant security.

The ASM must approach the system management from a team perspective. Many have input. Many must be informed and empowered. It becomes quite clear that a good technical manager manages far more than money.

Managing means managing all the resources. The good technical manager must also consider machine replacement, new products, new technologies, and training of personnel.

FACTORS AFFECTING THE AGRICULTURAL SYSTEM AND THE ASM'S DECISION MAKING

1. **Changes in Weather, Seasonality, or Biological Intrusions**

Perhaps the most significant and unique factor in agricultural systems management is dealing with the weather or seasonality of commodity production.

In our organic bagging plant example, an unknown or unplanned warm weather span could greatly spur biological activity of stored wood chips or manure.

Rising temperatures or microbe levels in the potato storage sheds would cause the potato chip manger to have to adapt to these conditions. Many processed products of agricultural systems are live biological entities requiring heating, cooling, pasteurization, sterilization, fermentation, or even radiation.

Seasonal changes or unusual weather patterns can greatly change schedules in Beld planting of corn or harvesting of soybeans. A meat processor knows that biological processes occur in known time frames. He or she must acknowledge and respond to unusual temperatures.

Processing changes must occur, or product quality is lost—or the product itself could be lost entirely.

A Florida citrus grower must change processes if an unusual cold snap jeopardizes the life of a young fruit tree Or if a disease such as aflatoxin enters a corn Beld nearing harvest, an immediate response by the ASM is required.

In production agriculture one must always be prepared to alter decisions when plant or animal diseases enter or threaten. The threat of SDS (sudden death syndrome) to a soybean crop would require changes in variety selection, planting dates, and harvest dates.

Likewise, a dry year would certainly spur the ASM of a grape vineyard to engage irrigation scheduling. The same dry year would spur the ASM of a winery to change the formulation of his winemaking process, since the soluble solids count of the grape juice would increase in a dry year.

In a wet year, the count may drop and the ASM might add sugar to fermentation processes.

2. CHANGES IN TECHNOLOGY

All so often dramatic changes in technology or innovations impact the agricultural system so much that the ASM is required to completely change the components, functions, or processes of the systems. In other words, we completely change the way we do things.

One dramatic example of this is the impact of biotechnology techniques and nanotechnology equipment on the development of plant seeds. The new technology completely changed how we exchange genetic information to form new varieties.

Processes were changed, new skills were required, and old seed technology was rendered noncompetitive. While this new technology changed forever how we promulgate plants, it also changed how we grow them in the Beld Genetically modified plants are now collegial in being resistant to certain herbicides.

Thus, we also have modified the cultivation and pesticide application in the production Beld systems of agriculture. Changing a technological process is not the only impact of changing technology. The development of a new product can greatly change an agricultural system.

The invention of the large round hay baler is a good example. The introduction of the machine completely revolutionized haymaking in the Midwest, where labour costs are high. The old system of baling hay in small rectangular bales was rendered economically noncompetitive, except in specialty markets. Likewise, another biotechnological breakthrough is allowing us to grow pharmaceutical proteins and compounds in corn.

Several billion dollars a year is now generated by growing this new ‘‘Pharma’’ corn product, but the system of growing and handling requires new and unusual techniques to ensure biological security of plant growing regions ‘‘Pharming’’ requires many changes in the agricultural system.

Sometimes the breakthroughs can come from other industries or other countries. Agricultural industries and systems were greatly affected when other manufacturing industries began to adopt and develop different sweeteners.

Corn growers benefited from high-fructose sweetener, while sugar cane growers were forced to change production methods to remain competitive.

Better irrigation technology in Israel and Brazil forced growers of citrus in Florida, Arizona, and Texas to completely change irrigation technology to remain competitive. Some examples of technology changes of great impact
would be:

- Analog/digital interfacing with microcomputers
- Global positioning systems (GPS)
- Introduction of microcomputers for data handling and
- controls
- Spreadsheet software
- New plastic extrusion methods
- Ethanol processing from corn
- Rotary threshing mechanisms in combines
- Ergonomic engineering of tractor cabs
- Soil conservation practices
- The cotton gin
- Evaporative cooling for greenhouses
- Hydra cooling of fruits and vegetables
- Irradiation of meats, fruits, and vegetables

The list is very long and continues to grow daily. One of new technologies having the most impact is the use of the Internet for marketing and purchasing—commonly called e-commerce. E-commerce now allows an ASM to purchase and market worldwide. Top ASMs will need information systems that allow them to be educated rapidly regarding new developments. The Internet itself is a technological addition that has had perhaps the most dramatic effect on 21st century agriculture.

3. LEGAL/POLITICAL FACTORS

New laws and regulations can have great impacts on decisions regarding Beld production, manufacturing and processing, and technical marketing areas of agricultural systems. Even without new laws, new rulings by regulatory agencies can have consequences.

Changes in the tax structure can have significant impacts on management. Throughout the 1970s and early 1980s, farmers enjoyed federal tax exclusions from an investment credit deduction. Farmers could derive great benefits that encouraged buying capital equipment such as tractors, combines, and portable buildings. Federal tax reform removed
these advantages, and equipment replacement planning strategies changed greatly. Because many did not know their income status until late in the year, there was a lot of lastminute December purchasing. This last-minute buying ceased. This change affected

not only farmer purchasing but the way money was spent. Manufacturing schedules, technical sales programs and activities, and managerial decisions were changed. Even tax accountants had to change their schedules of activity.

Some of the most significant laws now affect the livestock production industry. Some small rural cities now have ‘‘influence’’ up to three miles from their city limits regarding odor control. Many local agencies in counties now control animal unit limits. Changes in fees for grazing on public lands in the West are another example where ranchers are forced to manage differently under different rate structures.

Laws affecting migrant labor, labor camp conditions, and wage rates greatly affect the fruit and vegetable industries. The trade-off between labor and mechanization greatly changes.

Likewise, Occupational Safety and Health Administration (OSHA) regulations and labor laws impact management decisions in processing plants.

On the technical marketing scene, the North American Free Trade Agreement (NAFTA) has changed the playing Beld considerably. Some industries have greatly benefited, while others have suffered. Changes in EPA guidelines and standards now have great managerial impact regarding the use of fertilizers and pesticides.

Nonpoint and point sources of watershed runoff are now more controlled. The ASM must keep abreast of key local, national, and international issues. Some key governmental agencies are:

1. Bureau of Land Management
2. EPA
3. State Departments of Agriculture
4. Water management districts
5. Farm Services
6. US Forest Service
7. Zoning commissions
8. Department of the Interior
9. Bureau of Indian AAairs
10. Agricultural Plant Health Inspection Service (APHIS)
11. Homeland Security

4. <u>The Economy</u>

Since the events of Sept. 11, 2001, we have learned how catastrophes can send an economy reeling for many months. Numerous factors in the economy can affect agricultural systems decisions. Managers in the manufacturing and processing areas certainly must be in tune with changes in the economy. Some key factors of change include oscillating inventory levels for supplies, available disposable income, new housing starts, changes in gross domestic product (GDP), expansion/failures of businesses, price levels, and changes in exports or imports.

Today, agriculture faces many changes in marketing channels for livestock, increasing mergers of seed and chemical companies, and consolidation of equipment suppliers. Yet new opportunities abound in the emergence of alternative fuel processors and new crop initiatives.