Staff Paper Series

Staff Paper P73-22 August 1973

RESOURCE USE IN SYSTEMS OF INTENSIVE ANIMAL PRODUCTION

By

Delane E. Welsch

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture
St. Paul, Minnesota 55108

Staff Paper P73-22 August 1973

RESOURCE USE IN SYSTEMS OF INTENSIVE ANIMAL PRODUCTION

Delane E. Welsch

Department of Agricultural and Applied Economics
University of Minnesota

RESOURCE USE IN SYSTEMS OF INTENSIVE ANIMAL PRODUCTION

By

Delane E. Welsch

Invited Paper for Theme 4 - Intensive Systems of Animal Production

III WORLD CONFERENCE ON ANIMAL PRODUCTION
Melbourne, Australia, 22nd-30th May, 1973.

The helpful comments and suggestions of J. E. Johnston, L. D. Stifel, R. K. Davidson, R. W. Cummings, R. H. Brannon, W. P. Falcon, C. P. Timmer, V. W. Ruttan, and P. M. Raup are all gratefully acknowledged. Errors in fact and logic remain my own.

RESOURCE USE IN SYSTEMS OF INTENSIVE ANIMAL PRODUCTION

Demand pressures on an economy are what direct resource use. The "mix" or particular combination of resources used in production of products to satisfy those demands depends on relative resource prices, the technology available, institutional rules, and social and cultural aspects of the people.

The purpose of this paper is to describe several alternative mixes of resources used in animal production, explain why they came about, and question their appropriateness. My main thesis is that capital-intensive systems, although not inherently good or bad, have social and economic consequences for a country that may be either very good or very bad. If the capital-intensive technology being used leads to economies of scale, then production units will tend to internalize certain benefits and externalize certain costs. Furthermore, if this takes place in a society in which the institutional rules regarding taxes favor capital gains over current income, then resource use and ownership of production units will be distorted away from the pattern which would attain equity and welfare objectives of the society. This may raise questions about the appropriateness of capital-intensive systems in rich countries, and even more doubts about their role in developing countries. I will close with what I hope is a valid plea for research on labor-intensive systems that will contribute to increased employment and more equitable distribution of income.

At an early point in the development of an economy, the resource endowment of that economy determined the relative prices of resources. Relative prices, of course, were affected by demand, but the major thrust came from the natural endowment. The technology that the people developed reflected these relative prices. For example, Japan, with an abundance of labor and a scarcity of land, developed a labor-intensive rice production technology. The United States, on the other hand, developed a technology that used plenty of land and economized on the scarce resource, labor. The title of "induced innovation hypothesis" has been given to this phenomenon, but roughly one could say that "necessity is the mother of invention," with demand, both domestic and foreign, as the main driving force.

As either resource endowments or demand or both change, one could expect technology to change through innovation. But this self-adjusting mechanism doesn't always come about. There may be socio-cultural or religious constraints. For example, a society that develops as rice growers on a delta may be slow in changing resource use in response to changing relative prices,or a pastoral society may be slow in adopting to sedentary agriculture. A more serious distortion in resource allocation may occur when the society permits institutional distortions, such as when economic or political power groups or special interest groups override the self-adjusting mechanism. Import restrictions and tax advantages are examples. The effect of resource endowment on technical change may also be weaker in some developing countries today because these economies are more open

than Japan and the U.S. were. For example, not only trade, but also the flow of capital, technology, and management resources from advanced to developing countries is considerable.

The terms "intensive" and "extensive" in agricultural production originally referred to levels of inputs and output (yield) per unit area of land. Thus, an intensive system was one that used more inputs and produced a higher yield per hectare than an alternative system, which would be called an extensive system. Conceptually, increased output per hectare can come about in three ways: through increased application of either capital or labor; increased application of both; or change in technique. Thus, "intensive" per se is not a very useful term. It is not only the level (quantity) of land, labor and capital, but also the proportions of each, and the rate of return to that combination that are important. It is also important to note the case in which in a given system with constant level of output and total inputs, certain inputs may be substituted for each other as relative prices of each change.

In an earlier draft of this paper, I tried a six-way classification of livestock systems, specifying which of the three main categories of factors of production that I was referring to with respect to intensity of the use of that factor. This definition was too contrary to the usual terminology with respect to land for my reviewers, i.e., a system that uses a lot of land relative to labor and capital was called a "land-intensive" system, which in

the conventional terminology is called an extensive system. The usual concept of an intensive animal production system consists of only one of the six, the capital-intensive system, although labor-intensive systems have evolved in certain places. Therefore, I have subdivided the six categories into a group of three that are basically grazing systems and use a lot of land and another group of three that are basically confinement systems and use very little land directly. Also, since livestock is a form of capital, this complicates our analysis of intensity of production somewhat, and so in this paper I will distinguish between the two forms of capital: first, that embodied in livestock; and second, all other capital used in the production system.

Conceptually then there can be six types of intensive animal production, as follows.

1. Much land, basically grazing systems

1.1. Much land, little labor and capital. This type of animal production has existed since before the recorded history of man. At one extreme would be wild animals, with the only labor input being in the harvest and the only capital input being the weapon used in the hunt. There is renewed interest in this system of production today in harvest of game in certain areas of East Africa. As animals were domesticated, the amount of labor used increased slightly, in the form of herding, but land remained the major input. This level of intensity of production remained until the early 1900's in western

United States.

1.2. Much land and labor, little capital. As human and animal populations increased and sedentary agriculture developed, techniques of animal production evolved which used more labor than previously. Increased amounts of labor were needed as crop production expanded for herding and keeping the animals out of the areas where crops were growing. This technique of production still exists in many developing countries, where communal grazing areas are scattered amongst cropped areas. Technologies were also developed that involved better care of the animals, particularly at birth, requiring more labor. The increased use of labor was due to the rising price of land relative to labor.

1.3. Much land and capital, little labor. As the price of labor relative to land and capital started rising, (chiefly due to increased productivity and thereby returns to labor in non-livestock producing activities), capital was increasingly substituted for labor. The technologies which were developed also tended to permit some substitution of capital for land, for example, in increasing output of forage through brush clearing, fertilization, etc. The development of fences to reduce herding labor was a major step. Today the ultimate in substitution of capital for labor in grazing systems is probably the use of airplanes and helicopters for checking the cattle and overseeding and fertilizing pastures, automated watering devices, and mechanical devices for handling the stock for medical treatment. But these systems still use a lot of land relative to labor.

2. Little land, basically confinement systems

2.1. Little land and capital, much labor. In economies where capital remained very expensive, and the price of land rose rapidly relative to labor, chiefly due to human population expansion, stall feeding of animals evolved. In warm climates, this type of system may still have been based on roughages, but land became too expensive to permit letting the animal harvest it, so grass and hay were harvested by hand and carried to the animals. In cold climates, there was a need for protection during inclement weather, closer attention to animal health, etc., so systems combining winter confinement and summer grazing evolved. But this type of labor-intensive system has also become widespread in some of the developing countries where, although climate is not a restriction, the high man-land ratio leads to substitution of labor for land. This type of system also evolves in mixed cropping-grazing areas where either the price of capital precludes investing in fencing or the returns to carefully managed rotational grazing are unknown or undemonstrated.

2.2. Little land, much capital and labor. At some point in the development or growth of an economy, with land still scarce relative to labor, the relative price of capital starts falling, and two things may happen. First, capital is substituted for labor wherever possible. Second, technologies which use more capital evolve. In the latter case, capital isn't really being substituted for labor, but instead the technology requires a heavier capital input. The usual step is capital

investment both in structures to partially control the environment, in improved breeds or strains, and in animal health and nutrition, which distinguishes this confinement system from system 2.1. Considerable labor is still involved in producing feedstuffs and feeding the animals, and the system may be called labor-capital-intensive.

2.3. Little land and labor, much capital. A fully automated confinement system is an example of this type of capital-intensive system. It usually comes about as a consequence of high prices of land and labor relative to the price of capital. But as will be discussed below, these relative prices may be distorted by institutional or other factors. It also may come about from strong demand pressures for differentiated products and specific product qualities.

The reader will note that the amount of land actually required for systems 2.1, 2.2, and 2.3 is understated by the amount needed to produce the feedstuffs to be fed in the confinement systems.

The sequence of change from one to another of the six categories of systems listed above has varied a great deal among countries, among regions within countries, and over time. Most started with 1.1, and in some African countries this system still predominates. Other areas went on to 1.2, which is still common in other parts of Africa and some parts of Asia. System 1.3 seems unique to arid, sparsely populated regions of the U.S. and Australia, where it still exists. Other regions of the U.S. and most of Europe moved from 1.2 rapidly through 2.1 to 2.2, with 2.3 now coming in rapidly. Most developing

countries of Asia moved from 1.2 to 2.1 and stopped. Much of the current foreign technical assistance in these countries today deals with attempts to move from 2.1 to 2.2, through import of technology or adaptive research or both.

The remainder of this paper will deal with reasons for the spread of capital-intensive systems (type 2.3), their effect on society, and some alternatives.

Most studies in the past of size of agricultural operations in developed countries show that long run average costs (per unit of output) decline rapidly up to a certain size, then remain fairly constant over a wide range of output, and finally start increasing again. As the technique of production becomes more capital intensive, and as a higher proportion of the variable inputs are purchased, the unit costs tend to continue to fall until a larger size is reached. This is because large firms tend to be more able to internalize certain benefits and externalize certain costs than small firms. Examples of internalized benefits in both rich and poor countries include use of large scale equipment, bulk purchase of supplies and equipment at discounts, market power in the sale of products, and, perhaps most important, better access to capital markets. Examples of externalized costs include those of waste disposal and pollution control, added burdens on public services, and particularly in poor countries or poor regions of rich countries, of unemployment of labor displaced by capital intensive systems.

The result of the internalizing and externalizing discussed above is that the market prices for inputs and output faced by the firm do not adequately measure all of the costs of this system nor all of the benefits of alternative systems. This is not a condemnation of entrepreneurs or private decision makers, who maximize profits by responding to sets of prices. It is simply to point out that systems may be adopted in response to prices that are false in the sense that they do not measure total costs and benefits to the whole economy and society.

But there is another more serious form of distortion in rate of return in some rich countries that encourages capital-intensive systems, namely the tax system. In the U.S., due to the particular nature of the tax laws, tax shelters are available that provide strong incentives to convert ordinary income into capital gains. Income tax is graduated and progressive, whereas capital gains are taxed at a low and flat rate for incomes above a certain level, which is of benefit to those who convert high levels of non-farm income into farm capital which can then utilize capital gains tax treatment. This aspect of the tax structure is of no value to family farms in their regular operations.

The institutional tax structure, ownership of property, and the particular form of production organization are all tied together in the above example. Thus, the appropriateness of a capital intensive system is questionable if there are substantial distortions in the price structure which bring about deviations of private and social costs, and if the system is one in which the ownership of capital is

highly concentrated, and if the tax structure subsidizes the owners of capital. It so happens that capital-intensive systems have spread most rapidly in rich countries, in which the above all tend to be present. Such systems may very well have a place in situations where true relative social opportunity costs are accurately reflected.

Proponents of capital-intensive systems will argue that a major social benefit from such systems is plentiful supplies of low cost food. I don't accept that argument. First, low by what standards? Certainly not by world prices, or otherwise why would these same producers be leading the fight to restrict world trade through import duties, quotas, or even outright embargoes? Second, the expenditures on meat even by low income classes isn't large enough for price changes to affect their real income very much. Third, institutionally induced distortions in relative prices usually reduces consumer sovereignty and thereby welfare. I will not go into the vertical integration aspect that often accompanies capital-intensive systems, which is a potential source of monopoly power and further reductions in welfare of people. I should add that I do expect to see systems even more capital-intensive arising in the U.S., but they will be paying full costs, including environmental costs, and the price of meat will be higher.

If there are these many questions about the appropriateness of the present capital-intensive systems in rich countries, then their transfer to poorer countries becomes even more questionable. There

is a real place for labor-intensive systems in the developing countries, and a need for research on the creation of the technology for such systems. Let me cite a few of the most striking benefits.

The first has to do with capital formation. In poor countries capital is generally scarce and therefore high in price, so that capital formation or the adding to the stock of capital becomes an important objective. Conventional thinking dwells on machines and buildings, but I submit that a very important form of capital formation can be in the increase of a nation's stock of animals. And this method doesn't require a lot of foreign exchange to buy machines from rich countries. Increasing livestock numbers can be a labor-intensive method of capital formation, which can have important social implications if the nation also has an abundance of labor relative to other resources.

The second point is that many poor countries have nutritional problems. If it is chiefly protein scarcity, then animal products could be an important source of improving nutrition, if their cost of production could be brought into line with plant protein. With present technologies, however, animal protein is a luxury. If it is a total calorie problem, then can a labor-intensive system be developed that doesn't compete with people for grain?

The third aspect has to do with the income elasticity of demand for animal products. The evidence available thus far indicates that when their income increases, people in developing countries are willing to take a large part of this growth in income in the form

of food, particularly animal products. This fact makes the demand side of a labor-intensive animal production system consistent with the capital formation side. Getting rapid increases in income to thereby generate such an increment in demand is a broader problem.

The fourth point has to do with land. Up to now I have treated land as one resource, but we all know that land is not homogeneous. In any country or even within agroclimatic zones in the country, there are various qualities of land and topographical features, each with a best use, given the available technology and relative price structure. In most poor countries the quantity of land suitable for labor or capital or labor-capital-intensive crop production is limited. Yet one often sees proposals to develop "intensive grazing-forage production systems" on such land. But the method or technology of developing such systems actually requires considerable capital investment, i.e., they are really capital-intensive systems, and in a capital scarce labor abundant economy no less! Those who would rightly decry the building of a completely mechanized textile plant that provides very little employment and requires imported machines, will turn right around and propose such an animal production system! And if current prices are not such as to make the system profitable, they suggest that the government distort relative prices. What is needed is development of a technology that utilizes land which is comparatively disadvantaged in crop production. Animals, particularly ruminants, can use numerous plant materials which man

cannot use and can convert them into nutritious food. Ruminants are capable of converting non-protein nitrogen sources and low quality proteins into human foods of high protein quality. Even non-ruminants, considered nutritionally competitive with man, can convert unacceptable or unpalatable food or feedstuffs to high quality human food.

In summary, the term "intensive systems" doesn't mean much unless one specifies which resource or resources are being used intensively relative to the other resources employed. The appropriateness of capital-intensive systems is questionable in some countries under some situations. Labor-intensive systems need to have much more research effort directed to them as they hold much promise for developing countries, and may still have a place in the richer countries.