Development of Rice-based Integrated Multiproduct Farming in the Saku Basin in Nagano Prefecture from the 1880s to the 1930s

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Abstract The purpose of this study is to revisit the beneficial aspects of traditional Japanese integrated multiproduct farming by virtue of its effective use of land resources and agricultural byproducts. As a case study, this paper draws upon a form of multiproduct farming based on rice farming in Sakurai Village in the Saku Basin, Nagano Prefecture, practiced from the 1880s to the 1930s. Although rice cultivation was the major agricultural activity in Sakurai Village, in the 1880s the industry of sericulture was increasing, and by the 1920s it had overtaken rice in terms of production value. Subsequently, however, sericulture entered a period of stagnation due to falling silk cocoon prices, and as a consequence more farmers in the area turned to rice-carp culture (cultivating carp in paddies concurrently with rice). With the introduction of pig farming to the area, the 1930s saw the development of multiproduct farming system consisting of rice, silkworms, carp and pigs. Given that the average farm size per farming family in Sakurai Village was just 65 ares, rice-carp culture was an effective way to make a living from a limited amount of land. Not only was stocking carp in paddies beneficial to the growth of the rice plants themselves, but it cut down on the necessity of weeding. In addition, the silkworm pupae left over from silk production was fed to carp, rice bran to pigs, and barnyard manure became fertilizer for both rice paddies and mulberry fields. In short, this system of rice-based multiproduct farming enabled farmers in Sakurai Village in the 1930s to put small plots of farmland to very efficient use. It is evident that this system was based on the recycling of readily available resources, making efficient use of agricultural byproducts. This rice-based multiproduct system of farming likewise allowed the tenant farming family taken up in this study to actually turn profits, which is evidence that it was an effective means of increasing incomes for the peasantry.

Key words multiproduct farming, rice farming, sericulture, rice-carp culture, Saku Basin

Introduction

Traditional Japanese farming is characteristic in that farm sizes are quite small (averaging about one hectare), they produce multiple products, and they are family-run. Because of their size they cannot take advantage of economies of scale, and because they are multiproduct-based they lack the efficiency that inherently comes with specialized (i.e. single crop) farming operations. Likewise, since they are family-run, distinctions are often not made between maintaining a livelihood and making a profit. Such traditional farming families often lack the profit-oriented mindsets common to other enterprises, and as a consequence tend to be relatively wanting in “professional” business or managerial instincts. For these reasons, traditional Japanese farming overall is marked by low labor productivity. Similarly, these factors have weakened the international competitiveness of agriculture as an industry compared to other forms of production. This is why in today’s increasingly globalized economy many have asserted that it is necessary to reform the ways in which Japanese farms are managed.

Solutions devised to address this lack of global competitiveness and efficiency include: the expansion of individual farms, more specialized farming, and the introduction of corporate-style management. These steps have been promoted through governmental policies since the 1990s, and considerable progress in these areas has in fact been made. On the other hand, such changes to farming have given rise to a new set of problems. First, the pursuit of efficiency has meant that much inferior farmland has gone uncultivated, leading to an overall decline in land use. This in turn has brought about not only problems in the realm of agriculture but problems related to the conservation of land and landscape as well. Second, specialized farming has led to a decrease in the use of agricultural byproducts, and as a result to a larger negative impact on the environment. For example, the
separation of crop cultivation and livestock raising means that less manure is used as fertilizer, which in turn poses a higher risk for environmental contamination from improperly processed animal waste. In order to address these problems, efforts are underway in modern-day Japan to look at the multifunctionality of agriculture, and different farming strategies are being explored that rely on the recycling of resources (Nihon nogyo keiei gakkai 2007).

While traditional Japanese multiproduct family farming has been construed in a negative light from a business efficiency perspective, as I stated above, in terms of the efficient and effective use of land resources and agricultural byproducts, some aspects of such traditional farming styles are worthy of renewed interest (Kumazawa 1996). In past decades in Japan, there existed many variations of rice-based multiproduct farming. Until World War II, rice and silk comprised the two major sectors of Japanese agriculture, and as such, variations on multiproduct farming which included sericulture and rice production were widespread. This study looks specifically at the example of multiproduct farming that adds aquaculture to this combination, and in doing so attempts to shed new light on the value of traditional Japanese multiproduct farming from the perspective of land resource and agricultural byproduct use.

In the field of human geography, Yamamoto (2000) has noted the importance of research into traditional Japanese multiproduct family farming. A representative example of such research deals with farming villages in the mountainous areas of Fukushima Prefecture (Yamamoto et al. 1984). In the realm of agricultural economics, Tama (1994) has stressed the significance of multiproduct farming in pre-World War II Japanese agricultural economies. Tanaka (1990) has produced a case study that examines Gunma Prefecture and the development in early modern Japan of the combined cultivation of rice, silkworms, barley, and wheat there. While these studies provide many invaluable insights relevant to the present examination, there is still a relative lack of in-depth research dealing with aquaculture integrated as an element of Japanese integrated multiproduct farming. The fact that intimate connections existed among rice farming and the catching and cultivation of fish in traditional agricultural livelihoods in Japan has been recognized (Yasumuro 2005), which underscores the importance of research into integrated farming that includes aquaculture. Carp in particular was a widespread choice for aquaculture in early modern Japanese agricultural communities, and Nagano Prefecture was an area where this practice especially flourished.

This study examines a system of integrated multiproduct farming that combined rice, silkworm, and paddy carp cultivation practiced in the Saku Basin in Nagano Prefecture from the 1880s to the 1930s. When comparisons are made using the yardstick of efficiency in the use of land resources and agricultural byproducts, the system of farming that developed in the Saku Basin stands out as one of the most advanced and highly-developed forms of farming in early modern Japan. Within the broad Saku Basin, the former Nozawa Town and Sakurai Village (now both part of the City of Saku) were the major centers of carp cultivation. The scope of this investigation covers Sakurai Village.1

In terms of methodology, I first laid out the changing forms of multiproduct farming in Sakurai Village, practiced over time, from the 1880s to the 1930s, using administrative level statistics collected for this roughly half-century duration and analyzing them from a developmental history perspective. Next, I identified the established practice of rice-based integrated multiproduct farming from the 1920s to the 1930s through the example of a particular farming family. In this microscale study I analyzed the styles of farming, ways of using land, and the business performance of those farming styles. As for sources I used Sakurai Village office documents and the agricultural records available for the sample farming family taken up in this case study. I also relied on old cadastre maps to reconstruct the land use.

**Overview of the Area**

Nagano Prefecture is a land-locked mountainous region which is situated roughly in the center of the main Japanese island of Honshu. Because there are few flatlands, around 1930 the average area of farmland cultivated by a single farming family in the Prefecture was only 83 ares, which was a driving force behind the development of integrated rice culture and sericulture. For these reasons, Nagano Prefecture serves as a typical example of traditional multiproduct farming practiced in Japan.

The Saku Basin, which ranges from the relatively high altitude of 600 to 800 meters above sea level, is located in the east of Nagano Prefecture (Figure 1). The climate is typical of inland central Japan. The area experiences fairly extreme seasonal differences in temperature, with average temperatures of 22.8 degree C for August and −2.5 degree C for January. The average precipitation is only 900 millimeters annually. As for geological features,
the Chikuma River (best known outside of Nagano as the Shinano River) cuts through the center of the basin, flowing west with alluvial flats extending from both banks. The flats in the basin are collectively referred to as the Nozawa-Taira (Nozawa Flatland). As shown in Figure 2, around 1930 there were many towns and villages in the Saku Basin area in which dry fields, not paddies, were predominant. However, in Nozawa Town and Sakurai Village, which were located on the Nozawa Flatland, the paddy-to-farmland ratio was over 70%.

The parent material of the soil is unconsolidated sedimentary rock carried and deposited by the Chikuma River, forming a gray-brown, fertile paddy soil. As the data for the latter half of the 1920s shown in Figure 3 demonstrates, the average paddy yield for the communities on or around the Nozawa Flatland exceeds three koku (A koku is a unit of volume equal to 180 liters, equivalent to 150 kg of rice) per ten ares of land, which is an exceptionally high level. The natural conditions, namely an alluvial flat at the bottom of a basin housing fertile paddy soil, were the primary factors responsible for this high degree of land productivity.

Together with rice cultivation, sericulture was a major industry and occupation in the early modern history of the Saku Basin. Just as with other areas in central Japan, the 1880s marked the beginning of a boom in sericulture in the Saku Basin. As Figure 4 shows, by the 1930s sericulture was practiced in almost all of the towns and villages in the Saku Basin. What is particularly worthy of note here is that sericulture was just as widespread a practice in the paddy-dominated areas on the Nozawa Flatland as it was in the dry field-dominated areas. After the turn of the century we even see cases in which rice paddies were converted into mulberry fields, marking a significant step in the development in rice- and sericulture-based integrated farming.

Sakurai Village was situated on the left bank of the Chikuma River, and comprised four smaller communities: Kami-Sakurai ("Upper Sakurai"), Naka-
Sakurai (“Middle Sakurai”), Shimo-Sakurai (“Lower Sakurai”), and Kita-Sakurai (“North Sakurai”) (Figure 5). These communities had been separate villages under the feudal han (“domain”) system of the Edo period. Sakurai Village came into being through an administrative merger of these communities. At the time the administrative rezoning into towns and villages was instituted in 1889, the population of Sakurai Village was 1094 persons, with 225 households, making it extremely small for an administrative unit.

Land use in Sakurai Village had been dominated since the Edo period by rice cultivation in paddies. In 1875 the breakdown of cultivated land in Sakurai was about 111 hectares for rice paddies and about 16 hectares for dry fields. Figure 6 illustrates land use in 1890 around Naka-Sakurai and Kita-Sakurai. Overall, rice paddies are predominant, with dry fields and houses appearing to be only concentrated on slightly elevated spots that likely served as natural levees. Also worthy of mention is the extremely small ratio of undeveloped land, as shown in the figure, accounting for only about 30 ares. To augment deficiencies in resources that this distribution caused, in the Edo period the four settlements that would later make up Sakurai Village had secured the rights to gather firewood and grass/hay in the commonly held land with Maeyama Village, located to the south at the foot of the mountains (Figure 5). In 1895, however, this common land became the property of the government, and its use thereafter was regulated.

As for water used for agriculture, Kami-Sakurai chiefly used spring water, while Naka-Sakurai used water from the Chikuma River as well as spring water obtained within Nozawa Town. Shimo-Sakurai made use of water from the Katagai River, which flows to the east of the Sakurai Village, while Kita-Sakurai relied on a combination of the leftover water diverted from Kami-Sakurai and Naka-Sakurai as well as directly from the Chikuma River. Sakurai Village's plentiful sources of water were, in addition to rice cultivation, used for raising carp. As I shall outline in further detail below, carp cultivation in Sakurai Village was essentially an enterprise that took three years to establish, and involved raising carp in both rice paddies and separate ponds concurrently. Table 1 shows the breakdown of carp cultivation area into paddies and swamps/ponds for the chief towns and villages raising carp in the Saku Basin in 1926. Because Sakurai Village

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Table 1. Carp cultivation area for the main towns and villages raising carp in the Saku Basin (1926)

<table>
<thead>
<tr>
<th>Town/River</th>
<th>Swamps/Ponds (m²)</th>
<th>Paddies (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozawa Town</td>
<td>8,910</td>
<td>380</td>
</tr>
<tr>
<td>Sakurai Village</td>
<td>8,250</td>
<td>32</td>
</tr>
<tr>
<td>Nakagome Town</td>
<td>657</td>
<td>47</td>
</tr>
<tr>
<td>Hiraga Village</td>
<td>660</td>
<td>80</td>
</tr>
<tr>
<td>Maeyama Village</td>
<td>201</td>
<td>24</td>
</tr>
<tr>
<td>Kishino Village</td>
<td>3,135</td>
<td>31</td>
</tr>
</tbody>
</table>

Source: Tetsudou-shou Nagoya Tetsudou-kyoku (1928).
itself was a small place, the land area of the rice paddies used to raised carp is not that large, but the ponds used to raised carp, which were inextricably linked to paddy carp cultivation, accounted for the exceptionally large area of 8,250 m², second only to Nozawa Town’s total of 8,910 m². From these figures one can safely deduce that carp culture was quite popular in both Sakurai Village and Nozawa Town. Furthermore, Sakurai Village was home to merchants of carp fry and carp wholesalers, making the community a center of carp culture in the Saku Basin (Yasumuro 1998).

As of 1930, the average area of rice paddies cultivated by a single farming family in Sakurai Village was 54 ares, and the same average for dry fields was 11 ares, for a total of 65 ares. Compared to the national average at the time this was a very small scale. For these reasons, a concentrated style of farming with high levels of land productivity, which included rice farming and paddy carp culture, was essential for farmers in Sakurai Village. While paddies occupied the majority in Sakurai Village, sericulture was also highly popular, with 84% of farmers engaging in the latter in 1930.

In terms of land ownership, figures for 1929 in the Saku Basin indicate that 52% of the land was cultivated by tenant farmers. Sakurai Village exhibited a relatively high tenant farming rate of 57%, and the ratio of tenant farmed land in Nozawa Town reached the astonishing level of 82%. This means that the widely-acknowledged trend in early modern Japan of regions with high ratios of rice cultivation being characterized by high rates of tenant farming was also present in the Saku Basin.

Figure 6. Land use around Naka-Sakurai and Kita-Sakurai (1890)
Source: Old cadastre maps.
farming versus land ownership also applied to the Saku Basin. In relation to paddy carp cultivation, tenant rent for rice paddies were levied only against rice production, and not revenues from carp culture. In Nozawa Town and Sakurai Village, where most agricultural work was done by tenant farmers, it can be inferred that this system of tenancy rent was one factor behind the development of carp culture.

**Development of Rice-based Integrated Multiproduct Farming in Sakurai Village**

Although the chief industries in early modern Sakurai Village were rice, carp and silk farming, the relative importance of these occupations differed over time. Figure 7 shows changes over time in field area, rice paddy area, and mulberry field area in Sakurai Village. Figure 8 shows changes in cocoon yield and carp production volumes. As the figures show, the area of paddy fields from 1880 to 1930 was about 110 hectares showing little change over time. The cultivation area of rice paddies, however, saw a drop in the 1890s from about 110 hectares to roughly 80 hectares. This shift was caused by mulberry fields encroaching on paddy fields due to the rapid growth of sericulture in this period. Converting paddies to land for mulberry tree cultivation was highly unusual given the high rate of yield from rice paddies in Sakurai Village, but this attests to just how important sericulture had become to the economy at the time. There was later a slight recovery in the amount of land used for rice cultivation, but even by the 1930s it remained in the 90 to 100 hectares range. Therefore the area used for mulberry fields consistently exceeded that of dry fields from the 1890s on.

In terms of cocoon production volume, sericulture in Sakurai Village saw a rapid expansion from the period roughly between 1880 and 1918, but after that experienced fluctuating cycles, with peak production seen in 1930. One can conclude from this data that sericulture developed steadily until the 1910s, but subsequently proceeded to stagnate. Some of the reasons behind this decline were that there was a physical limit to the amount of land that could be allocated to mulberry fields due to the overall lack of land in Sakurai Village, and that after the 1920s the price of cocoons dropped off. The next industry to see prominent development would be carp culture.

It is difficult to determine the origins of carp culture in Sakurai Village, but there is evidence of it beginning in the Edo period, specifically in the 1780s. The practice of rearing carp in rice paddies appears to have begun in the 1840s, but only became widespread in the area after about 1880 (Minami-Saku-gun Noukai 1913). One of the reasons that carp culture was begun in the Saku Basin was that, due to Saku’s inland geographical location, seafood was extremely hard to come by, and carp was a way of augmenting the resulting lack of animal protein. As such, carp culture began initially as a subsistence-based activity, i.e. to be consumed by the same people who reared the carp. Carp culture, however, gradually went on to become a commodity-producing enterprise. Carp culture in the area developed as it did in part because from the 1880s the prefectures of Nagano and Gunma became major centers of sericulture and silk production in Japan, meaning that silkworm pupae, which could be fed to the fish, was available in large quantities at inexpensive prices in these areas. One can also point to the formation of the “Saku carp,” which is highly suited to aquaculture, from the crossbreeding of domestic carp with German carp imported to the Saku area in the first decade of the 20th century (Tansui-gyo kenkyuukai 1984).

As Figure 8 shows, rapid growth in the volume of carp production began in the 1920s. Production peaked around 1935. The development of the carp culture industry lags behind that of sericulture by about 20 years, and in fact
grew quite rapidly after the sericulture industry began to show signs of leveling off. From the graph it can be inferred that carp culture in Sakurai Village grew as it provided a new source of cash income to offset declining income caused by the stagnating silk market. Because existing rice paddies could be used, carp culture had sufficient potential for development as a business even in Sakurai Village, where there were formidable barriers to the development of new agricultural land. Another factor contributing to the development of carp culture after 1920 was that successful entries into the Tokyo market after the Great Kanto Earthquake of 1923 led to an expansion in sales routes for carp (Saku-shi-shi hensan iinkai 1996).

Table 2 illustrates monetary values from the production of the area’s major products for the years 1880, 1917, and 1934, and provides a more detailed perspective of how industry changed over time in Sakurai Village. In 1880, the product accounting for the highest production value was rice, at about 18,000 yen. Rice far outweighed all others, as second to rice were silk cocoons, which accounted approximately for a mere 4,000 yen. At this time silkworms were reared almost exclusively in the spring. Other sericulture-related products included raw silk and silkworm eggs, which together totaled about 2,000 yen. Another commodity was ginseng, while subsistence crops included barley, soybeans, Japanese millet, and potatoes. In sum, during this period in Sakurai Village’s history, rice was the most important crop, with sericulture practiced as a side business, while in dry

Table 2. Major products in Sakurai Village

<table>
<thead>
<tr>
<th>Major products (unit of volume/weight)</th>
<th>1880</th>
<th>1917</th>
<th>1934</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production volume</td>
<td>Production value (yen)</td>
<td>Production volume</td>
</tr>
<tr>
<td>Nonglutinous rice (koku)</td>
<td>1,315</td>
<td>15,780</td>
<td>2,140</td>
</tr>
<tr>
<td>Glutinous rice (koku)</td>
<td>186</td>
<td>2,269</td>
<td>216</td>
</tr>
<tr>
<td>Barley (koku)</td>
<td>143</td>
<td>950</td>
<td>—</td>
</tr>
<tr>
<td>Japanese millet (koku)</td>
<td>44</td>
<td>88</td>
<td>—</td>
</tr>
<tr>
<td>Soybeans (koku)</td>
<td>72</td>
<td>684</td>
<td>—</td>
</tr>
<tr>
<td>Potatoes (kan)</td>
<td>324</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Ginseng (kan)</td>
<td>240</td>
<td>1,125</td>
<td>—</td>
</tr>
<tr>
<td>Silk cocoons in spring (kan)</td>
<td>1,305</td>
<td>4,098</td>
<td>4,700</td>
</tr>
<tr>
<td>Silk cocoons in summer and autumn (kan)</td>
<td>—</td>
<td>—</td>
<td>4,740</td>
</tr>
<tr>
<td>Silkworm eggs</td>
<td>800 (sheet)</td>
<td>800</td>
<td>9</td>
</tr>
<tr>
<td>Raw silk (kan)</td>
<td>27</td>
<td>1,350</td>
<td>25</td>
</tr>
<tr>
<td>Floss silk (kan)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Carp (kan)</td>
<td>—</td>
<td>—</td>
<td>12,350</td>
</tr>
<tr>
<td>Pigs</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chicken eggs</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Source: Sakurai Village office documents.
fields barley, soybeans and other grains were grown for household consumption, with some households also producing silkworm eggs, manufacturing raw silk, and growing ginseng.

It is likely that some of the barley grown at this time was done so as an aftercrop for rice. The Saku Basin sees relatively little snow cover compared to other parts of Nagano Prefecture, so the cultivation of barley as an aftercrop was possible. Winters are nevertheless characterized by extremely cold temperatures, so the conditions were not ideal for growing barley in such a manner. For this reason, barley cultivation mostly ceased once carp culture developed. As Table 2 shows, the volume of barley production in 1934 was a small fraction of what it was in 1880, which is evidence for the decline of barley as an aftercrop.

By 1917 there had been changes to the ratios of these products in terms of monetary values. Silk cocoon production now accounted for more than 60,000 yen, an amount that by this time exceeded that of rice. This development can be attributed to a major expansion in output as well as an increase in prices. The growth in sericulture yields at this time was not due to an increase in farming households engaged in sericulture, but rather to the practice of rearing silkworms in summer and autumn (but mainly summer) in addition to the conventional practice of spring rearing. Another factor was the increase in cocoon yield per one sheet of egg-paper (one sheet of egg-paper holds about 10 grams of eggs) per household. Sericulture operations by this time, spurred on by the nationwide sericulture boom, had grown in scale, and income from cocoons had exceeded that from rice. Sericulture had become a major business. While carp at this time did account for about 8,000 yen, this figure was still relatively small compared to production values from rice and silk.

When we look at the production values for 1934, we see that cocoons accounted for just over 20,000 yen, in contrast to about 77,000 yen for rice, indicating that rice had once again gained its primary importance. Although a portion of this change can be attributed to higher volumes of output due to an increase in rice yield per unit area of land, most of this change is due to fluctuations in price. More specifically, silk cocoon prices fell much more dramatically than those of rice during the Showa Depression of the early 1930s. Cocoon production volume figures for Sakurai Village from 1917 and 1934 do not substantially vary, with both hovering above 9,000 kan (1 kan = 3.75 kg). However, because prices had plunged, the production values from 1934 had fallen to only about one third of what they were in 1917. Rice production volumes, on the other hand, had increased by about 30%, whereas the production value had grown by 80%. Ever since the rice riots of 1918, increases in the price of rice had been considerably large, and throughout the 1930s rice, when compared with other agricultural products, maintained consistently high prices. The increase the area of land devoted to rice from the 1920s on, seen in Figure 7, was a reflection of such price changes. As for sericulture, it is also worth noting that, compared with 1917, the production levels from the spring rearing fell in 1934, while those from summer and autumn rose.

Meanwhile, the production volume from carp culture had increased by a factor of about 3.5, worth approximately 35,000 yen, overtaking sericulture for that year and becoming second only to rice in terms of monetary value. Furthermore, as part of the Rural Economic Rehabilitation Plan implemented after the Showa Depression, people were encouraged to raise livestock, and by this time livestock had come to occupy a considerable economic position. Pig farming, for example, was now worth about 6,000 yen. During this period, rice farming and sericulture had become the staples of the area’s industry, but stagnating prices had caused the latter to lose much of its relative economic importance. The second place in economic relevance now belonged instead to carp culture, and with the addition of the practice of raising pigs and other livestock, farming had now become a highly integrated, multi-product enterprise.

The changes that occurred in industry in Sakurai Village can be summarized as follows: the last two decades of the 19th century were dominated by rice and sericulture (spring rearing), as were the first two decades of the 20th (but with summer as well as spring rearing), while the 1920s and 1930s were characterized by rice, sericulture (spring, summer and autumn) and carp culture, plus an extra component (pig farming, etc.). The 1920s and 1930s are particularly worthy of attention because they were characterized by a style of integrated farming that made efficient use of land resources and agricultural byproducts. The integrated multiproduct farming practiced during this period came into being as a result of the increasingly unreliable or poor performance of sericulture, active attempts by farmers to find new side businesses, and government policies, namely the above-mentioned economic policies implemented. In this sense, it grew out of a series of desperate measures. Yet when examined in light of today’s ideas about the efficient use of land resources and agricultural byproducts, this integrated
style of farming is deserving of greater recognition. These aspects are examined in detail below by way of a case study of an actual farm in Sakurai Village.

Rice-based Integrated Multiproduct Farming
Style through the Example of a Farming Family from the 1920s to the 1930s

In the previous chapter I laid out the changing forms of the rice-based multiproduct farming in Sakurai Village, but I did not go into the specifics of the ways in which rice culture, sericulture, carp culture, and pig farming related to one another, nor how these combinations affected the finances of farms. In this section I examine precisely these matters from the 1920s to the 1930s, using the data of an example farming family, which I shall call “Family U”, which resided in Naka-Sakurai. The reasons why I take up Family U and their farm are that there are detailed agricultural records extant from the relevant period and that this farming family practiced the kind of rice-based integrated multiproduct farming typical in Sakurai Village.

During the Edo period, heads of Family U served in official capacities as village heads, and they owned more land in Naka-Sakurai than any other in the 18th century. In the 19th century, however, they lost much of their land, and around the beginning of the 20th century, they had become tenant farmers. According to accounts passed down to current members of the family, their fortunes were reversed at the end of the 19th century due to a major debt involving the ginseng trade.

Details of the farming style practiced by Family U become clear only from the year 1922 onwards. Not much is precisely known for years preceding that. What is known is that after about 1900, the family worked roughly 1.1 to 1.2 hectares of farmland, that they practiced sericulture—mainly spring rearing—to a certain degree, and that they grew barley as an aftercrop to rice. Due to these limitations in the available data, the present study will deal chiefly with the farming operations of Family U after 1922. As outlined above, this timeframe coincides with the period when a style of integrated farming that included rice, sericulture (spring, summer and autumn), carp culture, and the raising of livestock were spreading. The example of Family U therefore presents us with a snapshot, so to speak, for the study and elucidation of integrated farming during this period. The labor that went into farming by Family U for the period examined was supplied exclusively by immediate family members, and while there are periodic variations due to family lifecycles, the average labor available comprised about four persons, consisting of parents and their children.

The data shown in Figure 9 graphs breakdowns of paddy and dry field areas as well as silk cocoon yields for farming families in Naka-Sakurai in 1932. Note that the dataset drawn upon is made up of only 23 of the 40 farming households in Naka-Sakurai, which, like Family U, belonged to the local farmers’ organization. Unfortunately, the dataset is limited by this participation. But this is useful for ascertaining just how the integrated style of farming practiced by Family U developed together with other individual farming households in Naka-Sakurai, and what position they occupied in relation to these other households.

As is evident from the figure, the lowest figure included in this data for paddy and dry field areas for individual farming families in 1932 is about 40 ares. It is reasonable to conclude that, given the high degree of land productivity and the popularity of sericulture in Sakurai Village at the time, 40 ares of farmland was considered the minimum in terms of scale for farm operations. On the other side of the spectrum, an area of about 1.2 hectares forms the upper boundary of the data. For contemporary Naka-Sakurai, one can infer that plots of land totaling 1.2 hectares formed the upper limit for farmland that a single family could work. As Family U’s farmland was about one hectare in area, they were among the top few in terms of farm scale within Naka-Sakurai.

From the available data, 21 of the 23 practiced sericulture. The cocoon yields varied widely per household, but averaged about 40 kan per household. Family U’s foray into sericulture was limited to summer and autumn rearing, resulting in a cocoon yield of 20 kan. It is clear from this data that the scale of Family U’s sericulture operations around 1930 were about half of the average for the Naka-Sakurai community at the time. In addition to the fact that Family U was operating one of the largest farming operations in the community at the time, there are also other important factors that must be taken note of, which are summarized in the analysis below.

Although we do not have data clarifying the extent to which particular farming families engaged in carp culture and to what degree, we know that in Sakurai Village in 1929 there were 189 households running rice paddies, and in 1930 there were likewise 189 farming households engaged in carp culture (Yasumuro 1998). Based on this, it is fairly safe to assume that in both Sakurai Village and the community of Naka-Sakurai within it, nearly all rice farmers also practiced carp culture to some degree or
An examination of changes in the farming areas of Family U from 1922 to 1948 reveals that by 1925, they operated about one hectare of rice paddy and 30 ares of dry fields. It appears that after 1925 their lands decreased, and in 1936 had shrunk to the 90-are level. In 1942 that figure increased to about 1.1 hectares, but in 1946 once again declined to an area encompassing roughly 90 ares. In sum, the rice and dry-field farming operations of Family U, in terms of land area, basically shrank from the latter half of the 1920s into the 1930s.

Figure 10 shows the distribution of paddies and dry fields farmed by Family U. Figure 11 illustrates the presence or absence of paddies and dry fields operated by the household as well as how they were used. All of the paddies farmed by Family U were spread across eight locations between the settlement of Naka-Sakurai and the Chikuma River. The most important paddies for the family were the lots located closest to their residence (about 200 meters) at Sawada and Matsubaramen, where they had dedicated rice nursery plots. Likewise, the most productive plots for Family U were Sawada, Matsubaramen and a lot in an area called Sugeta. These were also the main areas for carp culture for Family U.

Next I shall address methods of rearing carp in rice paddies. Figure 12 presents the basic principles for carp culture as practiced in Sakurai Village around 1930. In carp culture, carp fry (koiko) were released into paddies from the end of May to the end of June. Around the end of September they were extracted from the paddies and placed in special ponds for the duration of winter. The one-year-old carp were referred to as touzai. In Sakurai Village it was common at the time to have at least one pond on residential grounds for rearing carp, but due to the vulnerability of carp in their touzai phase to cold, it was necessary to place them in ponds in Kami-Sakurai, where natural springs kept water temperatures warm even in winter (Yasumuro 1998). The following year, touzai carp were again released into rice paddies together with carp fry, and in the autumn of that year they would be collected and transferred to the ponds of the responsible farmers. These two-year-old carp are termed chuppa. Chuppa were again transferred to the relevant farmers’ ponds, after which they were sold when deemed mature. When sold, the three-year-old carp were called kirigoi. The smaller of the chuppa were released into paddies and then sold when judged to be fit for sale.

Carp culture in Sakurai Village was distinct in this respect in that it was characterized by meticulous transfers from paddy to pond, in addition to the fact that under...
Figure 10. Distribution of paddy fields and dry fields farmed by Family U

The precise location of the dry field of Hattanda has yet to be identified.
Source: Old cadastre maps, Agricultural records of Family U.

Figure 11. Changes in paddy fields and dry fields farmed by Family U

Source: Agricultural records of Family U.
normal circumstances carp were cultivated for three years. Furthermore, carp released into paddies were only immature koiko and touzai, along with a small number of undersized chuppa. In addition to rice paddies, carp were also cultured year-round in dedicated ponds. Silkworm pupae formed a near-ideal feed for the carp. Silk pupae for carp feed were purchased cheaply from silk mills.

One important factor when raising carp in paddies is that water is readily available. In addition, it is also critical that the paddies were close to the farmhouse, because they needed to control water at short intervals and transport carp to the residential ponds. It was chiefly the proximity to their residence that led Family U to choose Matsubaramen and Sawada as areas to cultivate carp, mainly those of the touzai maturation phase and above. The paddies in Hattanda, Sugeta and other areas, which were relatively distant from the family residence, were mainly utilized by the family to rear fry, the transport and water management of which were relatively simple.

One may presume from the example of Family U that in Naka-Sakurai, paddies close to the community were mainly used for rearing touzai and chuppa, while locales more distant from the community were used mainly for the cultivation of carp fry.

Figure 13 illustrates the changes over time in carp culture in relation to both paddies and ponds. The figures presented in the graph represent the numbers of touzai and chuppa released in the months of May and June. Data from year 1922 onwards has been presented in graph form, but it is evident that at least to a certain degree carp culture was practiced for the years 1920 and 1921. However, the number of carp cultured remains unclear, and judging from the statements in the available historical materials it appears that number was minimal. Based on this evidence, it is reasonable to conclude that Family U began carp culture in earnest from the year 1922. The peaks from the data for the numbers of carp released to paddies are seen at 1923, 1929, and 1940, after which an overall decline is observed. As for the number of carp released to ponds, there is an increase peaking at 1930, after which we see a noticeable decline. From these changes in the number of fish released to paddies and ponds respectively, we can infer that the height of carp culture for Family U was around 1930. One other remarkable characteristic in the change in cultivated carp numbers over time for Family U is the sharp decline seen after 1933.

Dry fields cultivated by Family U, just as paddy fields, were distributed over different areas. Worthy of note is
the fact that some fields were close to cultivated paddies, as exemplified by Sawada, and that other fields belonged to the district of Maeyama Village. The fact that some dry fields were adjacent to these paddies meant that in Sakurai Village, which was lacking in available dry fields, what little sloped land that was available around these rice paddies was put to use in growing mulberry trees. Existence of fields within Maeyama Village meant that Sakurai farmers secured mulberry fields crossing over the village boundaries. From 1922, the only part of Family U’s paddy fields used for mulberry production was in Hattanda, but in the first decade of the 20th century, a part of the land in Matsubaramen had been used for the same purpose.

Regarding Family U’s sericulture activities, they used two or three egg-sheets per rearing, with a cocoon yield ranging from 20 to 30 kan. In terms of seasons, in the 1890s and 1900s they harvested cocoons only in the spring, but beginning in the 1920s they gradually shifted to summer and autumn harvests. In 1922 they harvested cocoons in the spring but ceased doing so in successive years. The reason for this change relates to the growth of carp culture. Specifically, the May and June work required in carp culture coincided with a season that would otherwise be occupied with work involving the spring rearing of silkworms. Furthermore, in Nagano Prefecture, spring sericulture work traditionally tended to coincide with work involving rice cultivation, the work of which saw its peak concentration in June. Because of this trend, the summer rearing of silkworms spread as a practice in Nagano Prefecture more quickly and to a greater extent compared to other silk-producing prefectures. That said, it was still possible to carry out both rice cultivation and the spring silk cocoon harvest, and indeed until 1922 Family U employed a combination of rice cultivation and spring sericulture. However, with the growth of carp culture, it became difficult to maintain all three industries with any degree of competitiveness during the month of June, so the spring rearing of silkworms was abandoned. After 1923, the style of farming that combined rice and spring sericulture seems to have been replaced by one that combined rice, summer and autumn sericulture, and carp culture.

As yet another side business, in the 1930s Family U began raising pigs. Pig farming in this family took the form of purchasing one-month-old piglets, feeding them for about seven months and then selling them. An average of two to three pigs were raised and sold per year. Rice bran that was either produced at their own farm and/or purchased was used for feed, and the manure was used to fertilize fields and paddies. As of 1934, 66 households, or about one-third of all farmers in Sakurai Village, were raising pigs. Of those, 49 farming households were raising one pig, while 17 households were raising two or more. In that sense, Family U was a relatively aggressive investor in pig farming for Sakurai Village.

In this type of multiproduct farming practiced by Family U, which integrated rice cultivation, sericulture, carp culture and pig farming, various elements were organically linked with each other. With carp culture, for instance, the carp stocked in paddies supplied both oxygen and warmth by swimming through the water and helped to break down fertilizers. Furthermore, uneaten feed for the carp, in addition to carp feces, worked as fertilizers in rice paddies. As a result, these served to increase yields as well as conserve on fertilizers that would otherwise be needed. The carp also ate troublesome weeds, which conserved the amount of labor needed to work the paddies. Sericulture was linked to carp culture in that after silk cocoons were shipped to silk mills, the dead silkworm pupae leftover from the reeling process made for an ideal feed for carp raised by individual farming families. Rice bran from the milling process became food for pigs, and the manure from pigs was an excellent organic fertilizer for paddies and fields. Put simply, this integrated combination of rice cultivation, carp culture, sericulture, and pig farming in the early 1930s proved to be a very rational style of farming in terms of effective land use and the recycling of agricultural byproducts (Figure 14).

In examining this style of farming one is reminded of the “linked” agriculture advocated by Misawa (1941). Misawa’s study dealt with the integrated industries of freeze-dried tofu, pig farming and sericulture practiced in the Suwa area in Nagano Prefecture, in which the remainders from the bean curd pressing process were fed to pigs, and pig manure was used in turn for fertilizer in sericulture. In each endeavor, Misawa points out, the byproducts from one are efficiently used for another in a virtually waste-free cycle. The integrated system of farming practiced by Family U at the time can indeed be seen as a kind of farming that links resources from several agricultural products and resources.

Next we should examine Family U’s variety of farming from a business performance standpoint. In this respect, inherent constraints in the available data compel us to examine expenses and revenues as of 1933. In terms of monetary value from agricultural products, rice accounted for the largest percentage by far: in 1933 Family U produced 33.43 koku (5,015 kg) of rice, which...
was equivalent to 714 yen in cash. This level of production value was a result of farming the relatively large 98 ares of rice paddies, aided by the extremely high degree of land productivity at the time. Ten ares of land produced an average yield of 3.4 koku (510 kg) of rice, well exceeding the three koku (450 kg) per ten ares average for all of Sakurai Village. The high level of productivity from rice paddies for Family U owed much to their plentiful use of soybean waste, ammonium sulfate and other purchased fertilizers, but in this author’s opinion one cannot ignore the beneficial effects from paddy carp culture. In the case of Family U, because they were tenant farmers they were obligated to deliver half of their rice crop, or 16.7 koku (2,505 kg), as tenant rent. In addition, they allocated 12.51 koku (1,877 kg) of that rice for household consumption. This left them with a trifling 4.22 koku (633 kg) of rice to sell.

Table 3 shows the breakdown of Family U’s income in 1933 from agricultural products, including the saleable rice mentioned above. The revenue from the sale of rice amounted to about 90 yen. While this outweighed any one other individual item, it constituted only one-quarter of total agricultural sales. Looking at Family U’s expenses, it becomes clear that tenant rent was a substantial burden. What augmented their income and made that burden less painful was revenue from the sale of silk cocoons, pigs and carp. Cocoons and pigs together make up 23% to 24% of total revenue, which is about on par with rice. In this particular year three adult pigs and two piglets were sold, so there is no basis for concluding that this level of income was sustained continually, but it does attest to the important role that pig farming played as a secondary or tertiary source of income at this particular point in time.

Income from carp takes up a mere 12% of the total, but as we have seen above, Family U had by 1933 seen a large decrease in their level of aquaculture production. One can extrapolate that they were getting two to three times as much from carp culture around 1930 at its height. Incidentally, tenant rents were not levied against carp. Even though the land used to raise them was borrowed, profits from carp culture went entirely to the producer. In short, Family U cultivated about one hectare of rice paddy at the time, but since all of this land was farmed on a tenant basis, they augmented their income from rice with silk cocoons, carp and pigs.

Conversely, agricultural expenses are shown in Table 4. Agriculture-related expenses for 1933 add up to 207 yen. The largest single expense is fertilizer at 76 yen. This money was for soybean waste, ammonium sulfate and other chemical fertilizers that were purchased, which is evidence that the use of purchased fertilizers amounted...
to a significant proportion of expenses. Other major expenses were 50 yen for feed, which included silkworm pupae for carp and rice bran for pigs, as well as 55 yen for livestock itself. What deserves notice here is the 30 yen spent for cattle and the 10 yen spent for a barn included in livestock costs. Family U decided to buy a head of cattle for farming purposes, which was an extraordinary expense for this year. In examining the revenues and expenses for agriculture—and this point deserves particular emphasis—what is most significant is that for 1933 the income of Family U significantly exceeded its expenses. A simple calculation of revenues subtracted by costs gives us a profit of 156 yen. From this it is clear that Family U managed their business in a manner that turned significant profits, despite operating during the Showa Depression and despite being tenant farmers. It is fairly safe to say that the secret lay in having several side businesses. Through multiproduct farming integrating rice, silkworms, carp and pigs, they not only used land resources and byproducts available to them efficiently, they also managed to increase incomes.

### Conclusion

From the 1920s to the 1930s in the Saku Basin in Nagano Prefecture, a style of rice-based, integrated multiproduct farming was practiced that incorporated rice cultivation, sericulture, carp culture, and the rearing of pigs. This was first a form of polyculture in the sense that it used the same plots of land for multiple purposes. Specifically, in addition to the cultivation of rice, carp were stocked in the paddies, which guaranteed an advanced and highly intensive manner of land use. There were synergistic effects as well: Stacking carp in paddies was beneficial to the growth of the rice plants (the carp supplied both oxygen and warmth by swimming through the water, carp feces and uneaten feed worked as fertilizers), raised the rice yield of the land, and reduced the amount of labor needed to work the fields because carp ate troublesome weeds.

Furthermore, as seen in Figure 14, there was the recycling system of readily available resources: silkworm pupae, leftover from silk mills after threads were extracted, were ideal as feed for the carp, which meant that a byproduct from a community and cottage industry could be put to use with virtually no waste. Pigs that were raised fed on the bran from cultivated rice, and the waste from these pigs was in turn used to fertilize mulberry fields grown for silkworms as well as rice paddies. In this manner, the style of farming practiced in Sakurai Village in the Saku basin facilitated the concentrated, efficient and effective use of the resources available, both in terms of land and agricultural byproducts. It deserves recognition even (or perhaps especially) today in that it was a form of agriculture rooted in the recycling of resources. It also contributed to higher levels of income for farmers of that era.

Rice-carp culture in the Saku Basin is no longer practiced due to the chemical fertilizers and pesticides that have been used in rice paddies since the 1950s. Modern rice-carp culture, however, is beginning to gain renewed recognition as one method of organic rice farming that does not rely on pesticides and such, and recently there have even been attempts to revive the practice in the Saku Basin (Sato 2007). Rice-duck farming is attracting attention in present-day Japan as a method of organic rice farming, and in this sense rice-duck and rice-carp farming methods share at least one aspect in common.

When one looks abroad, in the regions of the southern China and the Southeast Asia where the natural environments are similar to Japan and analogous agricultural traditions have been shaped, there are many examples of integrated farming that combine agriculture with aquaculture. In the Pearl River Delta in the south of China, for example, using what is traditionally called a dike-pond system, mulberries, sugarcane, or fruit is grown on elevated ridges (dikes) and fish are raised in the ponds. The byproducts from these crops are used to feed the fish, and the mud from the fishponds helps fortify the soil on which the crops are grown, embodying a resource-recycling agricultural system (Ruddle and Zhong 1988). Unfortunately, this scheme is gradually dying off in China. Meanwhile, though, in Vietnam's Mekong Delta there is another integrated agricultural system, known as VAC or VACR, that has been steadily attracting interest since the latter half of the 1990s. VAC is an acronym for

<table>
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<th>Table 4. Family U’s agricultural expenses (1933)</th>
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<tr>
<td><strong>Expenses (yen)</strong></td>
</tr>
<tr>
<td>Agricultural implements</td>
</tr>
<tr>
<td>Seeds and seedlings</td>
</tr>
<tr>
<td>Fertilizer</td>
</tr>
<tr>
<td>Feed</td>
</tr>
<tr>
<td>Expenses for labor</td>
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<tr>
<td>Livestock</td>
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<tr>
<td><strong>Total</strong></td>
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Source: Agricultural records of Family U.
vuon ("garden"), ao ("pond"), and chuong ("livestock stable"), and denotes the integrated cultivation of fruit, fish and livestock. The acronym VACR indicates the addition of rice (R) to this combination. In this system of integrated farming, byproducts from each crop are reused as a resource for one or more other crops in the system, making it highly attractive as a recycle-based integrated farming technique in addition to providing greater income for the farming households (Yasunobu et al. 2000, Ohira et al. 2005). Other studies exist that focus on the benefits in terms of environmental preservation or the high degree of land productivity of rice-fish systems in the Mekong Delta (Rothuis et al. 1998, Berg 2002).

One major issue that is beyond the scope of the current paper but deserves further inquiry is the comparison of other examples in Asia with the present one, and the identification of similarities and differences.

Notes

1. Yasumuro (1998) has recently conducted an in-depth survey from a folklore perspective on rice-carp culture in Sakurai Village. There is also a work by Yamashita et al. (1960) dealing with rice-carp culture, land ownership, and community structures in Nozawa Town in the 1950s. Concerning the present study, I am greatly indebted to both authors for their insights into the realities of rice-carp culture in and around Sakurai Village.

2. The 1932 Rural Economic Rehabilitation Plan for Sakurai Village lays out the following numerical targets for the raising of livestock. Horses: current levels; cattle: one-third of farmers, or 63; pigs: one for each farming household (two for those households that rear neither cattle nor horses), or 250. Chickens: 10 for each farming household. Rabbits: two for each farming household, or 400. The records for livestock in Sakurai Village for 1934 give the following: eight horses, 16 heads of cattle, 189 pigs, 1035 chickens, and 442 rabbits (data from the Sakurai Village office documents).

3. These points were stressed as benefits of rice-carp culture in contemporary literature (Minami-Saku-gun Noukai 1913, Tetsudou-shou Nagoya Tetsudou-kyoku 1928, Nagano-ken Noushou-ka 1930). The hypothesis that rice paddies stocking carp have a higher yield than those with no carp was verified in experiments done by the Nozawa Town Noukai ("Agricultural Association") in 1923 (Yasumuro 1998).

4. The heavy use of commercially purchased fertilizers is verified in experiments done by the Nozawa Town Noukai ("Agricultural Association") in 1923 (Yasumuro 1998).

5. Tenancy rent applied to dry field crops as well as rice, which they also paid for in rice. Of a total of 16.7 koku (2,505 kg) in rent, 14.85 koku (2,228 kg) was for rice paddies and 1.85 koku (228 kg) was for dry fields.

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(J): written in Japanese

(E): written in Japanese with English abstract